Changes in Employment Localization and Accessibility: the Case of Switzerland between 1939 and 2008

THÈSE N^{O} 5011 (2011)

PRÉSENTÉE LE 6 MAI 2011

À LA FACULTÉ ENVIRONNEMENT NATUREL, ARCHITECTURAL ET CONSTRUIT
COMMUNAUTÉ D'ÉTUDES POUR L'AMÉNAGEMENT DU TERRITOIRE
PROGRAMME DOCTORAL EN ARCHITECTURE ET SCIENCES DE LA VILLE

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

POUR L'OBTENTION DU GRADE DE DOCTEUR ÈS SCIENCES

PAR

Pierre-Emmanuel DESSEMONTET

acceptée sur proposition du jury:

Prof. V. Kaufmann, président du jury
Prof. M. Schuler, directeur de thèse
Prof. K. W. Axhausen, rapporteur
Prof. A. S. Fotheringham, rapporteur
Prof. F. Golay, rapporteur

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Suisse
2011

Abstract

Until about the end of WWII, the territorial organization of the economy could be expressed along a very strong center-periphery gradient, with industries and services concentrated in cities while the countryside supplied agricultural products. Since the industrial revolution, industrial regions had emerged essentially in mining regions which perturbed this very simple scheme, but without fundamentally modifying it. In the first half of the 20th century, with the advent of mass transportation and of the individual car, the residential functions started to deconcentrate and residential suburbs developed. However, as a general rule, most non-agricultural economic functions remained tightly attached to the city core and its immediate surroundings, and with them their jobs. These structures were accounted for by various theoretical models, of which the Von Thunen land-rent model family, the Weber models of industrial localization and regional specialization, and the Christaller model of hierarchical city networks were the most prominent.

However, since 1945, those jobs have seen their territorial distribution shift. First, the importance of agriculture dwindled, to the profit first of industrial activities, then of services. Land-hungry activities, such as the industry and logistical activities vacated the urban centers in search for ample space, which they generally found in suburban settings under the guise of industrial zones. But they weren't alone at deconcentrating. Retail and personal services tended to follow their customers in the suburbs. During the last quarter of the 20th century, selected suburbs evolved from purely residential or industrial functions to more complete economic ones, integrating retail, high tech and professional services. By 1990, the phenomenon was largely recognized in North America, where those job-intensive suburbs were nicknamed edge cities. Empirical studies showed convincingly that the same patterns of job and functional deconcentration were found in the whole world and especially in western countries.

Job suburbanization is contemporary with major spatial and functional economical upheavals. The economy, for instance, evolved from the fordist integrated economical model dominated by very large companies internalizing most of their functions in a vertical, hierarchical relationship pattern to a post-fordist disintegrated model where companies concentrate on their core competencies and subcontract in a horizontal, contractual manner their non-core needs. Economical spatial deconcentration is also contemporary with the current version of globalization, materialized by the emergence of global cities and metropolises which keep constant communication flow between themselves, in a horizontal manner, and which are less and less dependent on their hinterland for their economical survival and development. Likewise, the economy becomes more and more informational, relying on knowledge, immaterial services, instant worldwide communication, and the production of sophisticated products for which worldwide shipping costs became negligible, and for which the location needs shifted from access to markets to access to qualified workers.

While globalization, metropolization and the post-fordist economical transition have been thoroughly studied, job suburbanization has not been the focus of such an interest from the scientific community. Consequently, we lack empirical evidence and theoretical advances which would help us to better understand how the economy spatially evolved since 1945 and where the world is heading if the trends seen since 1945 are maintained. The prime goal of this work is to provide a better understanding of the way the economy spatially evolved at the intra-metropolitan scale, based on the example of Switzerland, a fairly exemplary western country.

The work is divided in three major parts – an introductory one, an empirical one, and a inferential one. The core hypothesis of this work is that as the individual car became ubiquitous, proximal relations were progressively supplanted by accessibility relations. We surmise that job distributions and their evolution can be explained by accessibility patterns and change, which are in turn dependent on a number of factors – the population distribution, the structure and state of the road network, the state of the car technology, and the time commuters are ready to travel to go to work.

The first three chapters aim at defining our object of study in chapter 1, to give an understanding of the country on which we will be working and of the data at our disposal in chapter 2, and a working definition of what constitutes a job center in chapter 3, where major distinctions between urban, mixed, suburban, exurban, touristic centers and edgeless space are introduced which accompanies us for the rest of the work. The next four chapters constitute the empirical part of the work. Chapter 4 seeks at describing as precisely as possible the territorial evolution of the Swiss economy since WWII, studying it at nine different points in time from 1939 to 2008. Chapter 5 takes a long-term view of the same series of data and seeks to detect, describe and explain the trends which are unearthed by this larger view. Chapter 6 concentrates on the latter half of the period under review and studies the distributions along more precise branch divisions, as well as miscellaneous other classifications according to added value and productivity, interaction needs, job qualification and creativity. Chapter 7 concentrates on the command and control structure of the economy as seen through the spatial relations entertained by headquarters and their subsidiaries, by Swiss and foreign multinationals, by the public and private sector.

Finally, chapters 8 and 9 undertake the inferential part of our work, and aim at testing our core hypothesis of a statistically demonstrable link between accessibility, which is defined and thoroughly studied in its historical dimension in chapter 8, and a measure of job quality. Chapter 9, the last of the work, takes this core hypothesis to the statistical test.

The results of this work are multiple. First of all, it shows that the spatial structure of the economy indeed transitioned from a very strong center-periphery organization in 1939, when two thirds of all non-agricultural jobs were located in urban centers, about a quarter in the countryside and the rest in numerous small industrial villages, to a vastly different structure in 2008 with less than half such jobs located in urban centers while suburban centers capitalize about a quarter of them, the rest being distributed mainly in edgeless space – industrial villages having somewhat lost in importance.

This work shows that the spatial components of the economical structure have also greatly evolved. While in 1939 urban centers concentrated most of the economic functions and all of the commanding ones, spatial specialization has been relentless since then, and especially since the last quarter of the 20th century. Suburban centers have grown, but also gained in quality, especially in the high tech and the professional services sectors, and in commanding functions: as of 2008, they hosted more jobs in headquarters than in subsidiaries. In parallel, cities have tended to specialize on some key sectors of the economy: finance and governmental services at large, accompanied by personal services catering for the new urban elite. Taken altogether those developments pick at the prevailing spatial economic theories and show a major departure from the Christallerian model.

Anecdotal evidence shows that by and large suburban centers seem not located haphazardly in the larger suburban belt, but are concentrated on several specific point within it, namely the higher accessibility areas, especially highway junctions and interchanges. This hints at the possibility that high accessibility is a determinant of job localization. In the course of this work we demonstrated first that accessibility is more dependent on road network changes that to other parameters such as population distribution, technological changes and attitude changes towards commuting, and that the accessibility changes due to road network evolutions display far stronger local accessibility gradients. Secondly, we demonstrated the existence of a link between accessibility and job density taken as a measure of job quality, after taking into account the effects of spatial autocorrelation. Much of the unexplained variance shown by a global regression model can be modeled away as regional effects when using a geographically weighted regression, so that the combination of regional effects and accessibility accounts for a major part of the job density variance. Finally, the introduction of time lags between accessibility conditions and job densities hinted at the possibility that a causal link exists between the two, accessibility changes preceding, and maybe then causing, job density changes: in short, this work shows that accessibility by car is a major determinant of job localization.

Keywords: urban geography, economic geography, regional geography, suburbanization, edge cities, edgeless, metropolization, global cities, globalization, accessibility, spatial analysis, spatial autocorrelation, modified t-test, geographically weighted regression, GWR, business census, Switzerland

Résumé

Jusqu'à la fin de la seconde guerre mondiale, l'organisation territorial de l'économie pouvait être décrite selon un très fort gradient centre-périphérie, les industries et les services étant concentrés dans les villes et la campagne fournissant les produits agricoles. Depuis la révolution industrielle, des régions industrielles ont émergé notamment dans les régions minières, qui se surimposèrent sur ce schéma très simple, sans toutefois le modifier fondamentalement. Dans la première moitié du XXème siècle, avec l'avènement des transports de masse et de la voiture individuelle, les fonctions résidentielles commencèrent à se déconcentrer et les banlieues résidentielles se développèrent. Toutefois, en règle générale, la plupart des fonctions économiques non-agricoles demeurèrent étroitement attachées au centre ville et à ses abords immédiats, et avec elles leurs emplois. Des modèles théoriques variés rendaient compte de ces structures, dont les plus fameux sont la famille des modèles de rente foncière à la suite de Von Thunen, la famille de modèles de localisation industrielle et de spécialisation régionale de Weber, et le modèle des lieux centraux de Christaller.

Toutefois, depuis 1945, ces emplois ont vu leur répartition territoriale changer. Premièrement, l'importance de l'agriculture se réduisit au profit d'abord des activités industrielles, puis des activités de services. Les activités nécessitant de grands espaces, parmi lesquelles l'industrie et la logistique, quittèrent les centres urbains en quête d'espace qu'elles trouvèrent généralement en banlieue, sous la forme de zones industrielles. Mais elles n'étaient pas seules à se déconcentrer. Le commerce de détail et les services personnels tendirent à suivre leurs clients en banlieue. Durant le dernier quart du XXème siècle, certaines banlieues évoluèrent d'une fonction purement résidentielle ou industrielle vers des formes économiques plus complètes, intégrant le commerce, les hautes technologies et les services aux entreprises. Vers 1990, ce phénomène était largement identifié en Amérique du Nord, où ces centres d'emploi de banlieue avaient été nommés « edge cities ». Des études empiriques montraient de manière convaincante que ces phénomènes de déconcentration fonctionnelle et d'emploi se produisaient globalement, et particulièrement dans les pays occidentaux.

La suburbanisation de l'emploi est contemporaine de bouleversements économiques spatiaux et fonctionnels majeurs. L'économie, par exemple, évolua d'une forme dite fordiste dominée par de grands conglomérats internalisant l'ensemble de leurs besoins spécifiques par des relations verticales et hiérarchiques, vers un modèle désintégré, dit post-fordiste, où les compagnies se concentrent sur leur cœur de métier et sous-traitent leurs autres besoins de manière horizontale et contractuelle. La déconcentration spatiale de l'économie est également contemporaine de la version actuelle de la globalisation, matérialisée par l'émergence de villes globales et de métropoles en contact permanent entre elles, de manière horizontale, et qui sont de moins en moins dépendantes de leur arrière-pays pour leur survie et leur développement économique. De même, l'économie devient de plus en plus basée sur l'information et la connaissance, dépendante de services immatériels, de communications globales instantanées, et la production de biens sophistiqués pour lesquels les coûts de transport deviennent négligeables et pour laquelle les critères de localisation glissèrent de l'accès aux marchés à l'accès aux travailleurs qualifiés.

Alors que la globalisation, la métropolisation et la transition économique vers le post-fordisme ont été étudiées en détail, la suburbanisation de l'emploi n'a pas suscité de telles études détaillées de la part de la communauté scientifique. Par conséquent, nous manquons d'études empiriques et d'avancées théoriques qui nous aideraient à mieux comprendre comment l'économie a

évolué spatialement depuis 1945 et dans quelle direction le monde se dirige si les tendances actuelles se maintiennent. Le but premier de ce travail est de contribuer à une meilleure compréhension de la manière dont l'économie évolue spatialement à l'échelle intra-métropolitaine, à l'exemple de la Suisse, un bon exemple de pays occidental.

Le travail est divisé en trois parties majeures – une partie introductive, une partie empirique et une partie analytique. L'hypothèse fondamentale de ce travail est qu'à mesure que la voiture individuelle se répandit, les relations de proximité ont été progressivement supplantées par des relations basées sur l'accessibilité. Nous posons l'hypothèse que la répartition de l'emploi et son évolution peuvent être expliqués par la répartition de l'accessibilité et son évolution, qui dépendent à leur tour de divers facteurs – la répartition de la population, la structure et l'état du réseau routier, le niveau technologique des véhicules, et l'attitude des pendulaires en regard du temps passé à se rendre à leur travail.

Les trois premiers chapitres ont pour but de définir notre objet d'étude dans le chapitre 1, de donner une description du terrain d'étude et des données à disposition dans le chapitre 2, et de mettre en place une définition opérationnelle de ce qui constitue un centre d'emploi dans le chapitre 3, où une distinction majeure est introduite entre centres d'emploi urbains, mixtes, suburbains, exurbains et touristiques, et de l'espace informé, distinction qui accompagne l'ensemble de ce travail. Les quatre chapitres suivants constituent la partie empirique du travail. Le chapitre 4 cherche à décrire le plus précisément possible l'évolution territoriale de l'économie suisse depuis la seconde guerre mondiale, en l'étudiant sur neuf périodes distinctes de 1939 à 2008. Le chapitre 5 reconsidère la même série de données d'un point de vue axé sur le long terme et cherche à déceler, décrire et expliquer les tendances mises à jour par ce point de vue plus large. Le chapitre 6 se concentre sur la seconde moitié de la période d'étude et étudie la répartition territoriale de l'économie selon une classification structurelle plus fine, ainsi qu'en regard de quelques autres classifications économiques discriminant selon la valeur ajoutée et la productivité, le besoin d'interaction et de contact, la qualification et la créativité des emplois. Le chapitre 7 se concentre sur les structures de commandement et de contrôle de l'économie du point de vue des relations spatiales entretenues par les sièges d'entreprise et leurs succursales, par les multinationales suisses et étrangères, par les secteurs public et privé. Les chapitres 8 et 9, enfin, constituent la part analytique de notre travail, et ont pour but le test de notre hypothèse fondamentale de l'existence d'un lien statistiquement démontrable entre accessibilité, qui est définie et étudiée en détail dans sa dimension historique au chapitre 8, et une mesure de qualité de l'emploi. Le chapitre 9, qui clôt l'étude, teste statistiquement notre hypothèse fondamentale.

Les résultats de ce travail sont multiples. Premièrement, il montre que la structure spatiale de l'économie suisse a bel et bien effectué une transition d'une situation de très fort gradient centre-périphérie en 1939, lorsque les deux tiers des emplois non-agricoles étaient situés dans des centres urbains, environ un quart en campagne et le reste dans de nombreux villages industriels, vers une structure grandement différente en 2008 où moins de la moitié des emplois sont situés en ville contre près d'un quart dans des centres suburbains, le reste étant distribué principalement dans l'espace informé, les villages industriels ayant pour leur part perdu en importance.

Ce travail montre également que les composantes spatiales de la structure économique ont fortement évolué. Alors qu'en 1939 les centres urbains concentraient la plupart des fonctions économiques et l'ensemble des fonctions de commandement, la spécialisation spatiale s'est déve-

loppée de manière inarrêtable depuis lors et en particulier dans le dernier quart du XXème siècle. Les centres suburbains, pour leur part, ont non seulement crû mais aussi gagné en qualité, notamment dans les hautes technologies et les services supérieurs, et dans les fonctions de commandement : en 2008, ils comptaient plus d'emplois dans des sièges sociaux que dans des succursales. Parallèlement, les villes ont tendu vers une spécialisation de leur économie sur quelques secteurs économiques clés : la finance et les services publics avant tout, accompagnés des services personnels destinés à la nouvelle élite urbaine. Considérés dans leur ensemble, ces développements contreviennent aux théories dominantes en matière d'organisation spatiale, en illustrant une déviation majeure d'avec la logique de la théorie des lieux centraux de Christaller.

L'évidence empirique montre que de manière générale les centres suburbains n'apparaissent pas être localisés au hasard dans les régions suburbaines, mais qu'ils le sont de manière concentrée sur quelques points spécifiques de la banlieue, en particulier sur les échangeurs et les jonctions autoroutières. Cela conduit à penser qu'il soit possible qu'une haute accessibilité soit un déterminant de la localisation des emplois. Dans le cours de ce travail nous avons démontré premièrement que l'accessibilité est plus fortement dépendante de changements intervenus dans la structure du réseau routier que d'autres paramètres, comme des changements dans la répartition de la population, la technologie des transports ou l'attitude face au temps de parcours des pendulaires, et que par ailleurs les changement d'accessibilité dus à l'évolution du réseau routier montraient des gradients locaux beaucoup plus forts que les autres. Deuxièmement, nous avons démontré l'existence d'un lien entre accessibilité et densité d'emploi, considérée ici comme indicateur de qualité d'emploi, une fois considérés les effets de l'autocorrélation spatiale. Une partie importante de la variance restant inexpliquée par un modèle global de régression peut être traitée en tant qu'effets régionaux qu'une régression pondérée géographiquement (GWR) peut modéliser, de telle manière qu'une combinaison entre accessibilité et effets régionaux permettent de rendre compte d'une majeure partie de la variance exprimée par la densité d'emploi. Finalement, l'introduction de décalages temporels entre conditions d'accessibilité et densités d'emploi semble montrer qu'une relation de causalité puisse exister entre l'accessibilité, qui précède, et qui donc pourrait causer, et la densité d'emploi, qui suit. En un mot, ce travail montre que l'accessibilité en voiture est un déterminant majeur de la localisation de l'emploi.

Mots-clés: géographie urbaine, géographie économique, géographie régionale, suburbanisation, edge cities, métropolisation, villes globales, globalisation, accessibilité, analyse spatiale, autocorrélation spatiale, test t modifié, régression pondérée géographiquement, GWR, recensement des entreprises, Suisse

Table of contents

List of charts

List of maps

List of tables

Acknowledgments

Carrying this work to its end would not have been possible without the help, encouragements and suggestions of many people.

First and foremost, my wife Laure played a quintessential role towards this achievement with her unwavering support, her acceptance of the sacrifices this work implied, and the kind but firm way she reminded me time and again that I had to complete this thing one day. Without her this work would simply not exist today. I'd also like to thank my family for their support, especially my sister Laurence for taking charge of Garance on Wednesdays at a critical moment in the course of this work.

Secondly, the whole MicroGIS Ltd. team, past and present, should duly be recognized for the multiple roles it played along the years, either by financially supporting this work, or by the numerous interactions and discussions we had, and still have, during the years. I'd like to acknowledge here the roles played by my two friends and MicroGIS co-founders, Christophe Jemelin and Stéphane Joost, as well as the role played by latter day members of the team, Abram Pointet and Joël Chételat. The fact that all four had preceded me in getting a PhD from this school was no small motivation to me.

Unbeknownst to them several people have played a major role in getting me where I stand today. Micheline Cosinschi-Meunier, from the Institute of Geography of the University of Lausanne introduced me to quantitative methods in geography and thus played a fundamental role in getting me to learn my job. Pr. Jean-Bernard Racine, from the same institute, was the first academic to believe in my abilities and helped launch my career by hiring me first as a student-assistant, then as a graduate assistant, co-publishing several articles with me and helping me get my first article published back in 1999. Finally, Pr. Martin Schuler rekindled me with academia by hiring me to co-author the Atlas des Mutations Spatiales de la Suisse, by providing me with complete access to the exceptional data and computer infrastructure of the EPFL, and his exceptional personal data collection, which he built across many decades, and by encouraging me at each step along the path towards a PhD, not least by accepting to be my thesis advisor, a role he played to its fullest extent.

I'd also like to warmly thank my jury for the time they dedicated to this work and the suggestions they have made, Pr. Kay W. Axhausen from the IVT at the Swiss Federal Institute of Technology in Zurich, Pr. A. Stewart Fotheringham from the National Geocomputation Center of the National University of Ireland in Maynooth, Pr. François Golay from the LASIG and Pr. Vincent Kaufmann from the LASUR, both at the EPFL.

Finally, I'd like to dedicate my work to my father, Alain Dessemontet (1938-2005), who would have loved to see this day finally come, and whose achievements I have tried to match my entire life.

Prologue

When my family moved in Lausanne's western suburban community of Crissier in 1978, I could ride along wheat and corn fields for close to two miles on the cantonal road linking us to Lausanne before entering a residential area, which marked the morphological entry in the agglomeration.

By the time I graduated from high school, ten years later, those fields had been replaced by a string of office parks. Ten more years and this stretch had become Renens main job place, overcoming its historical center. Throughout the western suburbs of Lausanne, the number of areas which experienced a similar development is in the double digits. In Switzerland, there are many hundreds of them.

This is the story of those places.

1. Introduction, issues and goals

1.1. Introduction and issues

In 1933 was published a most important work in theoretical geography, that of Walter Christaller (Christaller 1933) about the organization of services into central places in a market-oriented economy, which was supplemented several years after by that of Lösch 1940. At this time, according to theory and largely also to observation, the personal and professional services were located into centers (i.e. cities, towns, villages), the rarer and more select they were, the larger the center which held them, creating a hierarchy of cities and towns which were theoretically punctual and which catered to and were visited from the countryside and smaller centers around, which together constituted the center's hinterland. Christaller and Lösch formalized theoretically what had been, for centuries, the main economical rationale for the establishment of cities. With the partial exception of industry and manufacture, to which we will return shortly, the central place theory expressed and explained the spatial organization of most economical activities of the time and the past.

Although non-central workplaces were already common at this time, they were essentially active in the industrial sector. Industry needs in terms of space, energy and access to transportation could not always be accommodated in the centers. Thus, the suburbanization of industrial workplaces started with the development of industrial activities in the early 19th century and was boosted by the advent of rail transportation, which tended to skirt medieval cities or stop at their door. By 1930 suburban workplaces were thus widespread in Europe as well as in North America, but they concerned mainly industrial activities: while many industrial goods were produced in the suburban belts, in peripheral towns or in industrial villages, they were still being managed and sold from the center. While in terms of workplace the importance of non-central localization should not be understated, in terms of functions, especially commanding functions, the city, with its administrative role, its offices, its department stores, its retail and specialized services, hosted almost exclusively the whole spectrum of service activities, with the anecdotal exception of the recreational activities.

That being said, the territorial distribution of the economy is clearly very different nowadays than postulated then by Christaller 1933. Of course, at all times there have been epochal changes in the way the economy is spatially spread out, and anyway the economy never ceases to evolve, and with it its territorial distribution. In that sense we should not be surprised to find major differences between what the economic geography of the early 20th century postulated, and what we actually see on the territory three quarters of a century later. To explain those differences, three related phenomena have been called into account for the changes which have happened since the days of Weber and Christaller: suburbanization, globalization, metropolization.

Suburbanization is the phenomenon by which urban deconcentration has been taking place, as soon as it became feasible by the development of mass transportation means. Mass transportation first became available with the advent of the streetcar, at the time of the massive urbanization consecutive to the industrial revolution – the last time we in the western world experienced urban upheaval of such scale. The advent of the streetcar allowed a first wave of urban deconcentration, as people could now reside along its lines at further distances from their workplace than previously possible. Both industrialization and suburbanization triggered the development of cities of unprecedented size, with populations exceeding in some cases the million, and which were spatially spreading along streetcar corridors on great distances. A second wave of deconcentration happened when the individual car became widespread, in the early 20th century in North America, after WWII in Europe. The advent of the car opened up even more locations for people to inhabit within reach of their workplace, as there wasn't an obligation anymore to be located along a streetcar, metro or railway line. Morphologically, the cities did not grow tentacles anymore: instead, they spread like sheets, like oil slicks; later, they would grow by contagion, jumping across open land to grow periurban areas which would not be contiguous but would structurally still be related to it. Of course, infrastructure had to follow suit, which engaged it in a feedback relationship: infrastructure developed to tackle suburbanization encouraged more of it to happen. Cities sprawled. They formed agglomerations, which group centers with their suburbs and are now universally seen, more than their parent cities, as the base unit of the world urban network. In some respects, we are still engaged in suburbanization and periurbanization. Urban growth is still most visible at the edge of urban agglomerations and beyond, urban agglomerations are still growing by colonizing new terrains further and further away from their parent cities. But they can't be reduced to just suburbanization anymore as some of them started to undergo metropolization.

Globalization is the process by which local, regional and national economies integrated during the 20th century. Whereas in early 20th century the economy was still largely organized on a national basis – extending in some cases to colonial or neocolonial peripheries, since the end of WWII the western economies have been slowly integrating into one global economy which has then been extended to more and more parts of the world, so that nowadays the economy is truly global in the sense that all economies are interrelated, with only minor exceptions. Globalization warranted the emergence of global cities which were extending their influence at the world scale, and which weren't postulated in Christallerian theory. Globalization also went in step with the advent of the information economy, which has been developing since the end of WWII. The advent of information and knowledge as a valuable and important economical asset, in a context of globalization, meant that more and more information was exchanged across larger and larger distances. Eventually the world came to a point where those information exchanges became as important for the economy as exchanges of goods, as if, in a more and more technological society, knowing something which other do not knowhad become as important as owning or producing a tool. Cities and regions became central not so much because they produced and exported valuable goods, though this was, and still is, a very important activity, than because they could produce and exchange valuable knowledge and information. More interestingly, those exchanges tended to be more and more horizontal: global cities exchange as much between themselves than each with its hinterland. At one point, horizontal flows become far more important than vertical ones – the global city thrives on its exchanges with other global cities, far more than on its domination of a hinterland.

Metropolization is the consequence of the meeting of globalization and suburbanization at the urban and regional scale. Globalization and suburbanization often go hand in hand. The same technologies that rendered globalization effective – global communications and telecommunications means development – played a prime role in helping suburbanization. It enabled easy long-distance communications between offices and thus prompted spatial and functional disintegration of businesses. The globalization of the economy prompted the massive development of airports as gates to the world, airports which soon became major job centers of their metro area, deep in the suburbs. In the most developed countries, the reorientation of the economy towards products with very high added value, information and knowledge freed more and more businesses of most Weberian needs, and allowed them to locate more freely, knowing that the global communication and transportation networks put into place by globalization would allow them to ship and send their products just about anywhere regardless of their actual location – at least if this location is "in the network", which is the case for most places in developed countries. All those developments which allowed for horizontal exchanges at the global scale also permitted the development of horizontal relations within metropolitan systems. In a way, national urban networks are reduced models of the global network. The contemporary metropolis is the result of the two concomitant processes of globalization and suburbanization.

Together, those phenomena greatly altered the territorial structure of the economy as seen by Christaller 1933. At the very time Christaller wrote about his findings, this spatial economic organization started to alter. By 1930 the first retail outlets had begun to colonize North American suburban belts; by mid-century the massive suburbanization of the American population was taking place, quickly followed by a first wave of service sector workplace establishment in the suburbs. This wave concerned basic service activities, mainly mass retail and warehousing. In time though, specialized services and white collar activities started to follow suit, so that by 1990 many suburban belts in the U.S. held more service jobs than their downtowns, with the gap in qualifications narrowing, in what Garreau 1991 described as "Edge Cities". Along with metropolization processes, suburbanization can rightly be deemed the most important phenomenon to concern western urban structure during the latter half of the 20th century. Even so, some of its elements have been understudied, as is the case notably with the role of the suburbs as job places. This has long been somewhat the case in North America, and even more elsewhere in the world, even though more recently the subject has attracted more studies, as we will demonstrate further.

1.2. Core hypothesis

One of the goals of this work is to take Switzerland as a case in point, to study it in the long term and to describe how the economy spatially reorganized itself since the development of contemporary globalization, the entry into the informational age and the knowledge economy, the development of metropolization. As such a major part of this work is going to be descriptive. We will take the data, which for the most part has remained unexploited, and we will describe what we find. However, we aim higher than just at an encyclopedic description of Switzerland as an example of how globalization and suburbanization factually and empirically redistribute the economic actors in the territory. We aim at finding the underlying mechanism which provokes such reorganization. And we will try to show a functional relationship by statistical means.

While most Weberian constraints were progressively lifted during the onset of metropolization, there is one constraint remaining: while receiving, sending and shipping products and information is now easy and cheap no matter where in the developed world the enterprise is located, it still needs physical workers. In the case of the information economy, businesses still need highly qualified workers. We think, and it's at the roots of our core hypothesis, that workers residential location has become one of the major determinants of business location: as companies do not have to care much about where its inputs and outputs come from and go to, they have to care about whether they will find workers – in the informational age, qualified ones. More and more companies will locate where they will find an adequate supply of work.

Our core hypothesis, then, can be stated as follows: in the western world, the distribution of activities and jobs is linked to car accessibility. Locations which are successful at attracting and retaining jobs are those which are especially easily accessible by car by a great number of active people. This link can be statistically demonstrated.

1.3. Suburbanization, metropolization, globalization: a literature review

The central place theory exposed by Christaller 1933 was completing two earlier seminal works. Von Thünen 1842 had established the land-rent theory, which is still largely in use under modernized forms in geographical research. Most notably, the urban monocentric model of activities and residential distribution can easily be traced back to Von Thünen theory. A second important work was that of Weber 1909 establishing theoretical principle pertaining to industry localization by linking it to the mutual geographical situations of entrants, workforce and markets. The Weberian theory explained how industrialization processes may result in the emergence of specialized regions, as some regions were favored by their structure and position to host specific industrial activities. Christaller went away from the regional paradigm and back to a vision closer to the Von Thünen one, where cities were seen above all as markets and exchange places for the surrounding countryside, as Von Thünen had seen, and also for urban centers of lesser levels. Importantly, the central place theory denies a role to regional specialization: centers of a given level are similar. They are economically more complete than lower level centers, and less complete than centers higher up in the hierarchy, but they do not differ from one another according to their particular region.

The formulation of the central place theory resulted then in the advent of two competing but complementary visions of the way the economy is spread out. Either the focus is neo-Weberian and concentrates on regional differences and specializations, or it is neo-Christallerian and focuses on hierarchical relations in urban networks. Almost by definition, people interested in industrial distribution (Scott 1982, 1983a, 1983b, 1984, 1986, Benko 1991) follow the neo-Weberian school and concentrate on specialization patterns. People more interested in service activities (for instance Sassen 1991, Castells 1996) tend to adopt a neo-Christallerian point of view, which consider regional variations secondary to the processes of command and control set up between centers according to their size, the level of their economy, and more recently their insertion in the global economy.

That being said, let's embark on a very brief review of some works which have pertained to the subjects of suburbanization, metropolization and globalization. Some researchers had pointed out well before Christaller's time the existence of industrial suburbs. Those were attested in Douglass 1925, and in a major study (Harris 1943), a typology of suburbs was even given, which recognized two main types: residential and industrial, as grouping most suburbs – however he already found some suburbs specialized in other activities, mainly wholesale and retail. The same author published two years later another major contribution in which several urban models were proposed which took into account the suburban differentiation (Harris & Ullman 1945). In that seminal work, Harris & Ullman 1945 recognized wholesale and light manufacturing districts and, heavy industrial districts along central business districts – to them the existence of job-oriented suburban centers was already evident. In the 1950s, Schnore 1956, 1957a, 1957b, 1963 built on these foundations to give extended suburb typologies and devised a research program to understand them better.

However, despite the supply of research material regarding the growth of suburban job centers, the major works of the time remained strictly monocentric, as the Chicago school urban model (Park et al 1925) or the extensive works of August Lösch (Lösch 1940) testify. This tendency was shared by the Weberian school; several years before writing Megalopolis (Gottmann 1957), Gottmann 1950 failed to describe intra-urban economic differentiations – to the Weberians, economic differences were only regionally based. Isard 1956 came tantalizingly close to formalize spatial models which would account for intra-urban economic differentiation, working on transportation and labor costs, but his theoretical framework remained of regions served by point-like cities. Alonso 1964, Muth 1969 likewise remained firmly on the monocentric paradigm with their works on the bid-rent curve. Indeed, modelers waited for the 1970s to first integrate suburban job centers in their models.

Vance 1970 detailed how wholesale has slowly drifted away from downtowns, first with the arrival of rail, then with that of the truck and in a third stage with the advent of the freeway, and demonstrated thus the seniority of deconcentration processes. In a detailed study of business location moves, Cameron 1973 found that there was a tendency towards strong industrial deconcentration within metropolitan areas, towards both the suburbs of the major metropolitan centers as well as towards metropolitan subcenters, while showing the greater dynamics of those peripheral spaces. Meanwhile, Manners 1974 remarked that suburban deconcentration was happening not only to industries, manufactures, warehousing and retail but that offices were also concerned. In this work, Manners 1974 pointed out the importance of the worker's residence as a determinant of office location. Baerwald 1978 linked the emergence of office job centers at strategic points linked by the new freeway systems which was generalizing in the U.S. as the emergence of new downtowns along freeway corridors. This was confirmed and furthered by a major article by Erickson & Gentry 1985, who stressed the importance of accessibility reasons on the location choices of businesses and actors, and who pinpointed the fact that suburban job clusters were forming and not only an amorphous areal spread. Arguably, Erickson & Gentry 1985 constituted the first complete economic study of a suburban job center, unearthing several stages of development of expansion, diversification, and transition. By the late 1980s, a flurry of studies were published which confirmed, furthered, enlarged our knowledge of suburban economic development (Leinberger & Lockwood 1986, Cervero 1989, Pivo 1990). The symbolic and sentimental importance those locations started to have with American suburbanites was aptly described by Hart 1982: suburban dwellers were slowly adopting them, liking them, loving them.

The genius of Joel Garreau, then, wasn't in the discovery of a phenomenon in fact already well described and on its way to be understood by the research community; it was to capture it all in one highly readable book, grouping, resuming and synthesizing the information at hand with a vibrant feel for these suburban job centers, those new places he coined "edge cities" (Garreau 1991). For better or for worse, Garreau's edge cities changed forever the way the public, and no doubt quite a few academics, viewed suburban space. Before Garreau 1991 it was essentially seen as a residential place, its value as a potential job place minimized or neglected by the majority of the urban research, still hell bent on the monocentric model. After Garreau it wasn't possible anymore to do as if edge cities weren't existing – the debate, in many ways, shifted to better define and qualify them, as shown for instance in Kotkin 2000, Soja 2000, Sieverts 2001 and many others. Very anecdotally, sometimes in the mid 1990s, Garreau's book was the prime inspiration for us to undergo this work. Not coincidentally, after 1991 modelers started to publish theoretical works which took suburban centers into account, such as Anas & Kim 1996, Craig & Ng 2001, McMillen 2001a, Páez et al 2001 besides many others more completely described in chapter 3 and summarized in Bogart 1998. Likewise, some major empirical works were directly derived from Garreau's concept, such as Bingham et al 1997, a collection of studies of suburban job centers in Ohio which proposed edge city typologies much in the vein of the works by Harris and Schnorre. We published a first list of possible Swiss edge cities by looking at job distribution for 1975 and 1995 (Dessemontet 1999), which prepared the way for this much more thorough analysis.

A very meaningful development has been the work by Robert E. Lang about edgeless cities (Lang 2003). In that work Lang challenged the vision of suburban job developments as being clustered around massive edge cities, which had been dominant in the literature since the early 1990s. Taking as basis Garreau's definition of edge cities in ten U.S. metropolitan areas he was able to show that actually a plurality of suburban jobs weren't situated in suburban clusters at all, but dispersed throughout metropolitan space in what he deemed "edgeless cities", a concept we have made our own to describe everything not included in centers, even if what we call edgeless space will be different from Lang's ones, if only because of size threshold differences.

Curiously few authors have clearly explicated the link between suburbanization on one hand, globalization and metropolization on the other hand, and thus the two research domains largely evolved in parallel but without many intersections. The first major study about world metropolization is certainly Gottmann 1957 and the advent of the Megalopolis concept to describe the Boston-New York-Philadelphia-Washington conurbation. While the term of metropolis had been coined well before and is present in many of the aforementioned works, Gottmann 1957 elevated the use of the metropolitan concept above that of a surrogate for large city. Several main finds are pivotal in Gottmann's research: the metropolis is defined as the coalescence of several urban areas organized around a number of important centers; its economy is global in scope, oriented towards commercial, financial and command activities more than towards industry; they play an outstanding cultural role in the age of mass media; the fact that it is affected by urban congestion to a point unknown since then. Gottmann 1957 essentially described metropolitan characteristics which would be found later in very many works.

In a way, Sassen 1991 relayed Gottmann 1957 more than thirty years later by connecting Gottmann's megalopolis with other similar world metropolises, London and Tokyo. In her work Sassen 1991 attempted to connect the new urban form of the global metropolis with miscellaneous economic developments, mainly the globalization of investment flows, the post-fordist functional disintegration of the enterprise, and the advent of information technologies. She recognized that the new technologies needed new locations to base their businesses on, and was very close to recognizing the importance of suburban centers in that respect, without totally crossing the bridge: in the end, her work remained global in scope and the spatial internal structure of the metropolis finally wasn't treated. Several years later, Castells 1996 majestically connected the links between globalization and metropolization, with a very thorough investigation of the intertwining relations between the new informational and knowledge economy, the functional disintegration of the company, the new flexibility of work and work relations. Both Sassen 1991 and Castells 1996 is a major source of inspiration when trying to understand and to connect the discoveries we're about to make.

Recently, some authors do indeed try to establish a link between globalization and the urban form. Soja 2000 is one of them, a rich source linking postmodern capitalism and the new economy with new urban forms of which suburban centers and residential areas were the most visible members – although it is a bit too evident that the author, that old Marxist, passionately hates these spaces too comprehensively to be totally credible. On the other side of the political barrier, Kotkin 2000 surfs on the American dream to explain how the informational revolution will reshape cities, most notably by allowing peripheral areas to become focal points for the new economy by the grace of their superior natural surroundings linked to the availability of cheap and easy transportation and the near-universal availability of broadband internet connections. Kotkin named these new internet cities "Valhallas", giving as examples the likes of Boise, Idaho. A connoisseur of the United States can readily think of similar other places. In the same vein, Florida 2004 expounded how the new knowledge economy, needing creative workers above all else, was reshaping metropolitan competition by orienting it on the capacity of a given metro area to retain those workers. In both works then, the emphasis was put on the desirability of certain people. In a world market where access to producers and customers is essentially space less because fast, cheap and easy, or immaterial through the internet, what really matters is to find an adequate workforce. Those results confirmed the findings made notably by Glaeser et al 2001, which confirmed that nowadays, by far the most important discriminant for industrial or service location is access to the workforce.

As we just saw, accessibility plays a ever greater role at shaping the desirability of places as job centers. The patterns shown by the workforce when commuting between home and work show increasingly that classical central business districts command less and less trips, while tangential commute, those happening between different suburban locations, are growing to be dominant in North America (lee et al 2006), and more and more important in Europe (Dessemontet et al 2010). Taking it all together, it seems that we could hypothesize that accessibility from the suburbs could play a major role in the localization of new job centers.

1.4. Goals and hypotheses

1.4.1. A thesis in quantitative geography

The general goal of this doctoral thesis is to try to fill a gap by studying job localization and deployment in a European context, while trying to further the understanding of the spatial processes tending to their rise. Our core hypothesis is that the change in the spatial distribution of jobs, and in particular the rise of suburban job centers is strongly conditioned by automobile accessibility. While there is ample anecdotal evidence of this, up to now it hasn't been showed rigorously by statistical means.

Our research field is Switzerland as a whole, at the smallest relevant spatial unit available in the data, the commune. This work will be a research in quantitative geography, relying essentially on statistical information and methods. As envisioned, the study will call on an important set of data, hypothesis, postulates, axioms and definitions to be put into practice.

We now describe more in detail the hypotheses which have sustained this work, divided in three parts: the empirical study, the accessibility study, and the spatial statistics study.

1.4.2. The empirical part: a history of job distribution, 1939-2008

1.4.2.1. Hypotheses: what we expect to find

The set of hypotheses that we want to check in the empirical part of our work encompasses various domains of what we think is a complex and eventful history of development of tertiary occupational suburbs. In particular, the following assumptions are made, based on previous literature and on preliminary research.

- Since WWII, there has been a steady rise of non-urban job centers in Switzerland.
- Taken individually, the non-urban job centers tend to be fragile, especially at the onset of their growth; they can flourish and fade easily.
- There is a threshold size above which a non-urban job center will firmly establish itself and withstand economical crises.
- Taken as a whole, non-urban job centers show more growth during period of economic growth than the rest of the country and especially than the urban centers, and are more resilient during economic downturns.
- The non-urban job centers emerge above all in metropolitan areas, of which they are a marker.
- Most non-urban job centers emerged on former industrial districts, in the restructuring of which they played a major part. The "boomtowns" tend to be restricted to the outer metropolitan areas and the farthest outskirts of the cities, whereas land reuse is absolutely dominant closer to town.
- Non-urban job centers development is linked to the emergence of new economic sectors and ways of doing things. They are early adopters of novelty and as such, they have a substantially different economic structure than the downtowns and the central business districts of the cities around and between which they grow.
- With time, full-fledged, persistent peripheral centers gain complexity, diversity and commanding functions, and start to be able to compete with their downtowns.
- Being metropolitan, these centers are strongly integrated to the rest of the economy and in no way are they autarkic. In the command and control structure of the economy, they are dominated by servant activities. Given their size, they tend to have a deficit in commanding functions as compared to the urban centers.
- By siphoning off a sizeable chunk of the central functions of both centers and towns, the peripheral tertiary job centers have disrupted to a large extent the Christallerian urban network, replaced by a more diffuse system of metropolitan areas.

1.4.2.2. Making the hypotheses explicit

Once the definitions are clearly established and justified, and the data on hand, the work program will be rather straightforward. The first job will be to describe the Christallerian city network for Switzerland circa. 1939. A central node will be defined by its absolute numbers of jobs as well as by displaying enough density or what we call intensity (jobs on active ratio), for all business censuses at hand. The rationale behind this method is to detect peripheral job centers as they emerge in time. A method of detection has already been devised (Dessemontet 1999) and will certainly serve as a basis on which to build a more thorough approach. In particular, wherever applicable the method will concentrate on the market-oriented jobs and will try to distinguish the effects of the touristic boom, to alleviate potential problems already mentioned.

We expect that for a rather long time, this emergence of new centers was probably modest and till at least 1975. It is only since 1975 that the tertiary sector really took a newly ailing industry over. The industrial decline that Europe and Switzerland experienced at the time freed vast tracts of land at the gates of cities that, in such a small country as Switzerland, could not just lie in waste. When the economy upturned again, notably after 1983, it spawned a vigorous expansion of new suburban job centers, which were for the first time not industry-linked but service-oriented. Thus, the 1975 to 1985 period, and even more the 1985 to 1991 one, will be of particular interest as they should bear witness of the first wave of countrywide emergence of suburban tertiary job centers.

As the economy downturned severely after 1991, the period covering 1991 to 1998 can be used to test for peripheral centers resilience and their fragility; preliminary studies have shown that some of those centers, having emerged in the late eighties, disappeared during the nineties. On the contrary, the 1998 to 2008 period, especially between 2005 and 2008, covers a healthy economic cycle, and it will be interesting to see the difference between the boom of the late eighties and the growth period of the late 2000s.

As we have postulated, most of those new centers should have emerged on previous industrial zones or should have pervaded, instilled those. Today still, many such centers are still designated by the words “industrial zone” even if the vast majority of their jobs are in the service sector. It will be of interest to see how, when and with what characteristics this transformation occurred, if the succession of growth and downturn periods played a role, for instance by killing industrial activities during downturns to make way for service activities when the next growth period occurs, if those areas went through a crisis period where their total employment sank or if the process was more gentle on job figures. As we have said, we tend to believe that new employment centers have been on the rise throughout the latter half of the 20th century, but that doesn’t mean that their total employment has always been on the rise: the industry may have paid a heavy price to their inception.

It could also mean that the industrial zones did play a major role in the prime development of tertiary suburban job centers, as they lived in essence the same evolution, only several decades earlier. It is worthy to note that the first branches of the tertiary sector to show a strong trend towards decentralization were those with the most needs in terms of land use – essentially, utilities, transport, logistics, warehousing and postal activities, which bear a striking similarity with industrial activities regarding their land requirements and worker’s qualifications. We believe that at some point in time the suburban job centers overcome those similarities and gain originality, in the sense that unlike the industrial and the industry-like service activities which migrated from the city center in search of cheap land, or were expelled from it due to land rent reasons, in those new suburban service job centers, activities do locate that could have been staying in the central core, or elicited to establish themselves there. In that sense, the emergence of economical diversity in those suburban job centers represents a reversal of logic, a turning point, from an era when suburban job districts were hosting activities that couldn't afford to be in town, to an era where they represent a location of choice.

While non-central job centers tend to transform former industrial districts into service activities areas, they may not mimic the economic structure of the classical urban centers. Firstly, suburban centers have been innovation cradles, places where many new ways of doing things were tested, notably in relation to the democratization of automobile use. This is particularly the case in mass retail, restoration and recreation: the integrated malls, the specialized big box retailers, the fast-food outlets, the amusement and theme parks, the retail chains and the franchised ones, all first appeared in such places rather than in city centers. Moreover, there is ample evidence that lately, new activity domains have shown the same tendency to locate preferentially out of the loop, out of the city's core. This is above all the case in the computing & database industry and the liberalized telecoms. It then seems likely that the economic structure of the non-central centers differs markedly from that of the city centers, notably because peripheries are natural early adopters of new technologies and business models.

Suburban job centers are expected to be structurally different when compared to the city. While they are early adopters of new offices, outlets and stores, most of the time their functions are totally integrated into business models bigger and wider than themselves. We expect that in the suburban job centers, the proportion of warehouses, franchises, outlets, branches and back-offices, all of which the subservient units of bigger corporations, is substantially higher than in the traditional downtowns, while the proportion of independent firms and offices, notably in the professional services, tend to be clearly lower. This gives suburban job centers two distinctive traits as compared to the downtowns: first, in terms of corporate links, they are expected to be in a subordinate position. In Europe, they rarely hold commanding functions, which differentiates them clearly from their older, more mature American counterparts, where company headquarters are far more likely to be located. Secondly, they are integrated: a greater share of the job places there are located in subservient units part of larger companies, and thus linked to the national or the world economy in a more extensive way than in downtowns, where there is a mix between independent entities active on their local markets, some companies with a broader outlook and a sprinkle of subordinate units. As such, suburban job centers can be described as workshops and back office areas servicing the decision centers of the national and world economy.

As the North American example tends to show, with time well-established peripheral service jobs centers, having collected at first subservient activities, start to get more complex. First, some independent niche activities, essentially in the new technologies, begin to pervade those spaces, the best-known example being of course Silicon Valley in California. Secondly, once they start to acquire high-status occupations, they can then gather momentum by getting conference centers, high-status hotel complexes and some high-quality office spaces. We surmise that this is already happening in the most mature suburban centers in Switzerland, in the airport areas of Zurich and Geneva, and around the EPFL in Western Lausanne. The next step could be to gather command centers, i.e. company global or regional headquarters. This has been happening in North America for a long time now. It remains to be seen if this is happening in Switzerland.

In any case the emergence of powerful suburban service job centers during the last decades of the 20th century has had a powerful impact on the urban structure of the country. The changing geography of job localization, allied to the rise of the tertiary sector and mass residential suburbanization, wrecked the traditional Christallerian network of cities and towns and replaced it with something fuzzier, a mesh of polycentric urban areas and sprawling metropolitan space, where older local centers disappeared in favor of new suburban or metropolitan service areas and where it may be difficult to find Christallerian regularities amidst a perceived urban chaos. Or is it that order has in fact been present all along, but following new perspectives that we fail to recognize as such? We aim at answering all those questions in chapters 3 to 7.

1.4.3. The accessibility part: accessibility as a cause for center emergence

1.4.3.1. Introduction

As already stated, the major hypothesis subtending this work is that the emergence of the suburban job centers is strongly linked to their accessibility by car. But before we can test this prime hypothesis, we need a working definition of what we mean by accessibility. The main aim of this section of the work will be to define what will be considered as a measure of automobile accessibility.

This part of the work is then bound to be rather different than the first. As the precedent part is above all dedicated at describing a phenomenon and its inner workings as precisely as possible, it won't delve into explanation, at least not directly. The present part will aim at providing a prerequisite to test the fundamental hypothesis of this work, in terms of a working definition of accessibility. As such, it will be a critical study of the rather imposing literature that has be published on the subject. The review will allow us to take an informed approach towards the definition of accessibility by car with an original model. Then the model parameters will have to be extensively studied, before being applied at various times in history.

In most cases, accessibility studies have been focused on one side of the relationship, that of the resident, whether as potential worker, jobseeker or customer. Accessibility is thus measured generally at the place of residence according to the proximity – whatever that means – of retail centers, job places, or any focal point deemed of interest, and an accessible residence is one from which jobs or shops are readily within reach. In our work though, we take the reverse approach: accessibility of a place will be measured towards the residents, an accessible place being one which is readily accessible by residents. It goes without saying that the mathematics involved is strictly the same regardless the direction of the relationship.

1.4.3.2. Hypotheses: what we expect to find

We can now submit several hypotheses that will help us define what accessibility is and develop a measure thereof. Most of these will have to be tested and documented.

- The distribution of travel-time across a given population follows an extreme-value distribution; thus the extreme-value distribution can be used as base for an accessibility model.

- In a globalized economy where more and more goods are either immaterial or easily and cheaply transportable, the focus for localization shifts from proximity to the market to proximity to the available qualified workforce. This allows us to focus on the active population's residential pattern as one of the major determinants of job center localization.

- Changes in transport infrastructure have a major impact on changes in accessibility, as well as in hierarchical position of places within a network.
- Advances in car technology have only a minor impact on changes in accessibility, at least in relative terms.
- Traffic congestion is linked to density in the area around, and drives accessibility down; thus, density is a limiting factor on accessibility; the range of this limiting effect is a function of the road importance in the network, i.e. major highways can be affected at greater distance from a center than small roads.
- The accessibility measure is robust to changes in drive-time parameters, i.e. all things being equal, a place retains more or less the same position in the network regardless of the parameters regarding mean and variance of drive-time.

1.4.3.3. Making the hypotheses explicit

Once a suitable method has been chosen to measure accessibility and the technical aspects sorted out, we need to take into account external factors. In any case, we can say that accessibility is the ability to reach non-empty destinations. This, of course, depends on several factors, whatever accessibility measure has been selected. We can think of five elements coming into play in defining a given place's accessibility: population nearby, transportation network around, transportation means, density constraints, and acceptable time of access.

The first element is the targeted population localization around the site. If there is nobody around, there is in effect no point in having the best transportation system: the place will not be accessible. In order to be accessible, a location has to be within reach of its population of interest. Thus, all things being equal, a rise in the population near a given place will enhance its accessibility; conversely, a drop in population figures nearby will lower it. In that respect we can but emphasize the fact that what we mean by population can be extremely varied. In our case, job holders will be considered as our base population.

The second element to take into account is the transportation infrastructure, in our case the road network since we associate peripheral job center rise and automobile accessibility. The very base of this work postulates the paramount importance of the road network in having peripheral job centers emerging. The observation that they do not seem to emerge randomly seems to mirror the fact that the road network is highly discriminated, from major highways to local drives, and that this strong hierarchy tends to be reproduced in the desirability of the places they serve. Usable speeds vary vastly between highways and local drives, and that has an impact on accessibility: all things being equal, a location served by major highways will be more accessible than a location served only by neighborhood streets. A second very important characteristic of any road network is that it rapidly evolves, at least during the time span considered. This means that accessibility tends to evolve over time, generally towards better overall accessibility as the network develops. That being said, there are certainly feedback effects between road network development and accessibility as network development can lead to population redistribution, those effects being indeed complex and rather poorly studied. Moreover, the accessibility hierarchies can be challenged as network development put new locations at the top of the accessibility range. This in turn should have a definite effect of the development of peripheral job centers, at least according to our core hypothesis.

The third element we mentioned is the technological evolution of the transportation means we use. Aside from the network development, cars also evolved vastly during the time span under consideration, meaning that all things being equal, accessibility tended to rise with the advent of better automobiles. At the beginning of the period under study, this effect was probably dominant in the accessibility variations, whereas after circa. 1960, network evolution took over as the main factor in accessibility changes. But it would be wrong to neglect the technological capacities of the vehicles we use as a limiting factor to accessibility; they certainly were important, at least during part of the period under study.

But nowadays one can drive the fastest car on the largest highway and still find himself stuck at very low speeds, hindered by factors having nothing to do with the technical capacities of either the vehicle or the road. Thus our fourth factor on accessibility, which are the constraints put on by density. Those are at most sensible in the city streets, where the commercial speed of any vehicle is vastly less than either the car or the road could technically sustain. The impact of traffic congestion has to be taken into account as it tends to lower the commercial speeds, this having an effect on accessibility. One of the hypotheses we can make here is that all other things being equal, a dense neighborhood may be less accessible than an open one, a congested road network making its neighborhood less desirable than a fluid one makes its own. This statement needs to be qualified though: at first, a dense neighborhood is prone to host more people than an open one so that even if the commercial speeds tend to sink those neighborhoods could still be more accessible, by virtue of their sheer density. But more importantly, density is probably the major factor having a negative feedback effect on accessibility: in our hypothesis, as accessibility rises, density grows, which ultimately could hamper accessibility itself. In a way this is exactly what has happened to the city central core, once the most accessible place of all, getting denser and denser as a result, ending choking under extreme congestion, which stimulated the rise of secondary centers in less dense areas that could alleviate the accessibility problems experienced by downtown.

Finally, paralleling the notion of accessibility is the notion of proximity: what is “nearby”? According to what we seek, this notion will be vastly different, which in fact sits at the heart of Christaller’s central place theory: basic goods must be close to be accessible every day, more occasional needs can be covered from farther away. In a time where transportation costs are low, value has been put on time spent to reach destinations and thus it is fitting to use time as a distance measure. To be considered nearby, a bakery or a convenience shop must really be in the neighborhood, no more than 5 minutes away, whether by car or on foot; a specialized shop can be up to one hour away, a theme park up to one day away. Conversely, a workplace has to be reached every working day for the vast majority of the active population, which represents a major constraint on localization for the workforce, but also a definite one for workplaces. Studies show that in Switzerland, the mean time of access to jobs hovers around 20 minutes (Schuler et al 2006, pp. 282-3), with a rather large standard deviation of around 10 minutes, so that those values will be used as starting points for our study. But it is very likely that this value isn’t of the “one size fits all” kind: we can certainly submit the hypothesis that those mean times vary between workers and managers, that different people working in the company have not the same relation towards the time it takes to reach the workplace. More importantly, those times do vary regionally, as time spent to go to the job is a limiting factor towards residential choice, but by no means the only one: in most cases there is a trade-off between proximity to jobs (or relative lack thereof) and residential quality. It is therefore expected that mean drive-times are larger in outer periurban belts than they are closer to job centers.

The ultimate goal of this second part is to create accessibility measures of a range of potential locations for activities. This will be computed, essentially, for each potential location, as the sum of the population within reach; this figure will depend, as we have seen, on several parameters, of which some will have to be thoroughly used, namely the definition of the population to be targeted, and the threshold distances to use. Essentially though, this accessibility measure will be resumed to one figure attached to the point. Evidently, nearby points will tend to have accessibility values close to one another, closer in any case than for points further away – the very definition of spatial autocorrelation. This will allow us, in fact, to create trend surfaces representing various accessibility surfaces, for various years, under various time constraints. Those surfaces will be used first to test the hypothesis that we have stated in this part, and also to see how they compare with surfaces derived from the first part, i.e. jobs count data for all the censuses we test.

Up to this point we have considered accessibility as the only factor under study to explain job distribution across the territory. The third and final part of our doctoral thesis is to actually test this assertion, and to look for credible alternative contributive factors to tertiary job localization.

1.4.4. The spatial statistics part: showing the link between accessibility and employment

1.4.4.1. Introduction

The empirical part will aim at describing the emergence of tertiary job centers in the suburbs, which, besides other results, will provide us with trend surface maps of various job densities across the country at various times and for various branches of the economy. The accessibility part will provide trend surfaces obtained by way of a theoretical approach of what accessibility is, in order to provide, under our core hypothesis, a view of where the jobs should locate. This final part of the work will aim at two goals.

First and foremost this part will be dedicated at statistically testing the core hypothesis of our work, i.e. if it is possible to say that there is a strong relationship between job location and car accessibility, and furthermore while taking the spatial autocorrelation effects into account. This, of course, is critical. If we can statistically show that there is a strong, undisputable association between the two, and furthermore if we can indicate causality in this relationship, it would be a huge research result. In essence, it would amount to the fact that land planning can't fulfill its purpose without taking into account accessibility, which stands on residential location, transportation infrastructure and the will of the worker (Clark 1981).

On the other hand, it could be that to the contrary of what we will try to show in this work, accessibility as we defined it is not alone in defining zones of strong job growth. In that sense some alternative hypotheses may have to be tested. Three of them, in particular, will be considered as credible alternatives to the accessibility model. Those are the effect of planning, the effect of land rent, and the effect of economic unit disintegration, commonly known as post-fordism.

A possible reason for this would obviously be that our previous assessment about the irrelevance of land and urban planning is just wrong, and that in fact land and urban planners do have a major impact on job localization and the way the suburbs gained importance during the last fifty years. In particular, it is a fact that in Switzerland, the advent of legally binding land planning is more or less contemporary to the first signs of job growth in the suburbs and thus a link seems not to be completely out of the question: it may be, for example, that suburban job centers have developed only where they were allowed to from 1972 on, and that many suitable, accessible areas are devoid of such centers for zoning reasons. It's a well known fact that land planning in Switzerland has become more and more restrictive, from a situation of total freedom up until the late sixties to the inception of various restrictions afterwards, and especially in big cities.

A more subtle alternative would link the emergence of service job centers in the periphery to land rent and land scarcity in the downtowns. According to that hypothesis, competition for space in the city centers would reach a point where many functions would be excluded from the game and expelled from the centre. This has profound implications on the comprehension of the urban dynamics it would show: according to the accessibility hypothesis, the suburbs are desirable as such because they are accessible, thus pulling jobs towards them, whereas according to the land rent hypothesis, the centers are desirable and the suburbs grow only because the centers can't host all the activities: in that scenario, the center pulls jobs towards suburban receptacles and the suburbs are just passive receivers of what the city won't accommodate.

The third hypothesis is even more subtle as it renders accessibility subservient to a more profound cause, being the reorganization of the production model, from the all-integrated model of the industrial giants like Ford in the US, hence its name: fordism, to a more flexible, more focused just-in-time production model that triggered disintegration of the production chain, each production unit moving from being a jigsaw piece in a big conglomerate to being an independent company or at least independent-acting unit. In that sense, the new flexibility of the economy, the just-in-time production process suggest the advent of smaller, more flexible, highly accessible business units that could rely on fast transportation instead of on stock held in warehouses. In that sense, the rise of suburban job centers would not directly rely on accessibility as in our hypothesis, but more on production scheme reorganization.

1.4.4.2. Hypotheses and counter-hypotheses

The set of hypotheses that we want to check in the last part of our work can be thus divided in two categories: the hypotheses per se which sustain and complete our core hypothesis, and the counter-hypotheses that will need to be investigated if we can't demonstrate our core ideas.

The hypotheses are as follows :

- The link between accessibility and tertiary job distribution is statistically significant, and isn't due to the effects of spatial autocorrelation.
- There is a causal relationship between accessibility and tertiary job distribution: better accessibility will stimulate job growth.

The counter-hypotheses and alternative research domains are:

- Urban and land planning has a major effect on tertiary job localization in the suburban belts: the controlling factor is politics, regardless of accessibility.
- Competition for land, and land rent have a major effect on job localization: the controlling factor is land price, regardless of accessibility.

- The economical world shift from fordist vertical integration to post-fordist vertical disintegration, horizontal subcontracting, and flexible just-in-time production played a major role in the spatial reorganization of the economy; accessibility is then just a surrogate to post-fordist production organization which is the major factor.

1.4.4.3. Making the hypotheses explicit

The demonstration of our core hypothesis will be essentially conducted by statistical means. Our work will provide us with a series of job density maps across Switzerland, at various scales for various epochs and for differing populations of interest, as well as well as accessibility maps for Switzerland at various times and regarding various accessibility criteria. Those maps, of course, can be transformed into data for a list of places, and those can be compared in the usual statistical way by a standard regression analysis, or a related, better suited method given the data circumstances we will encounter.

But there is evidence that geography-based data do not respect classical statistical prerequisites. In particular, geographical data can be spatially autocorrelated, i.e. values recorded at points close to one another can tend to be more similar than values recorded farther away. This means that in such a case values at given points are somewhat constrained by values taken at points close by, which in turn means that the variance of a spatially autocorrelated dataset, if we compute it the usual way, seems to be smaller than it really should be if all data points could really take any value: that is, the real number of degrees of freedom is lower than for a similar analysis conducted with aspatial data (Cliff & Ord 1973). This has an effect when correlating "the aspatial way" two autocorrelated datasets: such a computation will show a stronger significance than it should, because it is computed on an artificially high number of degrees of freedom (Clifford et al 1989, for instance).

We define accessibility at a given point as the number of target persons able to reach this point in a given amount of time. Thus, very close points will have very similar values when compared to points farther away: in other words, the very definition we give and use of accessibility will mean that it will be spatially autocorrelated. This in turn means that for science sake we can't overlook the autocorrelation problem, lest we pretend to have statistically demonstrated something that in fact may not be shown. Thus, even if we currently have no certainty that the tertiary job pattern we will build will be spatially autocorrelated, we will have to take autocorrelation into account and to find ways to alleviate it.

Since we're no statisticians ourselves, it is not our purpose to devise a new statistical test to get over the spatial autocorrelation problem; this part of our work will be devoted to the research of a suitable approach and its application to our data situation. The subject of spatial autocorrelation has been extensively covered by many authors who are considered references in this research field. The works of Anselin, Cliff, Clifford, Fotheringham, Getis, Griffith, Legendre, Ord, are among the most significant. Those works open the following paths to exploration:

First, when comparing two datasets, spatial autocorrelation has to be taken into account only if both datasets are affected by it (Clifford et al 1989); if one of the two datasets appears not to be spatially autocorrelated then classical tests of association can be used. Secondly, far older results of spatial autocorrelation study showed that spatial autocorrelation tends to taper off at a given distance above which there is no difference in variance due to proximity: if the mesh size matches or exceed that threshold distance, then the resulting dataset won't be spatially autocorrelated. Taken together this means that a way to remove spatial autocorrelation from our datasets would be to resample them into larger and larger cells till at least one of the two datasets is not spatially autocorrelated anymore, and then to apply classical association tests on those recoded data. The trade-off of this method is of course that we may dilute the information to a point where it is rendered meaningless, but at this point we can't say whether this will be the case: we will have to investigate.

A second direction of research is to investigate the papers that tackle directly our problem, i.e. that try to dissociate the effects of spatial autocorrelation from a correlation analysis between two datasets so as to assess the real significance of the latter. Contrary to the preceding approach and in general to the scientific assessment of spatial autocorrelation, which is pretty much well established, this subject seems to be still in its infancy and many approaches can be found without having one clearly getting the upper hand. In a first approach, some authors (Clifford et al 1989, Dutilleux 1993) estimate the effective reduction of degrees of freedom due to autocorrelation, a method which delves largely on matrix analysis and may not be very practical. A more recent approach has been the one of Lee 2001, who tries to integrate in one measure both bivariate correlative and autocorrelative processes. His approach seems less widespread but also seemingly easier to put into practice. Another direction research, suggested to us by Prof. François Bavaud from the University of Lausanne, would be to use randomization as a testing method, as in Manly 2006, even though apart from computational difficulties, we'll still need to investigate how such an approach could be fitted to our needs, particularly with respect to (again) spatial autocorrelation.

Another crucial testing of our hypothesis concerns causality. Up to now we try to establish a relationship between car accessibility on one hand and job density on the other hand, but without postulating causality between the two. But what we're really trying to test here is that car accessibility is the main explanation behind job creation: that a gain in accessibility, by any means, will result in job growth, which is going to be in the tertiary sector as it is becoming hegemonic in western economies since precisely the seventies. This in turn would imply that the reverse hypothesis isn't valid, i.e. that accessibility gains results from job growth. This isn't an immediately spurious idea: when the national highway network was devised, as a whole it was devised to connect already developed areas between them, rather than to be used as a vector of economic development and in a sense established centers conditioned the development of accessibility. In order to demonstrate or disprove either postulate, we need to take time into account. If both phenomena are merely coincident, then the highest correlations between car accessibility and tertiary job location will be shown for the same years, whereas if there is causality then a time lag is going to show it. If accessibility causes job growth then job growth will occur with a time lag: thus, job density should correlate more with accessibility as it was several years earlier than with accessibility as it is at the same time. Conversely, if job density is the driving factor then accessibility will be correlated most with job growth as it occurred a few years earlier. This is where the historical data we are gathering will come in extremely useful, as it will allow us to test those different hypotheses on several time spans.

Whatever the method chosen and our hypothesis duly tested, its confirmation by a suited statistical test would be of major significance in terms of land planning. During most of the 20th century, land planning has been influenced by other paradigms, especially the ones proposed by the great architectural currents of the early 20th century, the soviet constructivists and the Athens Charter proponents. Although both currents emphasized, in their talks and papers, the importance of the functional city, they paid surprisingly little attention to how it actually functioned, concentrating instead on how it should function in their view, and on other considerations, mainly hygienist in their purpose. This is somewhat understandable for socialist planners, whose strongly ideologically motivated decisions could be implemented and followed through disregarding their unintended consequences. In the western world though, there are ample signs that traditional urban planning didn't (and still doesn't) work the way it was intended to. For most of its history there, land and urban planning has been merely reactive to what was deemed unsound territorial development, trying to limit or to alleviate the effect markets were having on land use. The confirmation of our core hypothesis would give strong evidence that traditional land planners, by using the wrong instruments (mainly, legislation and zoning) while neglecting factors that have an actual leverage on land use (namely housing location in conjunction with transportation infrastructure), worked their way to irrelevance, applying wrong medicine to correctly diagnosed situations?

Whatever our findings, we will close our work by examining some of the alternate explanations that we have cited before, which may have an effect on tertiary job location.

The first and most obvious explanation is that planning has a lot to do with where jobs locate. In order to test this land planning hypothesis, we can rely on several affirmations. In particular, if planning is the controlling factor then tertiary job growth should occur above all in designated areas: development poles, activity zones, while avoiding all areas not specifically designated for work-related activities. As it is well known, the designation of activity pole tends to be a major political action and thus the selection of such poles is political: they do not follow accessibility-based logic, or at least not completely. Thus, the results of a land planning dominated job place location will be different than an accessibility-based one. If the land planning hypothesis is correct then in remote designated areas jobs should locate that are not warranted by the accessibility factor. Conversely, accessible areas not primarily designated as activity zones should be largely devoid of any tertiary job growth (since industrial activities are strictly confined to industrial zones, they can't be tested as they would show such a planning-dominated trend). It will not be possible to test this counter-hypothesis at the country-level, but it is certainly feasible to check it in some areas where the planning information is at hand.

The second hypothesis, dubbed here the land rent hypothesis, suggests that tertiary jobs went into the suburbs because they couldn't locate in downtowns anymore, that is, they were pushed out of downtown instead of being pulled out to edge-cities. There are several ways we can envision to test this hypothesis. As such it is linked to downtown proximity instead of general accessibility, which would then mean that the development of suburban job centers would proceed from center to the outer core, along radial axes, towards most directions regardless of their accessibility. Secondly, there should be a massive difference in job qualification between the downtowns and the suburban job centers, as this hypothesis, ultimately based on land rent considerations, postulates that only the most qualified, highest value-added jobs could remain in the city, whereas lesser qualified, less interesting jobs would relocate in the nearby suburbs. Throughout a given agglomeration outer workplace centers would then have broadly similar profiles. A last test of this hypothesis would be to test the job density in the downtowns; according to this hypothesis, the job density in the city centre should be maximal, and remain so. The high job density should also have an effect on residential population, since office rental prices are usually higher than residential rents; thus, suburbanization of jobs should be accompanied by a net reduction of inhabitants in the city's core and a strengthening of the downtown as a job center, or at least by stabilization on both counts.

The third and last explanation we could find is, by far, the most difficult to test. It postulates that accessibility nexuses would indeed see a major rise in their job numbers, but only as a consequence of more profound changes, and not per se. According to the post-fordist hypothesis, the development of suburban tertiary job centers would just be a by-product of the economical reorganization from vertical integration towards flexible outsourcing, just-in-time kind of production. The difficulty to test this hypothesis comes from the fact that it would share many of the hypotheses we link to our core idea of accessibility as a determinant for tertiary job growth, since accessibility is of paramount importance for just-in-time production and flow of goods. Thus, we would expect a suburban job surge in industrial production, warehousing and logistics starting roughly in the seventies and which would express a need for convenient transportation. This surge would then be strongly linked to the available infrastructure, which is also postulated in our core hypothesis. Likewise, this organizational disintegration and outsourcing of tasks would mean a rather severe downsizing of the mean size of companies and business units accompanied by a surge of smaller units in the accessible suburbs. Partial outsourcing would mean more, smaller units still owned to their parent company, while a complete change would mean that all those smaller units would be independent, at least on paper. At this very early stage of this hypothesis' effects exploration, it is our sense that the best point of study for testing it will rely on the legal forms and the master-servant relationships between enterprises units. In particular, if most of the new arrivals in the outer fringes are linked to a post-fordist mutation of the economy, then independent micro-businesses should be largely absent and most establishments should be branches or at least companies whose capital is held by some other company, at least in the early stages of the suburban job centers developments. Another way to test this hypotheses is to rely upon the fact that while the accessibility hypothesis means essentially easy access for potential jobholders and customers (as individuals), such jigsaw pieces need to be accessible from and to other pieces of the production system, which could be hundreds of kilometers away; in short, according to our core hypothesis accessibilities should be most desirable when they are defined in a short-to-medium range (we envision, essentially, a time travel range from 15 to 45 minutes), whereas the post-fordist hypothesis will preferentially select nodes boasting a better long-range accessibility (from 1 to 3 hours, and near airports).

It is not our goal to delve further towards showing or disproving our three counter-hypotheses. While it is essential to have an idea of other factors that could have an impact on job localization than the ones we hope to show, those counter-hypotheses are whole subjects on their own. To be thoroughly tested they would need a similar amount of research and data gathering, for each of them, than we plan to spend on our core hypothesis. We will thus test those hypotheses roughly and indicate possible future research paths that they'll seem to show us, but without going the whole way to test them thoroughly.

Our main goal is two-fold. It is first to firmly establish a relationship between accessibility and job density in the latter half of the twentieth century. This apparently simple aim does have many ramifications, as we have seen all along this introduction. First of all, it needs a workable and actable definition of what accessibility is, and as such this work will do some ground breaking as most accessibility measures existing in the field are somewhat flawed; we will try to come up with an acceptable and well-rooted definition. Secondly, it asks for a thorough job of data research and concatenation, which in itself will be a first: as far as we know, no work has been published that studies Swiss employment spatial patterns on such a long period, even though excellent data has always been at hand.

Our second goal is to demonstrate in a statistical way the existence of a relationship between accessibility and tertiary job centers emergence, taking into account the effect of spatial autocorrelation. This implies the evaluation and eventual use of various statistical methods that have been proposed during the last fifteen to twenty years, since spatial autocorrelation and its effects have become one of the hottest subjects in quantitative geography. Those new tests and methods will be applied not so much as a methodologist than as a "practitioner" who puts them into use in a given context: in that sense, it will also be a ground-breaking work, as for all the methodology advances that have been made recently in spatial statistical analysis, very few have in fact penetrated the realm of geographers, as Fotheringham et al 2000 duly and sadly remarked already a while ago. It is one of our fondest wishes that our work could serve as a demonstration of the power those new advances give the spatial scientist in actual case studies.

We give now the precise structure of the study.

1.5. Work structure

1.5.1. General structure of the work

To test this fundamental hypothesis, the proposed study is divided in four major parts. The first part includes this chapter and the next and is devoted at describing the issues at hand, the object of our research, and in chapter 2 a description of Switzerland as a case in point for conducting our study, and the data considerations. The empirical part is devolved to the study of the spatial distribution of jobs through the period under review, and will aim at describing the phenomenon as it happened in Switzerland, from its inception to current times, against various point of views. The empirical part constitutes the main part of this work, and cover five of the ten chapters, from chapter 3 to chapter 7 included. Once the extensive empirical part has been covered, we will turn towards demonstrating our core hypothesis, which will be covered in two parts. The first part, covering chapter 8, will aim at defining automobile accessibility as we mean it, which we believe is the rationale behind the emergence of suburban job centers, taking into account residential location, proximity, and transportation infrastructure and conditions, and resulting in maps and data describing potential job distributions at different times. The second part of the demonstration, chapter 9, will compare job presence results issued from the empirical part of the work with theoretical potentials as computed in the accessibility part of the research, and will test for a statistically significant relation, which means delving on the subject of spatial autocorrelation. A conclusive part, chapter 10, will summarize shortly the finds we made and avenues for further research.

1.5.2. Chapter 1: Introduction, issues, goals and structure

We are already towards the end of the first chapter of this work, which presents first the general issues which subtends this work, and the core hypothesis. A second part of the chapter is constituted by a review of the general, theoretical, non-technical literature concerning economic deconcentration, metropolization and very additionally globalization, as more technical issues in the literature are treated in their respective chapters. The third part details the various hypotheses that will guide us in our work, and the rationale behind them. A fourth and last part gives the structure of this work, of which this paragraph is the first.

1.5.3. Chapter 2: A description of Switzerland as a case in point

In chapter 2, we aim at the following goals. The first is to explain why it seems to us that Switzerland is an excellent choice to test our core hypothesis, and to give a concise description of the country and its urban history. A rather extensive literature review will give the principal results which can be found regarding the urban history of the country, especially since WWII as those works concern directly our case. Indeed, some of the Swiss literature can bring us with a wealth of information on subjects parallel to our own, even though one of the main reasons for this work is that it has never been done on Switzerland. The goal of this part is to give a precise idea of how the country is laid out, for a better understanding of the phenomena will aim at studying afterwards.

The second part of the chapter will be devolved to data considerations. First, a description of what is available, at what spatial, thematic and temporal scales, and from which source they come. Secondly, a part will be devolved at the data reconstruction and harmonization procedures we have put into place in order to render our unorganized mass of data in an operative form.

1.5.4. Chapter 3: Defining and qualifying job centers

Chapter 3 is primarily devolved at finding an operative definition at what constitutes a center, and to classify them according to several possible discriminates. The first part of the chapter will be devolved to a literature review which focuses on those contributions which aimed at finding a way to define and detect job centers. In the wealth of methods proposed in the literature, we will then combine several propositions to create our own method of job center detection. This method will be applied to all periods for which we have data and thus an evolving geography of job centers, which will constitute our prime data base for the empirical part of the study.

Once our centers defined, we will classify them according to a list of possible discriminates. We will introduce there the notion of location type, or in short location: centers can be urban, mixed urban-suburban, exurban, touristic, while the surrounding areas not included in centers will join what we will call edgeless space. Other classifications will be made according to their size, whether they show strong dynamics, their orientation, that is whether they are industry or service-oriented, their form, i.e. whether they display a high job density, or a high workers-residents ratio – what we will call job intensity –, both or none.

In that chapter we will also introduce the notions of units, clusters and superclusters. Units are the basic form of job center; in suburban and exurban space some units are clearly organized in clusters, which are groups of contiguous suburban and/or exurban units, for instance each centered on a given highway exit along a highway corridor. In case of doubt we have tended to faction suburban centers in smaller rather than large units – the constitution of clusters will allow us to study job distribution as displayed by those larger units. Superclusters group parent classical cities – our urban centers – with their suburban and exurban "daughters" to form contiguous metro areas which in this work we will call superclusters. They will notably allow us to study the evolution of the Christallerian distribution by negating the suburban emergence and attributing it all to a point-like central structure.

1.5.5. Chapter 4: A geography of job centers, 1939-2008

Chapter 4 is the core of the empirical part of this work. In it we take the job centers defined in chapter 3 and study them at nine distinct points in time: 1939, 1955, 1965, 1975, 1985, 1991, 1998, 2005 and 2008, along a precise and unvarying analysis model which will be repeated for all nine dates. At this stage, job centers are considered with their whole non-agricultural workforce.

For each date, the analysis model call for studying the job distribution against two broad lines. The first line is aspatial; it considers only categories and their evolution, as opposed to the spatial line where the actual territorial distributions are studied. In this part, urban centers are studied against their location and centrality, their dynamics, their orientation, their form. Then,. They are studied according to their size and with that respect their rank-size behavior will be studied as it bears a strong link with the Christallerian theory, of which it is a test. Those distributions will be studied at the unit size as well as at the cluster and supercluster levels.

For each date then, the spatial study will then focus on map interpretations, and will describe and analyze the spatial distribution of units against their location type and their orientation, the analysis trying to distinguish urban network patterns, broader center-periphery behavior, differences according to center size, and regional discrepancies. Then, maps will be realized at the cluster and supercluster levels to nourish further our reflection. As it is, chapter 4 comes closest to an encyclopedia of Swiss job centers between 1939 and 2008. As concentrated on the intricate details of each of the nine periods under review it never takes on the larger view. Taking the long view, tackling the long term trends is covered in the next chapter.

1.5.6. Chapter 5: The evolution of job centers, 1939-2008: the long term trends

In chapter 5 we will take the data where we left them at the end of chapter 4 and look at them again, but in a broader context. In chapter 4 our scope is encyclopedic in the way we track down details about each of the period under review, while in chapter 5 we will try to be more synthetic, and look at the long term, at the vast and mighty trends which could have escaped us in the close analysis made in chapter 4. In a sense, while in chapter 4 we look at the trees, in chapter 5 we will try to describe the forest.

The structure of chapter 5 will be as follows. For each of our discriminates: location, dynamics, orientation, form, and size, we will look at the evolution of units and job numbers, job intensity and density, mean size – except of course when looking at size classes – and job-active imbalance. Then, a study of the long term evolution of the rank-size relationships is made for all three levels: units, clusters and superclusters. A third section is devoted to the purely geographical lecture of the long term evolution, looking in particular at the evolution of the urban network, general differences seen by size, and regional effects. The chapter will close by a broader, more synthetic conclusive part looking back at all the results and trying to summarize them by location and then coming back at several transversal remarks which close the chapter and in effect the three chapter sequence.

1.5.7. Chapter 6: The spatial division of economic activities, 1975-2008

In chapter 6, we will come back on those business censuses for which we dispose of more precise data about the job distribution across economic branches, which are the eight censuses having been made from 1975 on. We will first look at the evolution of the economical structure at the national level for the 1975 to 2008 period, in order first to get a feel for the national structure of the economy in 1975, how it evolved since the, and in particular if it evolved smoothly or through crises.

The second part of the chapter will then focus on the two limiting years of our sample, 1975 and 2008. For each of those years, economic structures will first be described with regard to location type and size against job numbers. The same logic is then played against other classifications than economic groups, namely added value by job and by floor area, interaction need, job qualification and creativity. To close the chapter, a second look will be given to dynamical patterns and differences between 1975 and 2008.

1.5.8. Chapter 7: The command and control structure of the economy, 1985-2008

In chapter 7, which will be the final chapter of the large empirical part of this work, we will come back on those business censuses for which we dispose of more precise data about the control and command structure of the economy, those censuses covering the 1985 to 2008 period. Chapter 7 will be divided in three distinct parts.

The first part will concentrate on dependence links between headquarters and subsidiaries, studied for 1985 and 2008, and which are first studied at the national scale, then against location and size. This part will be concluded by a rather extensive part on the dynamics having occurred between those two dates. The second part of the chapter will be devoted to the spatial aspects of the relations between headquarters and subsidiaries for the same two years, in particular regarding the cross relations between location types, but also with regard to their respective positions in the center network, whether or not they are situated in the same supercluster, or in the same location type. The third and final section of the chapter will take a look at the international insertion of the Swiss economy as displayed by two different characteristics: international capital ownership, and import-export patterns. This third analysis is conducted on the two years for which we dispose of the data, 1995 and 2005.

1.5.9. Chapter 8: Car accessibility and its many determinants

Chapter 8 will deal with the accessibility part of our work. It will be divided in four parts. The first part consists in a literature review regarding the many operative forms which have been given to the concept of accessibility, as well as gives our own operative definition, which stems directly from some of those given in the literature.

The second part of the chapter will be concentrating on the determinants of accessibility as we will define it and which is a combination of the mean and maximal driving time, the distribution of the active population, that of the transportation network and finally, that of the commercial speeds, in link with both technological progresses and urban congestion.

The third part of the chapter will study the complex interplay between our four determinants of accessibility and will be illustrated by studies of what happens when one of the determinants is modified. This part should give us an idea of which of those four determinants have the most impact on the way accessibility behaves.

The next part of chapter 8 will be devoted to the actual description of how accessibility evolved in Switzerland with time, taking into account changes in all four determinants. This history will be a general one, as well as a spatial one., and will describe how changing accessibility patterns could give us with anecdotal evidence of a link between it and job localization.

1.5.10. Chapter 9: Statistically showing the link between job localization and accessibility

The next to last chapter of our work aims at investigating the possibility of demonstrating beyond statistical doubt the existence of a link, if possible a causal one, between accessibility on the one hand and job localization on the other hand. As several other chapters, it will begin with a review of the statistical literature dedicated to the measures of association between different spatial data and the many pitfalls to avoid when exploring this particular domain.

This will lead us to discuss the effects of spatial autocorrelation on statistical inference, as well as the remedies which have been proposed, in the literature but also in an operative way, to alleviate the problems posed by spatial autocorrelation. In particular, three methods will be discussed: the Mantel test, the Clifford-Richardson-Hemon (CRH) modified t-test for spatial inference and its development by Dutilleux, and finally the Geographically Weighted Regression (GWR) methods developed primarily by Fotheringham and its team.

The third part of the chapter aims at defining which measure of "job quality" we should use in conjunction with our accessibility measure. Four measures will be tested: absolute job numbers, job density, which is computed on built-up areas only, job intensity, and finally what we have called general job density, which is computed on the total area, as opposed to built-up area. Those measures will be tested for spatial autocorrelation, as will accessibility. Then, all four measures will be compared to the accessibility measure, and the one giving the best results will be considered for further studies.

The next part constitutes the summit of our work as it aims at demonstrating a general link between car accessibility as we defined it and a given measure of job quality. In a more general way this link will then be studied by introducing time lags between accessibility and job quality to detect eventual causalities behind the relationship. As the method of choice is a modified regression analysis, it allows for residuals to be studied, which will be done.

Furthermore, GWR allows to go beyond this general demonstration and to examine how the discovered link between accessibility and job quality spatially varies. The last part of this chapter is constructed a bit like a post face, as our main goal is already covered, and will then examine the results of several GWR analyses which will allow us to refine our findings and anchor them better in science.

1.5.11. Chapter 10: Conclusion. What was achieved, what remains to be done, and does it matter?

The last chapter, of course, will try to summarize the findings made throughout our work, to put them in relation with the hypotheses we have formulated in this very chapter and to see how we can answer them. It will also discuss the alternate hypotheses which were put forward to give alternative explanations of the phenomena we unearthed in the course of this work and see if what we have found would help show or disprove them.

As is usual at such a stage, despite quite an investment there are many research avenues, paths and ways which we have seen in course of this work and which we haven't walked. Some of those possible furthering of the research will be described there. They could be starting points for further research. In particular, we feel that the richness of the census database we have constructed has been but superficially exploited. We feel that many, many more gems remain hidden in plain view in the data provided by the Swiss federal Statistical Office which could be put into good use rather easily.

Finally, we'll close this work in a more philosophical and political way, returning to some of the finds, some of the conclusions we reached in the course of this journey and, trying to make sense of them all, remembering we graduated in an Arts faculty, aiming at a broad synthesis of it all, we'll allow ourselves to delve into the political implications of what we have found.

Let's now see what we have found.

2. Switzerland as a terrain, 1939-2008

2.1. A brief description of Switzerland as a case in point

There are many reasons why we should choose Switzerland as a case in point for a study about job localization changes, and more generally for a study about urban development. One of the main goals of this work is to study urban growth and urban redeployment in a European context, which obviously is the case of Switzerland even if it is not a member of the European Union. Urban development in Switzerland hasn't been affected by socialist urban planning as the eastern half of the continent, nor was it perturbed by war damages like much of Europe. To the contrary of much of western and northwestern Europe, Switzerland has no major natural resources like coal beds or iron ore. Thus, it hasn't seen the development of mining and steel mill conurbations, which location depends solely on the local geology and not on external factors. Switzerland is small and strongly federal in its political organization, which precluded the emergence of a strong central power in a strong central city, as in France, Spain or England. Since the treaties of Westphalia in 1648, Switzerland has been somewhat withheld from the turmoil of the continent, except during the Napoleon wars and the 1848 national revolutions, and except at these times it has been politically extremely stable, which allowed for a gradual evolution of the urban network. In short, historically and structurally, Switzerland is very close to a form of ideal space where a rural society develops burghs and cities, industry and services in an unperturbed manner. The Swiss lowlands bear a striking resemblance with the plains and cities of southern Germany, which were taken as example and inspiration by Christaller (Christaller 1933) to develop his central place theory. For all these protections from the outside world, though, in the last two centuries Switzerland has very much integrated into the world economy and has developed into one of the richest and most successful countries of Europe. Last but not least, as we will see further there is a wealth of data available about the development of Swiss communities as job centers.

2.2. Switzerland: a concise urban history

2.2.1. Before the French revolution

As we just surmised, Switzerland wasn't born an urban country and for a great part of its history Switzerland was very predominantly rural, even if cities have existed on Swiss territory since the roman times. During all the middle ages and most of the modern epoch, Switzerland's population remained largely rural. However, that wasn't meaning that cities weren't existing – in fact, very many places were recognized as cities, and quite a few held mighty powers across the country – most of which are now capitals of cantons which bear their name. But for the most part, those cities were very small, in fact nothing more than the villages they were supposedly different from. By 1798, the largest cities in Switzerland were Basle and Geneva with about 15'000 inhabitants each, followed by Zurich with a bit more than 10'000 (Bickel 1947, pp. 61-2). Those were rather modest numbers for cities which were ahead in a old and stable country. At the same time, Berne, Lausanne and St-Gallen counted between 5'000 and 10'000 inhabitants, and all other cities, even important ones like Lucerne, counted clearly less, all in a country where the first census, held in 1798, counted about 1'680'000 inhabitants (Bickel 1947, p. 51). More than 90% of the Swiss population of the time was residing in rural space.

However, this does not mean that this population was entirely devoted to agricultural works. Craftsmanship and in many cases bona fide industry had developed during the 18th century and in large parts of the country crop and cattle raising was being supplemented by industrial work, predominantly made at home, during winter months, for the benefit of a nascent watchmaking industry and an already powerful textile industry. Areas where such industrial work was developed by the end of the 18th century covered large parts of the country, especially in the Jura Mountains and the eastern half of the Swiss lowlands, from Solothurn to St-Gallen. At the same time, in Basle the textile industry had spawned a spin-off in the guise of the dye industry which would give birth, later, to the chemical and pharmaceutical giants we now know. The industrial production was transferred to the countryside to avoid restrictions by the corporations which were very much in command in most cities (Favez et al 1986, pp. 436-8). This delocalization and dissemination of industrial production would later give rise to a much decentralized form of industrial production, under the guise of industrial villages and burghs. For their part, Geneva, Basle and Zurich had already long been important commercial centers. With the development of the first world-economy during the modern epoch, those three cities, along with several others, entered the world market by way of its commercial establishments, and the associated financial institutes (Favez et al. 1986, pp. 439-40).

2.2.2. The early 19th century and the inception of the industrial revolution: 1798-1848

In the 18th century, Switzerland's population had passed from approximately 1'200'000 to about 1'850'000, a growth of about 50%. According to Bergier 1986, Switzerland experienced in the latter half of the 18th century an anticipated industrial revolution which was distinctly rural in its settings, as the city corporations barred industrial development, which they rightly saw as a threat to their political and economical grip, from entering the cities. From this first industrial revolution came a much decentralized structure of industrialization which is still visible today in parts of the country, under the guise of industrial villages. In the next century, it would more than double, to attain 3'900'000 inhabitants in 1910 (Bickel 1947, p. 113) – the 19th century was a period of great upheaval for Switzerland, and indeed for the whole western world as the industrial revolution which was born in the latter 18th century in Great Britain diffused throughout Europe. The beginning of the industrial revolution in Switzerland can be traced back to 1801 and the importation of the first spindles in the country; by the middle of the century, Switzerland had industrialized very strongly and it was employing way more than 100'000 persons. By about 1880, industry had overtaken agriculture as the economical sector with the most jobs, which numbered in 1888 543'000 against 488'000 in agriculture. Industry would remain the dominant form of economic activity for most of the following century. In 1910, industry occupied 811'000 persons in Switzerland, close to half of the active population, against a quarter in agriculture and the rest in the nascent services (Bickel 1947, p. 127). For the whole 19th century, the textile industry remained by far the most important employer of the industrial sector. Including the clothing industry, the textile industry went from 270'000 jobs in 1888 to 324'000 jobs in 1910. Construction accounted for 116'000 jobs in 1888 and 205'000 in 1910, watchmaking for about 50'000 jobs throughout the period.

As we already surmised a great part of the budding industrial production of the 18th century was disseminated throughout large parts of Switzerland, so that initially the industrial revolution did not register as a sudden apparition of large-scale new industrial cities. In their definition of 2000, in 1850, there were 30 communes counting more than 5'000 inhabitants, for a grand total of 342'000 persons, or about 15% of the total population of the country. Of these, only nine units counted more than 10’000 inhabitants: Zurich (41’000), Geneva (37’000), Berne (30’000), Basle (27’000), St-Gallen (18’000), Lausanne (17’000), Winterthur (14’000), La Chaux-de-Fonds (13’000), and Lucerne (11’000). Interestingly, the upper hierarchy had evolved much, with the rise to top position of Zurich, the strong reinforcement of Berne, St-Gallen and Lausanne, the relative atonement of Basle, till then the mightiest city of the country, and the rise in the top six of a completely new kind of city, the industrial town, with Winterthur and La Chaux-de-Fonds. In the Zurich case, the city as it was then delimited counted only 17’000 inhabitants and had begun to spill over onto the already fast growing communes situated on the other side of the former walls of the city (Schuler et al 2002). As compared to the 1800 figures, one can still note that those cities had at least tripled their population in fifty years – while still very small in international comparison, cities were indeed booming. The second notable point is the advent in the biggest cities of the time of truly industrial centers without any political function, like Winterthur and La Chaux-de-Fonds, a testimony of the industrialization of the country.

2.2.3. The late 19th century: the urban revolution, 1848-1914

The second half of the 19th century was marked by the relentless urbanization of Switzerland, which gradually evolved from a agricultural country to an industrial one. In terms of job numbers, at the national level industry took over agriculture around 1880, so that by 1888 and the first population census which gave activity data, industry already had a clear lead with 543’000 job holders against 489’000 for agriculture (Bickel 1947, p.127). Since the early part of the 19th century, corporatist regimes had been progressively replaced by democratic and radical ones, an evolution complete by the end of the Sonderbund civil war, in 1847. The effect was that cities were now open to industrial development in the same way than other locations had been before. From then on, the industrial revolution would concern cities as well as countryside. At the same time transportation underwent its own revolution with the advent of the railroads. The first Swiss railway segment was opened in Basle towards France in 1845, and the first entirely Swiss line between Baden and Zurich in 1847. Half a century later, by 1903 and the nationalization of several railway companies to form the federal railways, the Swiss railway network was more or less complete except in the Alpine regions, and manufactured products could be easily shipped anywhere, provided that production was situated on a railway line. The combination of business liberation experienced by cities and the concomitant industrial and transportation revolutions ensured that cities duly exploded during the period under review – as said, by 1914 Switzerland was one of the most industrialized countries of the world – by 1910, industry was by and far the largest employer of the country, with 809’000 employees, against 483’000 in the primary sector and 403’000 in the service sector (SFSO 1920, p. 2 and following).

Those developments had two further effects: while it had always been an emigration country, Switzerland became, towards the last decade of the 19th century, an immigration country (Bickel 1947, p. 159). During the 60 years separating 1850 and 1910, the Swiss population passed from about 2’390’000 to 3’750’000 people; half of this growth had happened in just two decades. In any case, by 1910 the population of the major centers had duly exploded, to the following values: Zuirich counted now 215’000 inhabitants, against 132’000 in Basle and 115’000 in Geneva. Berne followed at 91’000, St-Gallen at 75’000 and Lausanne at 65’000, Winterthur at 46’000, Lucerne at 39’000, La Chaux-de-Fonds at 37’000 and Biel at 32’000 persons. In all, 24 communes counted more than 10’000 persons, a great number of which were genuinely new industrial centers: St-Gallen, Winterthur, La Chaux-de-Fonds, Biel, Schaffhausen, Herisau, Vevey, le Locle, Rorschach, or Arbon. The spatial repartition of those cities underlined the economical domination of the eastern half of the country, with Zurich having now definitely supplanted Basle as the largest city of Switzerland, St-Gallen playing the role of a regional center greater than Lausanne, and a number of new industrial cities implanted in eastern Switzerland – conversely, western Switzerland, outside the Jura Mountains, was clearly lagging behind. In all, the 1910 census publications estimated that about 27% of Switzerland's population was urban (Schuler 1999, p. 364). In 1850, taking into account only the communes with more than 10'000 inhabitants this figure hovered a little above 6% (Schuler 1999, p. 366).

2.2.4. The early 20th century: between wars and depression, 1914-1945

The period of strong growth experienced especially between 1888 and 1914 came at an abrupt end with the advent of WWI. Even if Switzerland wasn't directly involved in the conflict it signaled a change of epoch, which was marked, for Switzerland, by a period of very slow population growth, or none at all. There were 3'900'000 people in Switzerland in 1914, and 4'430'000 in 1945, while half of this difference made just during the WWII years. A number of reasons can be advanced to account for this very sudden drop in population growth. The first is that the foreign population growth was abruptly reversed in 1914 with the call to arms of most of its male members. The foreign population further dithered after WWI by a general political climate very much adverse to cross-border relations and migrations, especially with the two totalitarian powers which emerged in Italy and Germany, which were the two main purveyors of foreign workers (Bickel 1947, p. 167) till then. The great depression years, and then WWII prevented any trend reversal and thus the foreign population, which represented around 15% of the total population in 1914, dropped to just 5% in 1941 (Bickel 1947, p. 215). This happened at a time of demographic transition marked by a strong decrease of the birth rate, from 24 ‰ in 1911 to 15 ‰ in 1937, a phenomenon which was no doubt amplified by the scale of the economic crisis of the 1930s. The wars and crises of the time prevented much movement in the industrial structure of the country, which was strikingly similar in 1941 as what it had been in 1910, with industry at 868'000 employed people, less than 60'000 more than in 1910, agriculture at 415'000 employed, about 75'000 less than in 1910. Conversely, the service sector had strongly progressed through these troubled times, not least because of the state involvement in various domains, such as the number of people employed in the service sector jumped from 403'000 in 1910 to 709'000 in 1941, with various public services taking up to 200'000 of those (SFSO 1948, pp. 113 and following)

While the total population grew far less than before, the urbanization of the country progressed as before. By 1941, most, but not all, of the largest cities of the country had grown even through the war and depression period. This was the case, notably, of the "big five" which emerged during this period as the fundamental armature of the Swiss urban network, with Zurich (336'000 inhabitants, up by half since 1910), Basle (162'000, up 30'000), Berne (130'000, up 40'000 persons), Geneva (124'000, relatively stable), and Lausanne (92'000, up 28'000). It can be seen first that Zurich grew particularly strongly during these times, its growth being triple that of the second best, Berne, and quadruple that of the second city of the country, Basle. In that sense, the early 20th century is the time of the establishment of the Zurich primacy in the urban network. Elsewhere, the progressive affirmation of the federal state had a beneficial effect on the position of the federal capital, Berne, while Geneva was particularly hard hit by the depression years and merely stagnated during these times. Those changes, right at the top, hint at the fact that general urban growth was spatially quite selective. In particular, several industrial centers registered steep population declines during the interwar years, none more impressive than in St-Gallen

(62'000 inhabitants in 1941, down 13'000 since 1910). Other cases included Herisau, La Chaux-de-Fonds and Le Locle, Neuchâtel, Vevey or Montreux. In the last case, the touristic collapse consecutive to WWI was responsible, whereas elsewhere, industrial crises were to blame. In particular, the textile industry decline in Eastern Switzerland, till then the most industrialized, most modern part of the country, was particularly marked and contributed to relegate St-Gallen out of the big five league. However, all industrial towns didn't decline at the time, as the examples of Zurich and Basle, both strongly industrialized, demonstrate – Winterthur, Biel, Thun and Olten grew strongly.

Apart from those important changes in the urban network with the rise to prominence of Zurich and the loss of importance of several regional centers, another phenomenon started to manifest itself around bigger cities and some industrial centers: commuting. By 1910, commuting, here defined as being the travel from a commune of residence to a commune of work, was considered important enough to warrant its investigation in the national census (SFSO 1919). The results were that about 9% of the active population in 1910 was commuting (SFSO 1919, p. 3). It was also found that in all, commuting was most marked in the greater cities, where already 13% of all workers came from outside (SFSO 1919, p. 4). Likewise, rural inhabitants were already about 10% to commute elsewhere to work. By 1920, the phenomenon had become important enough for the Federal Statistical Bureau to indirectly recognize that functionally and in terms of commuting patterns, some cities had begun to form agglomerations. Those were a group of communes formed by one or two central cities around which several suburban communes would aggregate, and which would be recognized by the large share of their active population which would commute towards the central city or cities. Independently of the numerous methods that have been devised through time to define the agglomerations, those would become a fixture of the statistical publications in Switzerland starting with the 1930 population census (Schuler 1999, p. 355 and following). Accordingly, the Zurich agglomeration as of 1941 counted 449'000 inhabitants, Basle 242'000, Geneva 187'000, Berne 185'000 and Lausanne 127'000; all other cities and agglomerations remained well under 100'000 inhabitants, underlining the growing imprint of the big five on the Swiss urban network. Worthy of note also is the fact that by and large, cities remained clearly dominant in their agglomeration, grouping between two thirds and four fifth of the population of their agglomerations. Taking them into account the agglomerations, the figures for 1941 show a strong jump in urban population, which attained now 39% of the total population, against 27% in 1910. During the depression and the wars, Switzerland had continued to urbanize, albeit in a differential and slow manner.

2.2.5. The middle 20th century: the urban boom years, 1945-1973

The 1945 to 1973 period was noted for the relentless growth of the Swiss economy and with it the population in general, from 4'430'000 persons to 6'360'000 in 1974. The very favorable economic conditions and the advent of a peaceful and more open Europe boosted foreign population numbers, which climbed from about 225'000 or 5% of the total population to 1'085'000 or 17% in 1974. Of the about two million more people there were in Switzerland in 1974 as compared to 1945, about 40% were foreigners. Switzerland absorbed this population influx by urbanizing, or more exactly by suburbanizing. The urban population went from 1'660'000 persons, 39% of the total, in 1941 to 3'615'000, or 58%, in 1970. There was a near perfect correspondence between the rise of the total population, and the rise of the urban population. However, urbanization progressed above all by spilling over towards adjacent communes to the already urbanized ones. Whereas in 1941 only 109 communes out of 2896 were considered urban, the number had more than trebled by 1970 to attain 375 units, while the total urban population had more than doubles. Thus, cities, or more correctly by then agglomerations, had probably grown at least as much by spillover than by densification. This is further confirmed by the compared levels of the big five cities and their agglomerations, for 1941 and 1970:

	1941			**1970**		
	City	**Agglo**	**Comm. Nb**	**City**	**Agglo**	**Comm. Nb**
Zurich	336'395	357'475	6	422'640	719'324	51
Basle	162'105	201'972	9	212'857	381'453	24
Genève	124'431	144'423	5	173'618	321'083	28
Berne	130'331	161'641	8	162'405	284'737	21
Lausanne	92'541	106'584	4	137'383	226'684	24
Lucerne	54'716	83'543	6	69'879	155'742	11
Winterthur	58'883	58'883	1	92'722	110'041	9
St-Gallen	62'530	62'530	1	80'852	90'327	3

Table 2-1: Selected cities and agglomerations populations and commune numbers, for 1941 and 1970

Several facts can be read from the table. The first is that central cities grew very strongly during the period under review, at the same rhythm, in absolute numbers, than in the two decades preceding WWI. However, suburbanization had become even more impressive that the urban core growth, such as in the cases of most major agglomerations, whereas the burgeoning suburban belt of 1941 represented only a small minority of the agglomeration's population, by 1970 the suburbanites represented close to half of the major agglomerations population. The evolution was also spatial, as can be seen, with a spatial diffusion of suburban belts, which engulfed 46 communes in Zurich, 23 in Geneva, 20 in Lausanne, 15 in Basle and 13 in Berne: agglomerations were getting spatially larger as well as more populated.

Several other evolutions accompanied this phenomenon. The most important is probably the rise of the tertiary sector. True, the industry remained dominant throughout the period under review and played a major role in the economical development of the country. Correspondingly, the number of people employed by the industry grew from 868'000 employed people in 1941 to 1'452'000 in 1970. However, during the same period the service sector progressed even more, from 709'000 to 1'324'000, while agriculture had gone down severely, from 415'000 to 229'000 (SFSO 1972a, p. 210). The period was thus marked by the progressive marginalization of agriculture as an economic sector, and the strong progresses made by the service sector, even if at the time the industrial overtone of the Swiss economy still looked natural. The second big evolution of the time was the advent of individual transportation for all, which provoked a revolution of the same magnitude as the apparition of railways a century earlier. Whereas in 1941 most people were still travelling on foot, by bike or public transportation, by 1974 most actives had access to a car. The sheer numbers of cars suddenly invading the cities and the countryside had persuaded the federal state to respond in kind by developing the highway network of the country, which came progressively online during the last decade of the period under review. The advent of the motor car was evidently playing a major role in the spreading of the cities, as workers weren't limited anymore in their residential choices by the proximity to their workplace or to a relevant access to the public transport system. Whereas, till then, suburbanization had progressed mainly by adding dense residential and industrial neighborhoods in the immediate continuity of the central city or in a radial pattern along public transportation routes, the new way of moving around allowed for every space not too far from a work place typically situated in urban centers to be considered as a potential residential choice.

2.2.6. The late 20th century: towards metropolis, 1973-2008

The oil shock of 1973 opened a new era in the way Switzerland's urban network evolved. First, economic conditions took a turn to the worse in 1973 and even if the situation was rather rapidly overturned, for the next thirty years it would not return to the heights it had known between 1945 and 1973. Instead, the economic context alternated between periods of recession (the mid 1970s, the early 1980s, most of the 1990s, the late 2000s) and economic booms (above all the late 1980s and the mid 2000s). The global population reacted differently to those various phases, with migratory patterns growing less and less sensible to economic up and downturns. In all, the population of Switzerland went from 6'356'000 people in 1974 to 6'368'000 in 1980, marking a strong stagnation, and then resumed growth in the three decades which followed, to 6'874'000 in 1990 (+506'000), 7'288'000 in 2000 (+414'000) and 7'786'000 in 2009 (+498'000 in nine years). The effect of economical crises is striking in the 1970s, where the oil shock provoked a brutal halt in the population growth of the country. Twenty years later, the 1990s crisis only slowed population growth a bit, while the financial crisis of the late 2000s had essentially no effect on population growth.

The first of these crises put an abrupt end to the relentless of the population rise that had affected Switzerland after 1945, the country losing 140'000 inhabitants in the late 1970s to emigration alone, the highest figures ever recorded in such a short time and the reason why, essentially, the 1980 census recorded the same population numbers as the 1970 edition. However, this stagnation turned out to be quite temporary. During the 1980s, the net migration balance returned to the positive levels seen by the late 1960s, and then a great wave of immigration happened in the early 1990s. Contrary to the 1970s crisis, the 1990s crisis did not result in massive emigration, but only in a temporary halt in immigration. During the 2000s, the level of immigration returned to record levels with a positive migratory balance of 100'000 people in 2008, a figure seen only once before, in 1961. The third major economic crisis of the cycle, which started in 2008, seems to have had no major effect on immigration, and thus, decade for decade, the 2000s have been by far the period when net immigration was largest: the country gained 518'000 people by net immigration during the decade, against 367'000 in the 1960s, 258'000 in the 1950s, 248'000 in the 1990s, and 208'000 in the 1980s – the 1970s recording a loss of 125'000 people. This surge in immigration was however compensated by the decline of the birth rate since the 1970s, which explains why, even though immigration was at its highest, the total population growth remained comparable to what it had been in the preceding decades.

As expected, the foreign population took the brunt of the changes mentioned earlier – its proportion dropping during the 1970s from a maximum of 17.1% in 1974 to a low of 14.4% in 1979: by then, there were some 180'000 less foreigners than five years before. Then, their numbers started to climb back, such as in 1990 their proportion was back at 16.7%, then 19.8% in 2000 and 22.0% in 2009. In absolute terms, the foreign population progression is more impressive, going from 904'000 persons in 1979 to 1'714'000 in 2009. In short, Switzerland is in the middle of a population boom.

Those evolutions went together with marked changes in the territorial structure of the urban network. First of all, the period was one of marked urban growth, the urban population growing from a 58% share of the total population in 1970 to a 74% share in 2009. At the latter date, the urban population counted 5'733'000 inhabitants, up more than two millions since 1970. The population boom was coupled in Switzerland with a clear urban boom. As the following table shows, this period of urban growth was marked by various phenomena. Here are the 13 agglomerations with more than 100’000 inhabitants in 2009:

	1970			2009		
	City	Agglo	Comm. Nb	City	Agglo	Comm. Nb
Zurich	422’640	719‘324	51	368'677	1‘170‘203	132
Basle	212'857	381'453	24	166‘173	497‘973	74
Genève	173'618	321‘083	28	185'958	521‘396	74
Berne	162'405	284‘737	21	123‘466	350‘792	43
Lausanne	137’383	226‘684	24	125‘855	330‘865	70
Lucerne	69’879	155’742	11	59’509	207‘612	17
St-Gallen	80’852	90’327	3	72‘642	149‘592	11
Winterthur	92’722	110’041	9	99'377	136‘956	12
Lugano	27’121	61’818	24	25'254	134‘972	72
Baden(-Brugg)	14’115	66’855	12	17’684	115‘722	23
Olten(-Zofingen)	21’209	49’026	11	16’891	109’147	26
Zug	22’972	49’393	4	26’322	106’560	10
Fribourg	39’695	51’212	5	33’606	102‘963	42

Table 2-2: Selected cities and agglomerations populations and commune numbers, for 1970 and 2009

First of all, agglomerations had grown; there were 7 agglomerations above 100’000 inhabitants in 1970, there are now 13 of them. In the big five there were marked differences between Zurich, Geneva and Lausanne which all grew very strongly, and Basle and Berne which growth was more lackluster. Some agglomerations displayed very strong growth rates, especially in the bottom half of the table, with Lugano, Olten-Zofingen, Zug and Fribourg more than doubling their numbers. More importantly, agglomerations grew massively in size and colonized new areas. Correspondingly, the number of communes which were grouped in agglomerations exploded, from 375 communes in 1970 to 979 in 2000. At the latter datem, there were nine times more urban communes than in 1941, and since 1970, all major agglomerations of the country had more than doubled their communal numbers, as can readily been seen in the preceding table. The third major point worth noting is that while agglomerations were growing relentlessly, their urban cores had begun to lose population. Of the 13 major agglomerations urban cores, only four (Geneva, Winterthur, Baden and Zug) managed to grow since 1970, while some larger cities, notably Zurich, Basle and Berne, suffered very heavy losses against their suburban and periurban belts. The direct consequence was that whereas in 1970 central cities generally still hosted the majority of the agglomeration’s population, by 2009 in all major agglomerations save one (Winterthur), suburban and periurban populations vastly outnumbered urban ones. Thus, the general picture was contrasted. After 1973 the growing population continued to concentrate in urban areas, but in parallel, those urban areas spilled over formerly rural territory at a rate never seen before, and internally, the period was clearly one of population dissemination, with dense urban centers losing population to less dense suburban and periurban belts.

Looked at from the regional point of view the period of general urbanization before 1973 was clearly one of opposition between central and peripheral areas, and thus the population redistribution which had happened since the industrial revolution and the start of massive urbanization, with strong gains in urban areas compensated somewhat by the strong losses experienced by rural areas, especially in peripheral regions like the Alps. The 1973 crisis exacerbated this phenomenon as it hit especially hard industries that were prevalent in peripheral areas and thus threatened to further the division between a winning urban Switzerland in the central areas and the plains, against a losing peripheral one, especially in the mountains. The federal state reacted by promoting a policy of equilibrated development which was to sustain the areas of the country which were experiencing severe economical difficulties. Most of these areas were in periphery, and the majority of them were in the mountains. Thus, for about thirty years, Switzerland formally had a policy of regional equilibrium which was aimed at preventing the depopulation of peripheral spaces. Accordingly, during the first twenty years of the period under review, peripheries enjoyed a positive demographical and economical development. At the same time, many less developed areas in the plains also enjoyed better than average growth, which resulted in former rural and backwards areas taking progressively center stage in the urban landscape of Switzerland. In particular, Central Switzerland and Canton Fribourg strengthened during this period.

2.2.7. Current developments: the early 21st century

A second rupture happened after 1991 and the end of the cold war. From 1945 to 1991, the Alps had played an important symbolic and strategic role in the country, which benefited them as it received much attention from the federal authorities – then, and until 2007, the new regional policy also sustained the alpine regions. However, since 1991 the alpine arc has lost much of its strategic significance, at the same time that a severe economic crisis hit the country. Population and economic development since the 1990s show that after twenty years of equilibrated development where peripheries and small towns seemed to do, in all, better than major centers, growth disparities between central areas and peripheral ones started to appear again in favor of central areas from the 1990s on. Meanwhile, the strong development of formerly rural areas in the lowlands continued unabated, which reinforced the disparity between an ever larger central area, and the remaining peripheral ones, essentially situated in the mountains.

Lastly, the period was one of metropolitan growth. The massive spilling of agglomerations towards rural space first made many of them contiguous. By 2000, it was thus possible to go from the Gäu complex to Frauenfeld without ever leaving urban space, the same feat being possible between Fribourg and Burgdorf, or from Wil to Altstätten in Eastern Switzerland, and the four Ticino agglomerations are very close to being all contiguous. Preliminary studies show that in those areas agglomeration can't go on growing by feeding on rural space as interstitial rural areas have now disappeared there. Such growth seems now limited to areas where ample space remains, mainly in Western Switzerland, especially around Lausanne. At the same time relations between the agglomerations have been seen to develop strongly during the period under review, with the emergence of networks of cities around Zurich, Basle, Berne, and between Geneva and Lausanne and the four Ticino cities. By the publication of the 1990 population census results, the Federal Statistical Office had recognized the existence of metropolitan areas and agglomeration networks (Schuler 1994), with three metropolises around Zurich, Basle and the Geneva-Lausanne couple, and two agglomeration networks around Berne and Lugano, the difference between the two being above all their population size, metropolises counting, with their cross-border regions, more than one million inhabitants while agglomeration networks were clearly smaller.

It seems likely that the metropolization processes will go on in Switzerland as the continuous agglomeration spatial growth seems to have reached a wall. In major parts of the Swiss lowlands, the agglomerations are now contiguous and can't grow anymore by territorial spillovers. In the meantime, since 2000 the population growth has been very predominantly urban, with 469'000 more urban inhabitants against 118'000 more in rural space, such as the mean growth rate has been, again, superior in the urban areas than in the rural ones. Thus, as agglomerations can't grow by extension anymore, they start top densify. Surprisingly enough, it is interesting to note that the agglomerations where densification during the 2000s has been the most spectacular are often those situated in environments which would allow for spillover: Bulle holds the record, with Monthey-Aigle and Fribourg behind. All three agglomerations have ample space around them to develop further, which suggests that their real growth is probably larger than the one we have found of about 2.5% of annual growth for Bulle since 2000, 1.7% for Monthey-Aigle and 1.5% in Fribourg, Vevey-Montreux, Wetzikon-Pfäffikon, Sierre-Montana, Lachen, Yverdon-les-Bains, Kreuzlingen and Martigny. One can but note that the vast majority of those agglomerations are situated in the western part of the country and thus further the urban catching-up of this region. More generally, most of those dynamic agglomerations are situated either close to the limits of a metropolis, either in (Wetzikon-Pfäffikon, Lachen, Vevey-Montreux, Yverdon-les-Bains, Fribourg) or out (Bulle, Aigle-Monthey). This suggests that growth areas are currently situated in the outer ring of metropolitan spaces, and that the general dynamics of these metropolises plays a role in the dynamics of these outposts – in fact, the Zurich, Geneva and Lausanne agglomerations have grown more than the Berne and Basle ones in the last decade.

Conversely, the old industrial cities and agglomerations continue to lag behind, with 16 of them recording less growth than rural space on the decade: besides Basle and Berne, St-Gallen, Biel, Neuchâtel, Solothurn, Chur, Arbon-Rorschach, La Chaux-de-Fonds-Le Locle, Chiasso-Mendrisio, Brig-Visp, Burgdorf, Grenchen, Delémont, Langenthal and Davos. Except for four of them (Berne, Chur, Burgdorf and Davos) these places can be qualified as industry-oriented and correspondingly they are situated predominantly in industrial regions, especially the Jura Mountains and piedmont, with half of the units coming from there. None of those agglomerations are linked to the Zurich or Lake Geneva metropolises, and many of them are clearly peripheral. Worthy of note also that none of them is situated in Aargau, Central Switzerland or in the westernmost parts of Eastern Switzerland: the greater Zurich metropolitan area protects agglomerations in a vast area around it from declining. The same can be said for Fribourg and most of Valais regarding the Lake Geneva metropolis, which it at the center of another growth ring going from Yverdon to Sierre through Fribourg, Bulle and the lower parts of Valais.

Thus, in all probability, the metropolitan processes which have been first widely recognized in the 1990s are probably being reinforced as agglomerations situated at or near the outer edge of the two major metropolitan spaces of the country, around Zurich and Lake Geneva, thrived while peripheral agglomerations, and perhaps more surprisingly, metropolitan ones which are not close to the two focal points just mentioned seem to lag behind. Thus, territorial differentiation is still at work, still modifying the way territory adapts itself to new conditions. In the next decades, urbanization in Switzerland will have to reorient from the sprawling form it has assumed since the end of WWII as all territorial reserves will soon be used up already.

2.3. A literature review of developments in Swiss urban research

2.3.1. Introduction and scope

Even though a large part of this study is devoted to describing various phenomena taking place in Switzerland, Switzerland is not our prime subject. Our main concern is actually more general and is to describe a geography based on job places rather than residents, on people at work more than on people at home. A second goal of our study, beyond the actual analysis of the historical and recent developments in territorial repartition of job places, is to try to understand the determinants of those evolutions. In that sense, Switzerland is a "mere" case of study, and not the focal point of our research. Thus, we don't feel compelled to write a comprehensive history of the urban research in Switzerland. Instead, we will try an oblique take on this corpus from the point of view of the history of job place localization and its determinants.

Many of the elements we outlined in the preceding section have been taken from this corpus of research.

2.3.2. The Swiss geographical research: an oblique view

Many authors have delved on the urban structure of Switzerland since a very long time ago. We can for example trace thinking on the urban structure of Switzerland all the way back to Franscini 1848. A polymath, Stefano Franscini was the foremost statistician of Switzerland in the 19th century, as well as a successful politician. Franscini was convinced that good government came with good knowledge of the country to govern and dedicated his life to further statistical research in Switzerland. Once in power, which he reached after the 1848 founding of modern Switzerland, he was the driving force behind the creation of the Federal Statistical Bureau, the forbearer of the current Federal Statistical Office. In his writings, Franscini emphasized the very small size of Swiss cities as compared to their European counterparts. As already seen, this probably was a consequence of the "anticipated" industrial revolution of the 18th century, which affected above all rural settings and hindered urban growth (Bergier 1986). Piveteau 1982 had already hinted at this rupture in Swiss urban history occurring around 1848, with industrialization hitting above all rural settings beforehand, and urban centers after – Piveteau 1982 would then claim that a second rupture happened around 1950 with growth leaving again the centers. The decentralized political organization of the country made it very difficult for a city to emerge, at least before the complete economical unification of the country in 1848. Thus, the rapid development of interurban railway links was the real starting point for city developments as cities were becoming railway nodes, thus getting a far better accessibility than any other place, especially in their suburbs – development of suburban public transportation came only later and generally did not reach to the suburbs till even later (Aerni & Egli 1991). In his population history of Switzerland, Bickel 1948 treats urban development as a subject of its own. Written towards the end of WWII, Bickel 1948 still puts the emphasis on pure urbanization, without devoting much space to the emergence of agglomerations. In regional terms, by comparing cities, he was able to show that urban growth was above all affecting a class of large cities, while medium and small sized cities reacted less. Similarly, Bickel 1948 compared urban growth with rural depopulation, thus essentially conforming to a classical center-periphery model.

By then, however, suburbanization was a relatively old phenomenon. In 1893, Zurich grew by incorporating eleven communes. According to the website of the Zurich City statistical office, this communal fusion elicited its creation, in order to measure the differences between the old city and its new neighborhoods – an indirect recognition of the fact that cities were spilling over their neighbors and that those new city parts were different than the center. According to Schuler 1999, the first mention of the noun "agglomeration" was made as early as in the publications concerning the 1888 population census; however no definition is given of them. The same author argues that the main way official Switzerland dealt with burgeoning suburbs between 1880 and 1930 was by incorporating them into their parent cities. Such major communal fusions were made in Zurich in 1893, in Biel between 1900 and 1919, in St-Gallen in 1918, in Berne in 1919, in Winterthur in 1922, in Geneva in 1931, and in Zurich again, for a further wave of eight communal incorporations in 1934. This may explain why, in one of the great works of the epoch, Früh 1938 does not recognize agglomerations – to the author, urbanization does concern only the central cities and their recently annexed suburbs. Towards the end of the period however, agglomerations were first recognized by the Federal Statistical Office, with the official delimitation of agglomerations for the 1930 and 1941 censuses; however, the official publications give no indication as to how those agglomerations were built. On the contrary, Carol 1946 gave a precise method to detect and build agglomerations, essentially on a morphological basis, which in his work resulted in detecting 113 agglomerations of 1 sq km or more of built space, 44 of which were composed of two or more communes, for a total of 245 – to the dedicated researcher, Switzerland had clearly started to suburbanize. A few years later, Jenal 1951 unearthed unpublished results of the 1930 and 1941 population censuses. This paper is, to our knowledge, the earliest description of precise commuter flows between pairs of communes in Switzerland. In that important contribution, the author points out the fact that commuter flows are highest inside agglomerations, between suburban and central communes, which came close to say that commuter flows could be used to define agglomerations as well as morphological and built space continuity. The author concluded his paper by stating that short of industrial dissemination, the growth of commuter flows would one day stop rural depopulation – a quite insightful comment.

Starting in the 1950s, there was a strong growth of the number of studies devoted in suburbanization. Some, like Disteli 1954, concentrated on the morphological consequences of the suburbanization of formerly rural villages. A certain number followed Jenal 1951 by studying commuting: Wiesli 1959 on Grenchen and Zofingen, or Barbier 1961 on Lausanne, while others were pursuing the morphological road, like Schärer 1956 on Zurich. In any case, those developments caused concern among specialists, as Bridel & Winkler 1958 proved by describing first the problematic of urban expansion. To our knowledge they were the first, in Switzerland, to note the population decreases experienced by central areas against the suburban belts. Notable, also, the fact that urban expansion was seen as a problem, with possible solutions listed, mostly variations around the concept of the new town. At about the same time the Federal Statistical Office embarked on a far more elaborated effort to define its growing agglomerations and to give a clear definition of them (Schuler 1999, p. 372-3), which resulted in the first articulated definition of agglomerations in Switzerland, that of the 1950 population census. By 1960 in Switzerland, the existence of agglomerations, complete with centers and suburban belts, wasn't debated anymore. However, during those years, what was part of an agglomeration was still open to discussion, and in particular whether agglomerations should be described by their morphology – essentially, high density and continuity of built-up space, or functionally, encompassing commuting areas. Only for the 1970 census would the Federal Statistical Office clearly choose the second alternative to update its agglomeration definition – we could expect that by then, conceptually, agglomerations were accepted in their functional sense (Schuler 1999, p.378), even though there had been by then plenty of studies demonstrating such a link, starting more than twenty years before with Jenal 1951.

The 1960s were marked, in Switzerland, by a strong emphasis on regional geography. This was exemplified in the structure of the Opus Magnum of the time, the Geography of Switzerland of Gutersohn 1958, which was even more regional-oriented as Früh 1938 had been a quarter of a century before. It is also seen in the increase of the number of monographic regional studies, as seen for instance in Disch 1962, Piveteau et al 1968, Piveteau & Gaudard 1969, Valarché et al 1970, Wiesli 1970. This emphasis on regional geography was pervasive, in Switzerland, until the early eighties. One of the effects of triumphant regional geography was to make economic geography central, and the studies we mentioned were almost always interested by economics. Correspondingly, the 1970s were a time of renewed interest in economical geography and for the first time specific studies about job repartition were published. Many of the economical studies of the time were canton-based, which made their relevance for our specific subject rather remote (Elsasser 1972, Fischer 1985a). However, others were more specific. While by definition they were monographic, some chose new areas of interest, namely the working suburbs and the highway advent, as Alt & Elsasser 1971 on the Birrfeld area in Aargau, and Pfister & Moll 1973.

Both of those studies are very significant. Alt & Elsasser 1971 is to our knowledge the first study devoted at a suburban locality singled out as a job place as well as a residential one. Pfister & Moll 1973 unearthed the Gäu complex and the edge cities of northeastern Berne decades before others, and found out the importance of highway accessibility in the decision process of business localization. In that work the authors also remarked that all highway exits did not display the same potential, with exits away from great centers or at no strategic locations displaying less potential, and that the territorial impact of highway planning had been hugely underestimated and that their consequences needed to be taken into account when planning them. At the same time, Fritz et al 1973 established a strong link between general accessibility and land prices in the city of Zurich, a very important result which established again the desirability of accessibility and at the same time explained how the most accessible locations were becoming too pricey for land-hungry activities or people. In 1971, the ORL Institute at the Swiss Federal Institute of Technology – Zurich published its Leading Concepts for a National Land Planning (Rotach & Ringli 1971), an extensive analysis of the then situation of the geographical state of the country as well as a program for its territorial future. The authors detected that deteriorating access conditions in the urban centers, which were noticed by then, could result in companies leaving for easier to access suburbs – however this realization wasn't pursued in the rest of the work and of the ten or so territorial variants envisioned, none postulated the extensive development of the suburban job centers. Most of the scenarios envisioned various possible urban networks always strongly focused on the urban centers as sole job provider for the agglomeration, of which by the way very few things were said, even in their residential dimension.

Ten years later, regional geography would also triumph in the results of the National Research Program devoted to Regional Problems in Switzerland. Realized between the late 1970s and the early 1980s, many of the publications of this research program, while using newer methods, were aimed at describing the growing regional imbalances of the time and ways to correct them. From this program came besides many others Fischer & Brugger 1985, Flückiger & Muggli 1985, Brugger 1985, Brugger & Frey 1985. All those works were heavily tilted towards the study of interregional disparities far more than to differentiation happening inside cities and agglomerations. Nevertheless, the thematic responded to a political concern, which had resulted earlier with the federal state taking an active role in defending fragile regions, through fiscal policies aimed at firms established there. For sure, the 1970s crisis resulted in the federal state developing an active regional policy – a regional policy, in fact, it had started well before then with the "national redoubt" defense policy based in the Alps since WWII, and which necessitated that the Alps be occupied and populated. The result of these studies emphasized the role and the shortcomings of regional policy, but at the same time made absolutely no mention of an eventual urban policy to have.

From that point of view, one of the most important authors of the time was Angelo Rossi. In two major contributions (Rossi 1979, 1983), he treated suburbanization at the national scale, and emphasized the importance and meaning of job suburbanization. To our knowledge Rossi 1983 was the first to dedicate a whole book to the subject of urban sprawl in Switzerland. In this seminal work, he pointed out that suburbanization wasn't concerning just residents but that urban sprawl was also affecting jobs. Angelo Rossi then went on describing precisely the phenomenon. On the way, he dated the phenomenon origins to the 1960s, noticed the emerging spatial disparities between more tertiary centers, and more industry-oriented suburbs, noted that whereas centers could be very diverse, suburbs looked more alike and could then be playing a role at smoothing the spatial economical disparities. Maybe following the main interpretation of Fritz et al 1973, Rossi 1983 saw this delocalization as the result of increasing real estate pressures, both in terms of scarcity and price, which drove essentially industrial establishments to migrate to the suburbs, a result also supported by Würth 1986. Angelo Rossi noted, however, that points of greater accessibility in the suburbs would be of particular interest for businesses which were relying more and more on motorized commuters. As important was his idea that national, regional and local processes were also linked, and the process of dissemination was at play at the national as well as at the local level, with national peripheries gaining from the center as suburbs gained from their parent cities. In many senses, Angelo Rossi was a precursor, and his thinking helped spawn new directions of research which would flourish shortly after his works were published.

Quantitative geography had made its apparition in Switzerland in the 1960s, as demonstrated by several papers which gave precise descriptions of statistical and quantitative methods to be followed by geographers. Early evangelists included Roth 1962, Steiner 1965. By then, Switzerland had also embarked on the publication of its massive national atlas under the direction of Imhof (Imhof 1965), in a work which grouped for the first time a series of very precise thematic maps at the scale of the whole country and thus broke, at least in part, from the regional approach while using a formal representation closer to the quantitative method – although as a whole and true to its epoch the atlas remained a mixed work combining quantitative and regional paradigms. The early 1970s saw the advent of the so-called "new geography" with the arrivals of Professors Racine in Lausanne, and Raffestin and Bailly in Geneva, which combined a strong emphasis on quantitative geography, a return to an all-encompassing geography which searched less for regional specificities than for geographical laws which would be global in their outlook.

The advent of quantitative geography allowed geographers to handle the mass of statistical data they had to painstakingly decorticate before – and this had a profound impact on the way geographical research was done. Before the advent of the quantitative methods and machinery, the only way to exploit precise spatial statistical data was through monographic regional studies – anything of larger scope was unmanageable data-wise. By the mid 1970s though it was becoming possible to handle and study vast amounts of data using well-agreed and established techniques. The combination of regional geographers interest in peripheries, new geographer's bias towards all-inclusive spatial explanation, and the incitation coming from the State with the National Research Program on Regional Problems spawned an explosion in the number of studies devoted to urban and suburban studies in the country. Indeed, many of the propositions we will be making afterwards are based, at least in part, on studies which dates back from this very prolific period of Swiss geography.

Plenty of studies of the time display the results of classical quantitative geography, through the use of the factor analysis – hierarchical clustering combination. Examples of such works include Meier-Dallach et al 1982, in which a typological classification of Swiss districts was given according to their socio-economic characteristics, Schuler & Nef 1983, where the same exercise is redone, partly by the same persons, using a greater number of variables and three different regional partitions of the country, or Bailly 1985, which, working on the 1975 business census data used at the district level, resulted in the discovery of "runaway" central regions (Zurich, Basle and Berne) in terms of commanding functions and of differing regional specialization in districts without an urban centers. In all those studies, though, the emphasis was on the peripheral regions, which through such methods display a greater variety than the urban centers and more generally the urban regions. The fact that only district or similarly sized regions were used precluded the emergence, in these studies, of suburban belts per se. Thus, where they were in fact present as districts, they were classified out as either industrial central region by Meier-Dallach et al 1983, or ignored by Bailly 1985. Schuler & Nef 1983 did recognize the existence of specific suburban spaces, and classified 7 MS-regions as residential suburban and 3 others as job-oriented suburban, out of a total of 106, a result also published for Land Planning regions in Brugger & Schuler 1982. One year later, Schuler 1984 published the new definition of the Swiss agglomerations. In that seminal work 502 communes, or one out of six, was recognized as urban, although only 47 of them were bona fide urban centers: quite a recognition of the significance of suburbanization processes. Furthermore, the work included a typology of urban communes in 10 classes, including two classes of suburban job centers. Sadly, the numbers of communes included in each class is not given, but four years later, Joye et al 1988 built upon this first try to publish the official communal typology of Switzerland in 22 classes. Of those 22 classes, 4 were devoted to urban centers and 7 more to suburban and periurban communities, including 2 classes of suburban job centers; together, those 2 classes grouped 90 communes. To our knowledge this was the first time in Switzerland that suburban job centers were recognized as such, alongside many other suburban community types. In a history twist, the research team around Martin Schuler which started out as bona fide quantitative geographers had turned to answer-tree methods to build the official typologies the federal state would come to recognize for the best of three decades.

At about the same time, the fate of the central city came to the fore. In particular, the social impact of residential suburbanization was becoming a subject of interest. This would culminate in the apocalyptic visions René L. Frey frequently gave to his readers (Frey 1986, 1990, 1992), with a vision of conflicting interests between centers and suburbs, and between social and economic goals, with the central city losing out and becoming a ghetto for the old, the poor, the singles, the unqualified, the foreigners and the outcasts, in german the "A-Stadt". More generally, the distinction between centers and suburban spaces was made more often, as exemplified in Wolff 1992, Bopp 1992 – a splendid work about the adequacy of urban models with regard to the Zurich reality, Boesch 1996, Dessemontet & Racine 1996, Odermatt 1999, Rey 2001. In Odermatt 1999, the author made a link between social spatial segregation and the spatial dissemination of jobs, a subject that was slowly but surely gaining ground. The concern for the possible fall of the centers grew strongly in the wake of such studies, and became political at the start of the 1990s with cities veering left of center and asking for the same kind of attention which the economically struggling peripheral regions had one or two decades earlier.

During the 1980s, studies about the spatial segregation of economic activities had begun to appear. Keller 1980 showed that in Zurich banks, differential localization was happening, with the most prestigious locations devoted to the noblest functions, while back-office activities were being relocated, although as close as possible and in the case of Zurich at the time, still within the city limits. By 1980, the spatial dismantling of companies which were till then organized according to fordist principles had begun, and a new, post-fordist work organization was emerging, with its spatial consequences of spatial dissemination of service activities first towards less central parts of the central city, and very quickly to the suburbs. In another regional-based work, Rossi 1986 emphasized the importance of the service sector for regional development, and in particular international-oriented services, thus underlining the move from an industry-based economy to a service-oriented one.

In parallel, the 1990s allowed the first studies about job suburbanization to appear. Würth 1986 was a real precursor, dispatching the tertiary sector in four groups according to Browning & Singlemann 1978 – Distribution, commercial, social and personal services, and looking at their intertwined dynamics and localization, pointing out the growing spatial division of labour with the most value-added, intensive economic branches trusting the downtowns and urban centers and squeezing out both residents and less productive occupations. Würth 1986 linked the stronger spatial division of labor to the stronger production disintegration with the advent of post-fordist labor organization and the outsourcing to dedicated companies which could be located elsewhere, especially since the telecom innovations allowed for easier and cheaper contact between spatially distant entities. The only thing missing from Würth 1986 was the insight that even those most productive jobs were also going to disseminate – however, in 1986 that would have been a prophecy more than a measure. Several years later, Meier 1992 on the Berne agglomeration a precursor, thematized the local spatial segregation of functions using the same partition and found that at the center-suburban scale, there were very significant differences with, essentially, quality remaining in the center and distributive services going for the suburbs. Kampschulte & Strassmann 1999 developed further the idea of a differentiation between the economic functions of the center and the suburban belt on the Basle case. In Dessemontet 1999, we believe to have been the first author to specifically study the subject of suburban center emergence in the Swiss context. This study, in which we transposed the Garreau concept of edge cities in Switzerland, is naturally a far ancestor to the present work. In this work we identified 61 such suburban job centers ranging from 500 to 40'000 service jobs, covering 177 communes by 1995. Volman 2000 remarked also that commuter flows inside the Basle agglomeration were becoming less and less organized about the Basle downtown, and more commuting was now taking tangential routes – an indirect but potent reckoning of the rise of suburban centers is 21st century Switzerland.

The interest for job localization were paralleled, in the 1980s and afterwards, by the growing realization that metropolitan processes were at work in the country. Early proponents of such a theory were Cunha & Racine 1984, in which they developed the notion of central spaces defined by the quality and the leading role of their service functions, Joye & Schuler 1984 and Cunha & Bridel 1986, who found major center-periphery structures while working at the canton level and which were close to name the subject, Schuler & Bassand 1985, who first asked whether Switzerland was a metropolis, Racine 1988 who summarized the works of many and synthesized them in proposing the existence of two urban central regions, the Golden Triangle – a.k.a. the greater Zurich area, and the Azure Triangle, which is the Lake Geneva complex. The same ideas were formalized again and put into the light in Bassand et al 1988, and Racine & Raffestin 1990, which was the first "geography of Switzerland" to be published since the very regional Gutersohn 1958 and which was a summary of all the approaches and findings made by the new geographers during the 1980s, with new methods but also a newer outlook on geography as a science studying disparities, whether regional or not. Leresche et al 1992 then formalized the idea of a Switzerland where two metropolitan spaces existed, one around Zurich and the other one around Lake Geneva.

While the idea was hotly debated, it established the legitimacy of the question. As a follow-up then, the Federal Statistical Office mandated Martin Schuler once again to define metropolitan spaces in the more general mandate of agglomeration definition following the 1990 population census. Metropolitan space was recognized in Schuler 1994 as metropolitan areas and agglomeration networks. By then, the metropolization of the country was widely recognized, as remarked by Racine 1994. Cunha 1993 made the link between metropolitan processes and work qualifications, while Bühler & Dorigo 1995 based themselves on occupational data to point out that those opportunities, for Switzerland's most qualified people, were becoming metropolitan in essence. On the same line, Dessemontet & Racine 1996 proposed a geography of centers and suburban spaces which was devoid of contamination by data from rural spaces, as if to recognize the complete primacy of urban developments on the dynamics of the country. For its part, Boesch 1996 put the emphasis on the spatial disparities such metropolitan processes were creating, linking the "A-Stadt" with the metropolis, and emphasizing the double move of concentration of leading functions into metropolitan spaces and the dissemination of those same functions inside the metropolises to the detriment of the classical centers. That innovative professions seemed concentrated in metropolitan areas was broadly confirmed by Caprarese 2007b, in a paper that showed interest for searching in Switzerland patterns related to emerging subjects in economic and regional geography such as the emergence of the creative class as a driving force in the society, thus following Florida 2002, or the possible existence of high tech territorial complexes, called clusters, to which Caprarese 2007a makes reference by finding them in Switzerland.

By the turn of the century geography in Switzerland somewhat reoriented itself towards sustainable development and with time more papers were showing interest in that domain, including a growing will to intervene in the political process – at this time geography was becoming more political and often clearly green-oriented (Boesch & Schmid-Keller 2003, Bochet 2005), and more generally governance at the metropolitan level became a paper subject, as in Behrendt & Kruse 2001.

2.3.3. A synthetic view of urban Switzerland's history

As of now there is a certain consensus in the urban research in Switzerland on several facts, first that metropolitan processes were taking over the country and its urban network, dissemination of people but also of functions were affecting Swiss agglomerations, more regional moves were happening in parallel which affected the dynamics of mid-sized and small cities throughout the country with peripheral cities, especially in the southern half of the Mittelland, doing better than central ones, especially in northern Switzerland. In two major works (Schuler et al 2002, 2006), Martin Schuler and his team have identified different periods in the history of urban development. Both the studies we mention being primarily based on population census results, they are bound by census dates, mostly in years ending by zero, but it is not difficult to reconcile them with more significant dates in world history. The five Schuler periods cover each thirty years. Here is a brief description of those five periods, as described first in Schuler et al 2002, then again in Schuler et al 2006.

The first period cover the first 30 years after the creation of modern Switzerland, and is defined by the 1850 and 1880 censuses. This is a period of continuous if moderate urban growth in Switzerland, marked by the rapid development of railways, inexistent in 1850 and which primary network is complete, at least in the lowlands, by 1880. The period was marked by a variety of economic conditions, with a period of growth from 1848 to 1873, and a rather severe economical crisis afterwards, all in a context of ongoing industrial revolution which was slowly changing the face of the country. Spatially, this translated into moderate urban growth, strong rural exodus and significant international emigration. Thus, the period was one of spatial discrimination between the urban centers and the industrial villages situated on the main railway lines, which were growing, against depopulation hitting above all certain alpine valleys and more generally all strictly rural areas of the country, such as the Vaud or Lucerne extensive countryside. In terms of historical dates, the period can be understood as being marked by the foundation of modern Switzerland in 1848 which made it an economically unified country, and 1885, which marked Switzerland's exit from the 1873 economic crisis and the start of a period of very rapid economical expansion.

The second period, according to Schuler, is marked by the 1880 and 1910 censuses. It is one of very rapid demographic expansion due to the country's entry into demographic transition, with a strong fall of mortality, as well as by a reversal of international migration flows: around 1890, Switzerland ceased to be an emigration country and started to be a destination for immigrants. Economically, this was fueled by a strong acceleration of the country's growth and industrialization – all these facts contributed to an urban explosion, particularly felt in big and medium-sized cities. Suburbanization appeared during this period, although it was managed by incorporating into the cities the former villages which were urbanizing fast and chaotically: the period was one of major communal fusions in Switzerland. In parallel, rural exodus was still quite present in the countryside and outright depopulation was still hitting several alpine valleys on the southern size of the range, while a first touristic boom was noticed in the Alps, with strong growth of several "climatic stations" such as Montreux and Davos. In all, the period was marked essentially by growth and urbanization, population and territorial city growth, and by further spatial disparities between cities and countryside. In historical terms, this period opened around 1885 and, of course, went to an abrupt end in the summer of 1914.

The third period according to Schuler covers the interval between the 1910 and 1941 censuses. It was marked by two world wars and the great depression and of course, it is marked by a far reduced economic expansion, a period of relative stagnation. Accordingly, demographic growth was restrained, Switzerland entering in the second phase of its demographic transition with a fall in births. Foreign immigration was reversed, many foreigners leaving the country – although this reversal did not extend to Swiss nationals. Spatially, this translated into strong regional patterns, as the vast economic difficulties of the time hit regions very differently. The Jura Mountains and Eastern Switzerland suffering major economic losses and corresponding depopulation, while Northern and Northwestern Switzerland suffered less. Zurich emerged as "primus inter pares" among cities – taking advantage of the stagnation in Basle and Geneva. Urbanization remained strong, notably in formerly rural areas, such as Vaud, Berne and Lucerne, while rural exodus was still largely present throughout the country. Lastly, the premises of suburban development were for the first time made visible, suburbs emerging around most major cities of the time. Unlike in the preceding period, new suburban communes would remain suburban instead of being merged with their parent city. In all, the period was one of great regional disparities, with the affirmation of the greater Zurich area as the main engine of Switzerland's development, continuous urban growth, suburbanization emergence and continued rural depopulation. This period, which was opened by WWI, ended in may 1945 with the end of WWII.

The fourth period according to Schuler is limited by the 1941 and 1970 censuses. It was marked by the Swiss economic miracle: a period of thirty years of continuous demographic growth fueled by an ever expanding economy based on industrial development as a base and on expanding services, a healthy demographic excess – the baby boom – and massive foreign immigration. Spatially, the epoch was of very strong – Schuler deems it even excessive – urban growth, which affects all urban centers and even more their burgeoning suburbs – if anything, the period is defined by suburbanization. General rural exodus stopped as parts of the countryside were becoming suburban. However, for regions which remained out of reach of the growing agglomerations, rural exodus remained a reality, as in many alpine and prealpine valleys, which were still affected by depopulation. Thus, the period is one of growing disparities between urban centers and suburbs and peripheries, in particular alpine ones; the regional imbalances noted in the preceding period were all but forgotten in a period of general urban growth, which concerned the Jura Mountains and Eastern Switzerland as well as the rest of the lowlands. This period, which started in 1945, can be said to have ended with the oil shock of 1973.

The last period according to the two Schuler studies cover the time elapsed between the 1970 and 2000 population censuses. In economical terms, the period was one of alternation between deep economic crises and periods of strong growth. Structurally this was an epoch of change, with the transition from an industry based economy to one dominated by service activities – in fact, the last period was one of massive deindustrialization and tertiarization of the economy. In demographic terms, growth abated greatly, in part because a long-term "baby bust" trend, a lowering of birth rate, which was only compensated by ongoing immigration. In spatial terms, evolution was dramatic. Urban centers lost population for the first time since the industrial revolution to their suburbs. However, the most internal parts of those suburbs underwent a strong slowing of their growth, and the excess population fueled massive growth in more distant parts, the periurban belts. The periurban explosion reversed rural exodus in most lowland localities of the country, and depopulation was significantly less of a problem than at any time since 1850. In that sense, most low lying areas of the country seemed to participate in a same urban movement – a process of metropolization. Federal regional policies ensured a gain of dynamism in alpine regions – in fact, alpine valleys experienced strong growth during these times. The one exception was the Jura Mountains which continued to suffer in demographic terms. In short, the period was globally one of metropolitan processes like periurbanization, urban depopulation and regional dynamism.

More recently, Schuler, in an unpublished document, has refined this chronology by subdividing the last period in two, the period from 1970 to about 1990, and the one following it. Doing this allowed for the distinction between a periurban and regional period, up to 1990, noted for the strong dynamism of peripheral regions and their small and medium-sized cities as well as for the development of extensive periurban belts, and a truly metropolitan period which started around 1990 and saw the reversal of the trend in the Alps and more generally in peripheries, concomitant with the rise of metropolises, the network of cities and the ever growing importance and area of their extensive suburbs, exurbs and secondary centers.

Thus seen, Switzerland saw then a near continuous period of urban growth, which was essentially central up to WWI, then which developed more and more in the suburbs, which had emerged at the end of the 19th century but which were the quintessential urban form of most of the 20th century, with periurbanization taking over from 1975 on, relayed and paralleled by metropolization since 1990. As we have seen, many, if not most of those turning points can be linked to events of extreme economic significance: 1873, 1914, 1945, 1973, 1991.

2.3.4. Towards a job localization oriented periodization of the Swiss urban history

As can be seen in the literature review, most of the urban studies about Switzerland have been conducted with an emphasis on demographics and residential aspects before economical and job localization aspects. One of this study's main aims is to try to write an urban history analogous to that written by Schuler et al 2002 and 2006, but with the emphasis put solely on jobs instead of residents. We expect to find periodicities in such a study, and we also expect to find correspondences between the periods as outlined in the preceding section, and the ones we may find. However, we do expect to find major differences in the way those periods deploy spatially in residential or in job localization terms.

As the study of commuter flows shows, for instance in Schuler et al 2006, most of the recent developments in urban residential history stem from the dissociation between locations of residence and of work – thus it is widely expected that spatial patterns between residential and job locations will vary widely once commuting took hold. But this remains dto be determined. Chapter 5, in particular, is aimed at detecting such trends and periods.

2.4. The data catalogue

2.4.1. An ideal data situation?

This work is supposed to be very heavily reliant on raw data. One of the reasons we choose Switzerland as a subject was that data availability was excellent, both in theory – the official data offer – than in practice – the data we could actually obtain. Here is a description of the possibilities offered by the data catalogue actually accessible.

First, the communal level in Switzerland, which serves as the main unit of analysis and data dissemination for geographical data, is both quite stable in the long run and fine-grained. Even if historically there has been a movement towards communal mergers, as of January 2010 there were still 2'600 communes covering a country inhabited by 7.8 million people, down from a maximum of 3'211 in 1860 (Schuler et al 2002), with France one of the most detailed territorial mesh to be found in Europe, and at the country level, essentially as precise as the smallest territorial meshes available in the north American literature. Furthermore, those units have remained territorially stable for most of their history, which gives for easy harmonization between the differing censuses. Therefore, if using the communal network, the territorial consistency of the data can be readily reestablished all the way to the earliest sources used, in our case the 1937 Swiss Statistic of Factories.

The second point is that regular exhaustive censuses have been held in Switzerland, which since the creation of the modern federal state, has held 16 population censuses, once every ten years since 1850, and 13 business censuses since 1905. Agricultural censuses were held even more often and we are in a situation where it is always possible to reconcile agricultural censuses with business ones to obtain a complete view of the state of the economy at any of the 13 points in time we're interested in.

Individual record data are made available by the Swiss Federal Statistical Office since the 1970 population census, and the 1985 business census, which allow for autonomous work on any data combination we could want to study. Recently, data have been made broadly available at a finer scale still, starting with the 1990 population census, the 1995 business census and the 1996 agricultural census. For those and later years, census results have been made available at the hectare level, allowing the territory to be studied in 100 by 100 meter cells for which extensive information is available. Furthermore, for the same censuses, coordinates are available for census individual records. In all, the amount and quality of the information at hand is indeed exhaustive for the last 15 years regarding the business censuses, and quite good indeed for the preceding decade. In that respect, we find ourselves in a quite ideal situation regarding data availability and quality for the purpose of this work, which allows us to test practically any method we may choose to delve into.

In the following sections, a precise description of the data on hand is given.

2.4.2. The business census as a core data repository

The main goal of this work is to study the spatial repartition of jobs, in particular the non-agricultural ones, and to try to find a relationship between the evolution in their repartition and the concomitant evolution of accessibility. In order to study the spatial repartition of jobs through time, only two sources can be chosen.

The first is the population census, which currently records, for all active persons, an array of information regarding their activity: their learnt and current profession, the location of their job place at the communal level at worst, the economic specialization of their company of institution, their activity rate and status, in all, a wealth of information which would cover nicely our work. However, the data from population census suffers from two fundamental flaws with regard to our thematic. The first is that it is population based. It will then give us all information needed about the people who work, but not quite about their workplaces. In particular, all information pertaining to the size of their companies, whether they are controlled from the outside or not, and many similar information are lost to the researcher. Furthermore, only Swiss residents are asked about their working places, which would exclude the cross-border workers and thus severely underestimate the economic size of border areas which rely heavily on them. The greatest default of the population data, though, is that information about the work place location is given only from 1970 on – before 1970, all professional and activity information is solely referred at the residential place, which makes it impossible to research older phases of job location deployment.

The second possible source is the business census. Unlike the population census, the business census uses the establishment, a localized part or whole of a company, as its base unit. Thus, all the information pertains to a company or a branch which is unequivocally lined to a given site, a necessary information when looking after the job repartition through time. Business censuses have been held in Switzerland since 1905, which gives us the temporal depth of information we are looking into, and give results at the communal level, which gives us the territorial detail we're basing our study on. However, business censuses have some shortcomings. The first is that it doesn't include in its count the primary sector, which was censed separately for most of the period under review. Thus, data must be reconciled in order to obtain a global view of employment in Switzerland. Secondly, and more annoyingly, for a long period of time business censuses were censing only entities active on the free market, excluding, for instance, most public services and administrations and even some liberal professions which were not thought to be of business orientation, notably in the health and law services. Lastly, while the first edition of the business census in 1905 was very detailed, some subsequent editions were less so and up to 1965 included, economic activity wasn't detailed at the communal level.

It seemed to us that the advantages of using the business censuses were far greater than its pitfalls and that the wealth of information contained in it would be superior to what we could extract from the population censuses. However, this will require that in some cases we will need to try to fill some of the voids the business censuses left open. The various reasons and means we took to alleviate those shortcomings will be discussed in the following sections, which present in more detail the data we'll use in our study.

2.4.3. The chronology of business censuses

The first edition of the business census was held in 1905, and its results were published shortly afterwards (see for instance SFSO 1906). The depth of information, for such an early effort, was impressive. The census covered all sectors of the economy, including agriculture in the count. Such was the quality of the 1905 business census that it elicited a remarkable extension of the 1910 population census, notably in the activity domain, and the 1905 business – 1910 population census attained a quality and a depth of information that would not be matched in future censuses for at least half a century.

Initially, it was planned that such business censuses would be conducted every ten years, on years ending in 5, and in alternation with the population census held in years ending in 0. However, WWI and the various crises which followed prevented the federal state to carry this plan and if population censuses were maintained, their quality went severely down (Busset 1993, Schuler 1999). Business censuses were simply not held for a quarter of a century. The second Swiss business census was held only in 1929 (SFSO 1931). From now on, agriculture would be treated separately (SFSO 1933), and the published information was not as detailed as in the first edition by far. The third business census was held in 1939, and essentially published along the same lines (SFSO 1942, 1945).

The fourth business census was held in 1955, realigning itself with the original plan laid out half a century before (SFSO 1959). From then on, the alternation between business and population census would held. The 1955 results were also of better quality at the communal level, with jobs and establishments now divided in finer classes. The 1965 census (SFSO 1967) yielded still more detailed results. In this census, a first attempt to include public administration jobs into the business census was made in a by-publication (SFSO 1968) – however the census was still missing plenty of para public jobs, such as in the schools and hospitals. The real breakthrough came in 1975 with the official inclusion of all jobs, including public and para public ones; from 1975 on, the census results are available in electronic form on the SFSO website; from the 1985 edition, individual records for companies and establishments are made available. Following the 1985 census it was decided that business censuses should be held more often – as it was the case, since 1965, for agricultural ones. The first "off year" census was held in 1991. Then, business censuses would be held three times per decade, in years ending in 1, 5 and 8, with the "5" edition being more complete in what was asked to the companies. From 1991 to 2008, six business censuses were thus held; the 2008 edition was the 13th business census held in Switzerland.

As more and more information about businesses and institutions are held in federal registries, it is expected that the 2011 business census will be the last to be conducted the current way – from then on, censuses will be held on registries alone, but with a yearly periodicity.

2.4.4. The increasing depth of information in censuses

Swiss business censuses have always be of great quality and depth as long as the exploitations were made at the cantonal or higher level. However, published results precision has strongly varied at the communal scale. To that respect, agricultural censuses were always benefiting from a better spatial coverage and have always published detailed results at the communal level, as if agriculture was seen as more territorial.

In the first business census of 1905, very precise data was delivered at the communal level, giving for instance the detailed repartition of jobs in 40 economic activities, a precision not published again since 1975. Subsequent censuses were giving far less information. The 1929 and 1939 censuses would give only the total number of establishments and employees were given at the communal level, except for a very select number of cities. That changed in 1955, with communal data given by activity sector, the tertiary sector being further divided in three classes: thus, jobs could be apportioned to five activity groups: agriculture, industry, trade & finance, transport & catering, health & education. The 1965 census added a further refinement by separating industry in two classes, manufacturing and building, so that six categories could be used. At last, the 1975 census returned to the precision of the 1905 census, as it allowed the distinction between 51 activity classes.

From 1985 on, individual records are available – this allows us to group and compute data as we wish. Using different translation keys used to convert between the various activity classification schemes which were used from 1985 on, we were able to recode activities to the NOGA 2008 classification in use at the SFSO, and which is an adaptation of the NACE international classification to Switzerland (SFSO 2008). At the level we will use in this work, this classification scheme yields 85 activity classes.

The use of the individual record files allows us also to exploit data which were not otherwise published. Such data include notably the exploitation which will be made in chapter 7 which concerns their market orientation, their public or private status, the establishment's status within their parent company – whether they are unique units, seats or branches in a multi-establishment company, their commitment on the international market, whether they possess international branches, or conversely whether they are owned by foreign capital, this information only until 2005 – it seemingly has been dropped from the catalogue from 2008 on.

2.4.5. Censuses spatial precision and the retrofitting to the year 2000

As we have already said our main spatial level of analysis is the commune, of which remained about 2'600 in 2010. The history of the communal level has been expertly described in Schuler 1999 and Schuler et al 2002 and we refer to those works for a precise history of the communal changes in the country. In very broad terms, the communal mesh in Switzerland has remained fairly stable since 1850, and most moves have been of communal fusions, where two or more units coalesce to form a new one, which allows for very easy data harmonization towards the most recent state.

The main exception to this was the communal fusion process which took place in Thurgau between 1990 and 2000, and which completely redrew communal boundaries there – here, harmonization was done using an attribution from old municipal communes to new united communes, which are not always unequivocal, hence introducing some uncertainties in the way establishments were attributed to the new communes. However, for the most part significant changes concerned above all rural spaces with rather few businesses apart from agriculture – which was censed, anyway, at the more precise level of the local commune before the reform, for which most harmonization into the new united communes is unequivocal. In all we think the risk we took of attributing a business to the wrong commune has no great impact on the way the communes would be characterized further in the study.

From 1995 on, coordinate pairs with a precision of 100 meters were given to all establishments – this allowed us to free ourselves from the communal level at a time it became necessary to do so in our view. From 2000 on, various cantons have seen the great acceleration of the communal fusions, above all in rural space, but unlike in Thurgau a decade earlier, there is generally no territorial plan to help ensure that a particular territorial logic is applied across the cantonal territories, with the effect that some gerrymandering has occurred here and there. In some cases, major fusions have greatly reduced the interest of the communal level of analysis, such as in the Val-de-Travers region of Neuchâtel, which saw a massive fusion of nine units, including all former local centers of the valley, in the Glarus canton where only three out of thirty communes now remain, or in the urban center of Bulle which merged with its suburb of La Tour-de-Trême. Sadly, many such examples are now happening in the country. For this reason, we decided to use the coordinate data to attribute for all subsequent censuses the communal mesh of 2000. Thus, we have a stable territorial base on which to work on.

2.4.6. Around the business censuses: surrogate data in fabric statistics and population censuses

As we have seen business censuses do not always give all the information we could need to accurately describe the situation at a given time; the next section is aimed at describing how such data reconstruction can be made. In that section we will just describe the data used in those various manipulations.

During the period of financial difficulties it had to sustain between 1914 and 1945, the federal bureau of statistics, the forbearer of the modern SFSO, could neither hold business censuses as often as it would have liked, nor analyze and publish the data as they wished. For this reason some mitigating strategies were put into place, one of the most significant of which was the series called factories statistics it held from 1923 to 1949 (SFSO 1930, 1940, 1946, 1950). The 1929, 1937, 1944 and 1949 editions allowed a precise count of such factories and their employees at the communal level, an information which could then be used to infer at least part of the secondary sector by commune, as demonstrated further down.

2.4.7. Land use statistics

In order to be able to compute job density the way we do here, basing it on built-up areas, we need a data source which can give us the extent of those built-up areas. The Swiss federal Statistical Office has a long tradition of compiling such statistics, although it has to be said that for most of history, only agricultural land was of interest to the Office, which thus lumped built-up areas together with lakes, glaciers, snow covered areas and bare rocks as improductive land. For this reason, the first three land-use censuses are of no use (SFSO 1912, 1925, 1952). The fourth such census (SFSO 1972b) did give precise figures for built-up areas, as did its subsequent editions, in the early 1980s and the mid 1990s, all of which were obtained in electronical form. As this work was written, such a census, covering the mid to late 2000s, is ongoing, but its results were too partial to be considered here – a situation mirrored by the 1952 land use census.

2.4.8. Data reconstruction

2.4.8.1. Actual data provenance and the need for reconstruction

In that work, censuses were considered from 1939 on, and we based our analyses on data we collected from various sources and supports. Here is the concise list of where the data actually came from.

The 1939, 1955 and 1965 business censuses results were transcribed from the official publications (SFSO 1942, 1959, 1967), as were the 1939 and 1955 agricultural census results of relevance to our study (SFSO 1945, 1961). Later editions were available electronically either at the communal level (1975 business census, 1965, 1975, 1985 and 1990 agricultural censuses), at the hectometric level (1996, 2000, 2005 and 2008 agricultural censuses) or at the record level (1985, 1991, 1995, 1998, 2001, 2005 and 2008 business censuses). To supplement the 1939 business census, we also transcribed the 1937 and 1944 editions of the factories statistics from the official publications (SFSO 1940, 1946). Population censuses were also used in our study to compute the active population for any given date during the 1939 to 2008 period. Census results were made available at the record level for censuses from 1970 on; for the 1941, 1950 and 1960 editions data was directly transcribed from the SFSO publications (SFSO 1944, 1954, 1963).

As hinted before, this vast data repository does not allow for immediate study. In some cases, data is missing in the original files, like for instance most public service jobs in business censuses up to and including 1965. In other cases, the data is present but not detailed enough for our purpose, as in the case of the 1939 business census. In other cases, major time lags separate different sources, as for the active population estimations coming from population censuses held in years ending in 0, to be compared with jobs as censed in years ending in 5. Of course, territorial harmonization problems need to be taken into account. For all these reasons, extensive work has to be undertaken on the data before it can be put into use. The goal of this section is to describe those manipulations and estimations.

2.4.8.2. Reconstructing the 1939 business census

The 1939 data does not allow for a direct access to the communal number of jobs by economic sector, except from the agricultural census: the 1939 business census gave only the total number of jobs held in the private sector in the secondary and tertiary sectors. For cantons and for 28 cities, the business census distinguished between industrial, construction and tertiary jobs. As hinted before, the 1939 business census did not count public sector jobs, and a certain number of liberal functions which were not considered part of the economy, like most notably law offices. Thus, the census numbers underestimates the real number of tertiary jobs.

However, other sources exist. As we have already seen, the Swiss Federal Statistical Office published a factory statistic which counted all jobs held in factories or in factory-like environments, a statistic which was given at the communal level and distinguished, at the cantonal level, between industry, construction and services. Such statistics were made available for 1937 and 1944, from which we interpolated values for 1939 to create an artificial 1939 factory statistic. This was then benchmarked on yearly factory job numbers given at the cantonal level for industry, construction and services. In parallel, the 1941 population census registered all people exerting a profession, including the sectors which were not counted in the business census, at the communal level. As the vast majority of these jobs were in the public sector, many of those were attached to the community: communal public servants and most liberal professions were required, by law or by practice, to live where they worked. We may hypothesize that most of these jobs were held by people residing in the commune in which they were professionally active. Thus, it is possible to estimate the jobs held in each sector at the communal level. Two distinct estimations are made, one based on the factory statistic and which concerns essentially secondary sector jobs, and the second, involving the population census, which exclusively regards tertiary jobs.

The exploitation of the factory statistic is made by canton. For the fully described 28 cities, the data are taken as such. All factory jobs are compared to the censed jobs, and thus, for each commune, we obtain a number of factory and residual jobs. The factory jobs can readily be dispatched into secondary (industrial and construction jobs) and tertiary (service jobs) domains. The residual jobs are apportioned with respect to the cantonal repartition of industrial, construction and tertiary jobs as given in the business census, once fully detailed cities and jobs already attributed to factories duly taken out. This operation is repeated for all cantons, and the result is a definitive secondary sector job number and a provisory tertiary job one by commune.

The exploitation of the 1941 population census is then made. From the preceding stage, we have obtained a provisional number of tertiary jobs per commune. The population census gives also a communal figure for tertiary job holders, further divided in two categories: trade, transportation and catering on one hand, all other service jobs on the other hand, which has to be obtained indirectly, by subtracting the agricultural, industrial and trade, transportation and catering jobs from the total number given. The 1939 business census numbers are less than the 1941 population census numbers because of the jobs not taken into account in the business census. It is then hypothesized that in each district, the number of tertiary jobs matches the number of actives in the tertiary sector as given in the 1941 population census. In each district, the number of unattributed jobs is computed by subtracting the tertiary jobs found at the preceding stage from the tertiary job holders as counted in the 1941 population census. Those unattributed jobs are then apportioned to communes according to the communal repartition of tertiary job holders outside trade, catering and transportation in the district. The end result is that for each commune we obtained a partition of jobs in economical sectors, and which includes jobs not counted by the original business census.

2.4.8.3. Reconstructing the 1955 and 1965 business censuses

The business censuses or 1955 and 1965 differed from the 1939 edition by the fact that at the communal level, job numbers were split into several categories; industry, construction (in 1965 only), trade, catering & transportation, and professional & financial. However, as in 1939, the 1955 and 1965 business censuses still didn't count a number of tertiary jobs, mainly in the public sector. Thus, a reattribution of unaccounted service jobs had to be made on the basis of the population censuses, in a similar way than done for 1939, and based on similar hypotheses.

From 1955 to 1985, business censuses were held solely on years ending in 5, whereas population censuses were always held on years ending in 0. Thus, no directly available data on the active population was at hand. As our subject concerns jobs more than active people, it was decided that the reference years would be the business census years and that active population data would be interpolated between two population censuses to obtain artificial population census data for the year ending in 5. Thus, active population data was obtained for 1955 and 1965, by pure linear interpolation. Then, the process was the same than the last stage of the manipulation for the 1939 census, that is, a comparison between censed tertiary job numbers and tertiary active population at the district level, and the reapportionment of the difference to the individual communes according to the communal repartition of tertiary jobs holders outside trade, catering and transportation in the district. The main difference is that by 1955 several groups of districts were taken as base for the repartition, taking into account growing commuting across district boundaries, such as in all urban regions of the country.

2.4.8.4. Reconstructing business censuses from 1975 on

The 1975 business census marked a turning point in the way business censuses were conducted, and their results made available. First and foremost, from then on all jobs would be counted, whether in the private sector or not, whether active in the market economy or not. Thus, from 1975 on, there was no need to rebuild or estimate the number of jobs in the public service, public education, public health, defense and justice – now they were censed as all other jobs. Secondly, the 1975 census job numbers were made available by commune in 54 economic classes, against just 4 in 1965. Furthermore, for the first time in 1975 jobs were separated, for each of the classes, into full-time and part-time jobs, which allowed the computing of full-time equivalent jobs, a concept on which we based our study given the growing importance, in later years, of part-time occupation in the economy.

The seven censuses straddling 1985 to 2008 are made available at the record level, which means that our liberty in recombining data was total. In particular, a very precise indication of the main economic activity of each establishment is given, and as the economic activities definitions evolved, as they have to do to cope with an evolving economy, transfer keys were given which allowed for retrofitting old censuses on new classifications, or the inverse. Thus, we were able to retrofit the NOGA 2008 classification on all establishments starting from the 1985 business census. Even if the correspondence between the different systems used at those different epochs – during the years, three different classifications were used, the agreement is good enough that we can neglect the imprecision wrought by the use of two transfer processes. Thus, the study about the spatial repartition of the different economic activities is made possible from 1975 on, and fully comparable from 1985 on.

At the same time, 1985 marked the last census year at which agricultural and business censuses were systematically held in the same year. From the on, agricultural censuses approximately kept a five-year periodicity and thus were held in 1990, 1996, 2000 and 2005, when business censuses were held in a three-per decade periodicity, in 1991, 1995, 1998, 2001 and 2005. Thus, the following matching operations were made: the 1990 agricultural census was directly matched to the 1991 business census; the 1996 agricultural census was matched to the 1995 business census. For 1998, the results of the 1996 and 2000 agricultural censuses were interpolated to create a pseudo 1998 agricultural census, which is matched to the 1998 business census. The 2000 agricultural census was matched to the 2001 business census, and lastly, in 2005, both censuses were held together as a test for a further complete unification of the two censuses, the first edition of which was to be held in 2008.

The use of record-based databases allow for the distinction between company seats and branches, between companies active on the international markets and those active on the domestic one, between companies owning subsidiaries abroad and Swiss subsidiaries of international companies. Thus, the study of the territorial repartition and the spatial division of labor between commanding centers and executioners is rendered possible from 1985 on.

2.4.8.5. Reconstructing active populations from population censuses

Active population figures are necessary to compute job intensities, i.e. the ratio between jobs and actives in a given location. Furthermore, we need these figures split by economic sector. Population censuses since 1910 give these data at the communal level, but they weren't held at the same dates than business censuses. Thus, to obtain active population estimations for business censuses years we interpolated the active populations for each sector and each commune in a linear manner, with the exception of the 1941 population census which results were readily collated to the 1939 business one. However, interpolations are made only up to 2000, year of the last available population census. If active populations for 2000 can be matched to the 2001 business census, such is not the case with 2005 and 2008 business censuses. For those two years, extrapolations had to be made. They were based on two different data: for the first half, total communal growth rates as given in the annual population statistics were applied, and for the second half, the active population growth rate as measured between 1990 and 2000.

2.4.8.6. Reconstructing built-up areas from land use statistics

As mentioned implicitely in a preceding part, we have a reliable estimate of the built-up areas at only three points in time, corresponding to the late 1960s – early 1970s (1965-1972 land use data), the early 1980s (1979-1985 land use data) and the mid 1990s (1992-1997 land use data). It was somewhat arbitrarily decided that no new data could be inferred from the ongoing 2003-2009 land use dataset, which was too partial at the time. Thus, for 1998 and later business censuses, the built-up area figures were taken directly from the 1992-1997 data. For periods between 1965 and 1998, interpolations were made between the three datasets to infer built-up areas. The 1965-1972 figures were taken as valid for 1965. For 1939 and 1955, they were inferred as follows. First, 1972 figures were taken as valid for 1939 and 1955 and the resulting job densities computed at the national level. As there were fewer jobs in 1939 and 1955 than in 1965, this computation resulted in lower national densities for 1939 and 1955. It was then assumed that at the national level, job density could not have been rising between 1939 and 1972, as everything was deconcentrating at the time with the advent of mechanization and the automobile. Thus, national correcting factors were computed which would make 1939 and 1955 job densities equal to 1965 job densities, and those correcting factors were then applied at the communal levels for the 1939 and 1955 job densities computed in the first stage of this manipulation.

These manipulations are somewhat arbitrary and it is our hope that they could be refined, especially by working thoroughly on the partial results of the 1952 land use statistics (SFSO 1953).

2.4.8.7. Reconstructing road networks from 1939 to nowadays

One of our aims is to compare a form of job quality to a form of accessibility, for which we need a road network model that we can decline from 1939 to 2008. The base network used in this study comes from the Swiss Federal Topographical Office, extracted from the Vector200 database, which represents a road network suitable at the intercommunal level, which is used in this study. The original version of the database was originally adapted in 1998 and evolved gradually to encompass the additions to the road network. All segments of this database, around 26’000, were awarded an opening year, which was by default placed in 1930. Then, all road segments that had been opened since 1930 received their opening year. To our surprise, we found the information about the opening year of a given road segment devilishly hard to find. We resorted to two data sources.

The first concerns the federal highway system, which are described in the annual reports of the Swiss Federal Road Office. Until 1999, those reports gave an exhaustive list of all federal highways segments with their date of commissioning. After 1999, the complete listing was dropped, but the list of federal highways segments recently commissioned remained.

For all other roads we had found impossible to find exhaustive information using traditional sources. A reliable source turned out to be the road maps published by various publishing houses – mainly SwissTopo, Kümmerly+Frey, Hallwag and Michelin – for which we had originally a sizeable collection that we expanded in the course of this work. By the end of this work we had access to road maps at the 1:300’000 or better scale for each year since the early 1970s. For earlier periods the catalogue is not as furnished, but includes notably a complete cover of the country in 1935, 1950, 1956, 1959, 1964 and 1968, the two last occurrences through Michelin maps, all other through SwissTopo forbearer, the Swiss Federal Topographical Office. Through the verifications thus made, 314 road segments in the principal road network were seen to have appeared since 1935 and were given their commissioning year, along with 283 federal highway segments. Thus armed, we could then build models for the road network for any year since 1935.

2.5. Management summary

In this chapter, we have:

- Described a concise version of Switzerland’s urban history since the inception of the industrial revolution about two centuries ago, which described the main trends having marked its history;
- Given a review of what researchers had found out about the evolution of Switzerland’s urban network, which could then be resumed in several periods, of diffuse industrialization to 1850, then of massive urbanization for one century before suburbanization, pe-

riurbanization and metropolization took successively over around 1945, 1974 and 1991. In that part we saw that such classifications were largely based on the residential status of people and places, which were setting our research apart as it is primarily based on job locations rather than residences.

- Lastly, we precisely described the data catalogue we will use in the study, as well as the means we used to translate them in numerical format, and harmonize them.

With that done, we can now turn into the main part of this work.

3. Defining job centers: a methodological survey

3.1. Introduction and summary

In this part we will establish a literature review and an assessment regarding the diverse definitions that have been given to the various concepts (suburban centers, edge cities, urban villages, and so on) used to describe the phenomenon at hand, i.e. the emergence of employment centers in suburban and exurban settings. This review will show that although there is no definite agreement on how to statistically define such a center, and thus how to detect them, the different methods can be summarized in several main research directions that can be then activated in our context.

Up to this day there hasn't been broad agreement as to the definition and detection of urban centers and different approaches still compete to establish themselves as the recognized definition and associated detection method to identify suburban centers from the available statistical information.

3.2. A literature review

3.2.1. Prehistory: up to 1990

The subject of urban polycentrism has been widely studied by spatial economists since at least the 1970s, building on the ground-breaking work of Alonso and Muth in the 1960s on the monocentric city and the bid rent curve (Alonso 1964, Muth 1969), which models the decaying land rent away from a unique employment center and explains it by commuting costs. Examples include Lave 1970, Romanos 1977, Ogawa & Fujita 1980, Fujita & Ogawa 1982, Peiser 1982 beside many others. These approaches remained essentially theoretical and the authors did not bother to find out if their theories would actually match what was being observed in the field. The main focus of those researches was to check if the Alonso-Muth gradient could be adapted to a polycentric setting, and to compute the compounding effects of those centers to the rent situation of any place in the city. The spatial econometrists were not so much interested in the reasons for subcenter emergence than in modeling for the implications of their rise on their surroundings. In that respect, they took the polycentric city as a given and dedicated very few efforts towards suburban centers detection. Hence, the work on a statistical definition and detection of subcenters remained rather crude there.

Springing from the bid-rent curve school, in the 1980s research started to check theoretical advances against empirical data, above all in the United States where the phenomenon was first detected. Those studies focalize on providing definitions and detection methods to qualify suburban centers. While working on the population density function, Odland 1978 did find out that empirical evidence was going strongly against the monocentric model, and explicitly devised a method to detect suburban centers, defined as non-central areas showing a higher than expected density than modeled by a monocentric density decay function. In this pioneering study, Odland 1978 concentrated on population density instead of employment density, assuming an identity between the two. Greene 1980 introduced the idea of varying density with time and identified suburban centers as areas where employment rose, along with more traditional methods implying the monocentric bid-rent curve. By doing so, he introduced in the literature the idea of a dynamical definition in a field that was till then essentially static in its approach of the phenomenon. Bender & Hwang 1985, in their study of the house price according to proximity to central places, postulated the existence of three subcenters to check for their hypothesis. Gordon et al 1986 refine further propose a method to eliminate “satellite centers” from the initial sample of subcenters by examining their characteristics as compared to a classic bid-rent curve. Ultimately though, Gordon et al 1986 relied on a visual inspection of a density map to get their initial sample of centers. In a related approach, Heikkila et al 1989 took Regional Statistical Areas centroids as proxies for subcenters in their study of Los Angeles. All those authors obtained major results on their hypothesis, which was the effect of subcenters on housing prices nearby, but did not much to advance the subject of what is a subcenter and how to define it. That being said, extremely useful results were shown by some of those studies. Gordon et al 1986 showed that there was no clear relationship between population and employment density. Thus, the study employment should rely exclusively on employment density and locations. In another way, the extensive work of Mahmassani et al 1988 estimating density gradients away from downtowns in four metropolitan areas of the US went a long way towards identifying suburban centers, even if it stopped short of actually doing so.

While spatial econometrists did base themselves on the Alonso-Muth model as a starting point, the planners and geographers, short on theory, had to rely on a more empirical approach. This resulted in them detecting the phenomenon at about the same time than the econometrists, whether by observation, through census results or even pure intuition. In those fields of research, the use of administrative or operational definitions to locate subcenters has been widespread. Baerwald 1978 postulated that very diverse jobs were relocating from the central business districts (CBD) towards what he called “new downtowns” situated along highway corridors; Erickson & Gentry 1985 indeed showed that position with regard to highway exists did play a significant role in determining land value. In both studies, subcenters were supposed located on major highway junctions. Earlier, Dunphy 1982, a transportation researcher, devised a rather complex empirical method based on density and economic diversity in an iterative process that for the first time uses the notion of a cutoff: subcenters, which are based on employment, rather than population, density, are eliminated if they are smaller than a certain size. The Atlanta Regional Commission (ARC 1985) simply defined an activity center as an array of contiguous and related census blocks which hosted a total exceeding 7500 jobs, a simplification of the threshold idea. McDonald 1987, McDonald & McMillen 1990 proposed a density-based approach to identify subcenters which introduced a new criterion, the ratio of employment to population (what we call job intensity) and further emphasized the role of job over residential density. A location was defined as an employment center if its job density or intensity exceeded those of all its neighbors. Cervero 1989 took a size-based definition of either 2000 jobs or 1 million sq ft (about 100’000 sq m) of office space. Giuliano & Small 1991, in their study of the greater Los Angeles area, took notice of the sprawling variety of methods and definitions proposed, noting that their results did not match, and that the data used were above all local, proposed a set of definitions to be easily applied to the whole of the US. According to this definition, a subcenter should consist of a group of contiguous zones which all exceed some given job density, and which taken together would exceed a given job number, while areas adjacent to the group should all fail the job density criterion. In their study, Giuliano & Small 1991 eventually settled on a job density of 10 employees per acre (i.e. about 25 jobs per hectare, or 2500 jobs per sq km), and a minimum number of 10’000 jobs to define their subcenters. In a follow-up study, Small & Song 1993 doubled those cutoffs.

Meanwhile, notice was taken in the media that something was changing in the American urban landscape. Leinberger & Lockwood 1986 devised an operational definition of suburban centers which mixed several elements already mentioned. As cited by Richardson 1988 (who stumbled on it in a Washington Post paper probably written by Joel Garreau, see Garreau 1991), and more completely by Cervero 1989 (who took it by way of a Garreau paper in the Washington Post), a suburban center should be defined as a place with large office and retail space, diverse activities, and where jobs outnumbers active residents and homes. This led in 1991 to the publication of that most seminal work by Joel Garreau, “Edge City” (Garreau 1991), which elaborated on previous definitions. According to Garreau, an Edge City should have 5 million sq ft of office space (about 500’000 sq m, or 50 ha), 600’000 sq ft of retail space (60’000 sq m, or 6 ha), more jobs than active residents, be perceived as a diverse and complete service-oriented place, and didn’t exist in 1960 According to Bontje & Burdack 2005, the office floor space requirement translates to about 24’000 jobs, an assessment very close to our own (25’000). Obviously, Garreau built heavily on Leinberger & Lockwood 1986 work (his cutoff criteria are the ones Leinberger & Lockwood 1986 used), although he proposed to it two major defining factors: first, that those places should be diverse and service-oriented so that more traditional suburban work centers hosting plants or warehouses, or indeed any economic monoculture, should be excluded by the definition; and secondly, that those were new, emerging places: Garreau’s definition is dynamical, a factor absent from all the definitions that were proposed at the time, save Greene 1980.

3.2.2. Maturation: from 1990 on

Garreau’s book has had quite an impact, not least because it arrived at precisely the right time to popularize and epitomize what has been identified in the research, but remained there, throughout the 1980s. Many studies had been published before, as was at least one very important book (Cervero 1989), but all of those were scholarly; “Edge City”, in contrast, was to be read way beyond the traditional public of geographers, land planners and spatial economists. The main effect on the research community was to stimulate further research on the subject and to establish a reference point in the literature. Often criticized, Garreau’s work remains nevertheless instrumental in the broad publicity it gave to the subject of urban deconcentration and, more importantly, of reconcentration at different places. That being said, in a way Garreau’s book was almost due, as the literature on the subject showed clear signs of maturation in the late 1980s and early 1990s. A sign of this coming of age is that most of the methods that are still used today (above all Giuliano & Small 1991, and Garreau 1991) were proposed in their final form at or just prior to “Edge City” publication, at least the ones the planners, geographers, urban scientists and practitioners noticed. It is true that urban economists had been plowing the field for longer and that consequently 1990 does not represent such an epiphany for them as it does in other fields.

By the early 1990s the principal methodologies used to detect suburban centers were broadly in place and since then the literature provides for testing, fine tuning and development of those methods more than for entirely new proposals. On the other hand, all methods seem to have survived well in the literature and they still compete with each other, showing that research in the field has not attained maturity yet (Forstall & Greene 1997, Giuliano et al 2007, Riguelle et al 2007). In later years convergence started to happen, mainly with tentative to combine econometric and empiric methods.

The bid-rent curve derived methods have remained at the forefront since 1991 and many studies have been using such methods to model the polycentric city. Further refinements have been proposed more recently, mainly to correct the non-directionality of the bid-rent methods, which decrease solely as a function of distance from the CBD. Craig & Ng 2001 use quantile splines to detect high-density outliers in concentric zones around the CBD, which are then easy to identify by census tract. McMillen 2001a proposes another approach which replaces classical regression analysis of the density function by a nonparametric one, here also to cope with the directionality problems as seen from the CBD. His work is based first on a combination involving the bid-rent curve and spatial autocorrelation: he identifies potential subcenters as areas with highly positive residuals from a geographically weighted regression (GWR, see Fotheringham et al 2002 for a complete description), and then measures the effects of those centers on local job density to confirm their subcenter status. McMillen 2001a takes advantage of the progress in quantitative geography, especially explicit spatial analysis methods, and in computing power. His method does not require much prior knowledge on the area under study to be put into action. In the same vein, Páez et al 2001 introduced Luc Anselin's Local Indicators of Spatial Association (LISA) (Anselin 1995) in a study to check for the effect of two potential subcenters on land prices in the middle-sized Japanese city of Sendai. In 2003, McMillen refined his method by substituting the Giuliano & Small approach for his second stage while automating it with the help of contiguity matrices (McMillen 2003), still taking advantage of technological advances that allows for computing on large arrays - here, the matrices.

Broadly taken, the empirical methods have followed the steps laid by the density / size method (Giuliano & Small 1991). Giuliano & Small have been widely used since publication, in various contexts. Small & Song 1994 used the Giuliano & Small method to pick the subcenters to fit their polycentric density functions. Forstall & Greene 1997 argued for the replacement of job density or job-population ratios by job intensity, which they raised at 1.25 jobs per active resident to consider a tract being at the core of a suburban center, which they study then only if they count at least 10'000 jobs. After arguing that bid-rent methods were theoretically superior to empirical ones to detect subcenters McMillen & McDonald 1998 nevertheless used Giuliano & Small's approach to identify Chicago's subcenters. Shearmur & Coffey 2002a used a method directly similar to Forstall & Greene 1997 for detecting suburban centers in Canadian metropolises, only with different cutoffs (5'000 jobs and a job intensity of 1). As we have already seen, McMillen 2003 performed a crossover from the bid-rent school by mixing bid-rent methods with the Giuliano & Small method. Those refinements are now widely popular and reused (Bogart 2006). Shearmur et al 2007 is an adaptation of the Giuliano & Small's approach where an employment center is defined as an area with a job intensity superior to one and at least 500 workers. This seemingly very low figure stems out of the fact that the authors had for the first time a spatially very detailed dataset on hand, not unlike the ones we have in Switzerland.

The Garreau 1991 detection method coming from outside the academic realm, it has been carefully avoided by most empirical scholars, who preferred to use the Giuliano & Small method. Although formulated vastly differently, both methods do share many similarities, notably in terms of size and intensity, the Garreau criteria being vastly more restrictive in terms of size. However, several important studies have been based on the Garreau definition. The Ohio Edge City Project, led by Richard Bingham (see Bingham et al 1997) took the Garreau criteria to define edge cities in Ohio. Robert E. Lang, of the influential Brookings Institution, also used some of Garreau's definition, namely the 5 million sq ft office space cutoff, to separate between edge cities and what he calls edgeless cities, the low-density vastness of urban space in between primary and secondary centers (Lang 2003).

As we have already surmised, there have been comparatively few studies opening other forays in the quest to detect and characterize suburban centers. Such an approach was given by Gordon et al 1989c, which based their detection method entirely on the traffic flows they generate, computed as a function of the economic sector. This way, big traffic generators tend to mark the suburban centers, which would include many commercial centers and malls, as retail is the most intensive traffic generator of all, while eliminating industrial and purely office-based centers. This method does not seem to have spawned many follow-ups, except by those who proposed it (e.g. Gordon et al 1996, Giuliano & Small 1999). The multivariate statistical methods have been rarely used to detect for suburban centers, which is astonishing since they are well suited to resume the information contained in vast arrays of data. To our knowledge, such methods have been used by Heikkila 1992 in a ground-breaking study on Los Angeles. It has attracted few comments and did not establish itself as an alternate method to describe and detect suburban centers. A decade later, Shearmur & Coffey 2002b use a similar method, the Principal Components Analysis, to detect specialized centers in the Montreal metro area. A method based on job density trend surface has been proposed by Redfearn 2007, whose nonparametric method is essentially an interpolation surface laid on density figures, completed by a adoption/rejection method based on the statistical significance of the peak detected earlier.

3.2.3. Europe's awakening

In Europe, there has been a long tradition of defining urban areas partly on commuter sheds, and the study of commuter matrices has been instrumental in Northwestern Europe's urban areas official definitions, including Switzerland's (Schuler 1984). However, the focus of those definitions was to define urban cores, formed by central cities to which suburban or periurban (the European equivalent of exurban) places would be aggregated to form urban areas, agglomerations, and so on. In that context, suburban centers, when present, were generally aggregated without further due to the central core, to which they were generally contiguous; the rare cases where suburban centers were standing alone were considered oddities. In Switzerland, while defining Swiss urban areas for the 1980 population census, Schuler 1984 created the concept of "employment commune" to take into account non-central communes that were job centers; in 1990 (Schuler 1994) those were aggregated to central cores to where commuter sheds were to be computed. All the same, the urban definitions found in northwestern Europe remained largely monocentric and did not fully recognize the nature of the peripheral job centers.

More recently, the already discussed methods have been put into use in western and northwestern Europe, where some of them were actually invented. Part of an influential team of experts from the University of Burgundy in Dijon, France, under Jean-Marie Huriot, Baumont & Le Gallo 1999 popularized in Europe a lot of the methods we already discussed. Baumont & Bourdon 2002 took the Giuliano & Small method to apply it to the Dijon metropolitan area in France; here, they defined a employment pole if it contained more than 1'400 jobs while having at least 2'500 jobs per sq km, or a job/population ratio superior to one. In a follow-up study, Baumont et al 2003 reduced the cutoffs to 1'000 jobs and 2'000 jobs per sq km, but used all three of the parameters. A similar approach was also taken by Boiteux-Orain & Guillain 2004, who complemented it though by those of Shearmur & Coffey 2002a and ended up defining a suburban employment center as a concentration exceeding 7'000 jobs and where the job/population ratio is superior to its regional mean; then, they classified some of those poles in three classes: central (more than 50'000 jobs), primary (more than 15'000) and isolated (where an isolated community gets more than 7'000 jobs). A further step towards formalization of the empirical methods was taken by Baumont et al 2004 who identified subcenters as areas with significantly higher job densities than their neighborhood by using Exploratory Spatial Data Analysis (ESDA), developed by Luc Anselin at the University of Illinois at Urbana-Champaign (Anselin 1995). Guillain et al 2004, Guillain et al 2006, Guillain & Le Gallo 2007 also used ESDA to search for suburban centers in the greater Paris area.

Another influential team is based in Belgium and northern France, around Ann Verhetsel and Isabelle Thomas, from University of Antwerp and University of Louvain-la-Neuve. Servais et al 2004 elaborated a rather complex array of methods to identify potential suburban centers in Belgium by using LISA (specifically the localized version of Moran's I), also used by Riguelle et al 2004a. In their very important work, Servais et al 2004 also applied several multivariate methods among others to detect for "edge cities" in Belgium, among which a factor analysis – clustering combination, a shift and share analysis, which is often used in France under the name of structural-territorial analysis (see for example Jayet 1993), and a job density-based interpolation surface which they were the first to propose. A flurry of publications have been spawned by this effort, which all converge squarely with the University of Burgundy school in terms of methodology (Riguelle et al 2004a, 2004b, 2007)

In unrelated studies, we used an approach derived from Garreau, using job intensity and dynamics to identify suburban centers in Switzerland (Dessemontet 1999). Gaschet 2002 used a more flexible combination of job density and differential job growth rate to identify them in French urban areas. In a comprehensive study, Berroir et al 2004 identify suburban centers based in part on already discussed methods (identification of employment peaks of a certain size), which they complement by communal commuter matrices to identify commuter poles. In their study, Berroir et al 2004 defined a "brutto polarizing capacity" measured as the number of communities that send a minimal number of commuters or more to the area under consideration, a "polarizing intensity" being the number of communes that send a given proportion or more of their workforce towards the area under consideration, a "first destination" which is the number of communes for which the area is the first destination of its commuters. All five indicators are then compared in a multi-criteria analysis not unlike the ones Martin Schuler developed long ago to classify Swiss communes from 1980 on (Schuler 1984, Schuler 1994, Schuler et al 2005). This approach is especially interesting for our study as the French and Swiss communal grids are very similar. Aguilera & Mignot 2004 devised another method based on commuting practice, which identifies subcenters as the set of areas that between them attract 85% or more of the internal commuters of a given urban area.

3.2.4. The data availability question

Except for the spatial econometrists, who did essentially further their developments in a theoretical manner, availability of relevant data is paramount to the methodologies put forward. In a way, empiricists do propose methods that are suitable to the data they have on hand. Since they differ widely by country, the methods given vary likewise. In particular, there are major differences between European countries on one hand and the US and Canada on the other hand. This is particularly the case for commuter statistics. As we have already pointed out, various European countries used to have very detailed commuter matrices, whereas those are essentially absent from North American ones. Consequently, European research has made wide use of commuter matrices and sheds definitions, while American ones essentially rely on indirect evidence for commuting, such as job ratios, job intensity, or in one case flow estimations.

Secondly, the censuses are not conducted the same way across the different countries. Switzerland has (up until now) a very privileged situation since it has a detailed decennial population census along with business censuses conducted thrice a decade, a situation broadly similar to the one in Italy (with decennial population and business censuses). France does not have any business census per se, and replaces it with an indirect business enquiry; furthermore, the population census provides with data at the workplace. Belgium is in a similar situation, with an additional drawback that the basic territorial unit there is quite larger than in France or Switzerland. In Germany there has been no census, either business or population, since 1987. In the United States, censuses are conducted every ten years and are fairly complete as long as residential population is concerned, but the population at work is rather poorly known and for most areas, there is no commuter matrix.

Hence, depending on the terrain studied, the variety of palliatives used in the literature is great: Garreau 1991 and Lang 2003 used private real estate statistics to assess the size of their edge cities. McDonald 1987, McDonald & McMillen 1990 had to combine census data with job data at the zip code level collected by the Illinois department of labor, and commuter flows from the Chicago transportation board. Gordon et al 1986, Giuliano & Small 1991, Craig & Ng 2001 used census data that described journey to work, which was available for a 12 percent sample of the population to estimate job densities, a somewhat risky approach, statistically speaking. Small & Song 1994, McMillen 2001 resorted to using "transport analysis zones" for which data were aggregated by the census bureau for some metropolitan areas. Thurston & Yezer 1994 used instead local personal income series by the U.S. Department of Commerce. Forstall & Greene 1997 had access to some unpublished census data along the ones already mentioned for Giuliano & Small 1991. In some cases very detailed information is available, such as the one used by McMillen & McDonald 1998 on Chicago (jobs at the quarter-mile section). The examples can go on and on on the American side, while in Europe essentially census data are used in more classical spatial frameworks.

Indeed, a third difference concerns the administrative territorial divisions in use on both sides of the Atlantic. In Europe, except in the United Kingdom, the basic territorial unit is the commune. Taken together, communes cover the entire national territory (with some exceptions) at a fairly fine-grained scale. They are universally recognized since they generally also constitute the fundamental political and administrative entity, thus having a municipal government. For all those reasons, they are historically the basic spatial unit at which census data have been collected and dispatched.

During the second half of the 20th century, various territorial reforms have been enacted in European countries that have altered the local territorial structure, on which generally census results were tabulated. Some countries have experienced massive and far-reaching changes. West Germany was certainly the most striking example in western Europe, going down from 24'278 to 8'514 communes during the 60's and 1970s, while also modifying commune boundaries as to render the harmonization of older censuses results onto the new territorial grid impossible (Auxetier 1984). In Belgium, a similarly far-reaching reform diminished the commune number from 2'359 to 596, essentially by merging older entities which at least allows for harmonization of older censuses on the new territorial mesh (De Witte 1984). The situation is broadly similar in the Netherlands, where historically communes were larger to start with (Hoogerwerf 1984). In Scandinavia, very big reforms were also enacted after WWII which resulted in a very small number of huge communes for all countries concerned. In the 1980s, there were for example only 275 communes remaining, down from 1'299, in Denmark, 279 in Sweden (down from 2'500 in 1950), 454 in Norway (Kjellberg & Taylor 1984) and 461 in Finland (Nurminen 1989). Furthermore, those countries remain in a fluid situation, since territorial reform tends to be a recurrent process in Scandinavia. For example, Denmark furthers its move towards extreme rationalization of its administrative grid. It is good to remember that all those countries have a population similar to, if not smaller than, Switzerland's, for a vastly lower number of communes. Austria, on the other hand, reformed but retained a large number of communes, 2'359 in 2000 for a size similar to Switzerland's. In southern Europe, communal structures remained stable since WWII. Spain and Italy started with communes quite larger than Switzerland's which gives them a rather low number of entities, around 8'000 in each country. However, in Italy large rural communes occur above all in the south, so that in regions bordering Switzerland, the communal structure is broadly similar to Switzerland's. Portugal and Greece both have a high number of communes that they have retained, between 4'000 and 5'000 for countries far smaller than Spain or Italy. The extreme example of stability remains France, which left its very fine-grained communal grid essentially unchanged and where modernization of the local administrative functions went essentially through commune associations of all sorts. Consequently, France retains its 36'700 communes up until now (Schuler et al 2002).

The central and eastern European context being too radically different for much of latter 20th century we will not invoke it here. As we have seen the situation differs widely throughout western continental Europe. In general, countries have either a similar communal network than Switzerland's (notably in France, southern Europe and Austria) or sensibly larger communes, especially towards the north and northwest. Combined with the fact that all those countries have also different ways to conduct their censuses, which range from the regular exhaustive ones conducted both on population and businesses, like Switzerland up until now, to the inexistent (Germany, since 1987), with all situations existing in between, like censuses conducted on registries (northern and northwestern Europe), the effect is that in most cases, detailed territorial statistical information is not available as easily as it is in Switzerland.

In the Anglo-Saxon world, the administrative-territorial situation is completely different. Historically, there is no unique administrative unit like the commune in continental Europe, as the structures were, till the late 19th century in U.K., directly inherited from the *Magna Carta*. At this time the complex array of territorial jurisdictions were replaced by a system distinguishing between urban areas, the cores of which received municipal powers while outlying areas were to be administered by urban districts, rural areas, last, being administered directly at the county level through rural districts. The boundaries of those entities could be easily redrawn, for example to cope with urban extension, a radical departure from the continental logic. This fluidity, in turn, renders overhauls of the system easier, and that is what finally happened in the U.K., with complete overhauls of the administrative-territorial structure in the 1970s and again later on (Newton 1984). Consequently, the censuses have to rely on other territorial grids than the administrative ones; in turn, the fact that the statistical grids have no administrative value makes them likelier to be modified from census to census, with dire consequences in terms of territorial compatibility between censuses.

Meanwhile in North America which is administered according to British traditions, there is likewise a distinction between the countryside, which is managed directly at the county level, and the "incorporated" areas, generally urban or at least with some concentration of population, to which the county devolves some, or all, of its attributions. The territorial frameworks of those municipalities can be very dynamic: cities do annex countryside recently urbanized, some newly urbanized parts incorporates into suburban communities. For all these reasons, North America lacks a well-defined fine-grained territorial level to base their statistical data on. As a result, like in the U.K., census offices have to rely on themselves to create meaningful territorial divisions for statistical purposes and those, being unofficial, can change easily. Hence, the variety of concepts: census block, census tract, transportation analysis zones, etc., varying according to thematic purposes, along with a great variability of all those territories with time, makes for a very diverse array of territories and a great difficulty to collect data at a meaningful and stable territorial framework.

3.2.5. A short discussion of the methods

Even if we accept that the data situation and the territorial reforms play a big part, as they do, in the varying methodological propositions that we just reviewed, they can't account entirely for their variety. With regard to our research question, which is to identify suburban centers, monitor their evolution, and explaining their emergence, we need to evaluate which of those methods fulfill our purpose.

From this point of view, bid-rent based methods have two main defaults. Firstly, they are not self-contained in the sense that they can't detect suburban centers by themselves: ultimately, the subcenters must be picked by the user, either directly, or by running a monocentric model which will identify them, but will ask for the main center to be defined by the user. Secondly, being monocentric, they are suited to study metropolitan areas one at a time; thus, those methods aren't designed to cope with polycentric spaces, such as a complete urban network like Switzerland from 1939 on. Thus, the earlier versions of the bid-rent curve methods aren't adapted for our study. Latter versions, though, involving detection of urban centers and subcenters using either GWR (Geographically Weighted Regression) or LISA (Local Indicators of Spatial Association) can be considered inasmuch as they would prove practical. Specifically, we think here about the methods proposed by McMillen 2001a, 2003, Páez et al 2001, Baumont et al 2004 and its successors.

It has to be noted that none of those methods is dynamic in its essence, which can be considered both ways. First, it can be seen as a default, as they ignore one of the cardinal facts about suburban centers emergence, the fact that they are indeed dynamic, emerging places. But it can also be seen as an opportunity: as those methods do not require time series data, they can be applied without further due to data coming from different times. In our case, it would eliminate problems of consistency between censuses from varying times, as well as giving results for at least one more census. The dynamics of the phenomenon can then be recomposed by looking at the results given at different times.

The advantage of the empirical methods over the earlier bid-rent curve ones is that they do not suppose that an employment center exists in the first place, and thus do not ask the user to pick it. Similarly, those methods can be applied to whatever territory deemed suitable, whether it contains a unique center or more, without having the user selecting a center *a priori*. That being said, they also suffer from notable drawbacks, the most important of which is the threshold question: above what size and density is a center defined from statistical noise? As many have shown, notably Forstall & Greene 1997, there has been utterly no consensus in the research as to how high to put those parameters in order to fit any situation. Instead, it has been generally recognized that those thresholds should be determined according to local knowledge of the context, which is as unsatisfactory an answer as was the obligation to manually locate a center for the bid-rent methods. It didn't hinder these methods to be very widely used in the literature, up until the advent of computer-intensive methods we referred to in the next to last paragraph. At the same time, measures of density have also been questioned; the literature shows that the focus went from measures of population density to measures of job density following Gordon et al 1986. Measures of job intensity have also joined the pool of indicators used to detect job centers. In that respect, the evolution has been smoother and seems more directed than the ones about thresholds. There is now broad consensus that a measure involving jobs should be used instead of population. Furthermore, job intensity could be considered on equal footing with crude job density, especially for medium-sized territorial units.

Whereas Garreau's coined term "edge city" took hold up to a point in the literature, his and Leinberger's criteria have not established themselves as major ways to detect centers. It is to be noted that their criteria relied heavily on office space data that were not coming from official statistics and thus that were not readily available to the research community the way census results are. However, as Bontje & Burdack 2005 have shown, those criteria are rather easily translated into a job number, which can then be referred to. More astonishing to us is the fact that the main novelty in Leinberger and Garreau's criteria, i.e. the explicit mention of those centers as emerging, was not taken on by other researchers; apparently, the research community does not consider it a problem that classical methods of detection will provide with both downtowns and emerging suburban centers. It is indeed possible to dispose of the dynamic definition by comparing results given by non-dynamical methods at different times. Nevertheless, as we have used an explicitly dynamical method in the past (Dessemontet 1999), we intend to further the exploration with dynamical methods of detection.

A further surprise to us is the nearly complete neglect of aspatial statistical methods to detect such emerging centers in the literature. The quantitative revolution of the 70's provided human geographers with a battery of new tools to study the world and indeed, during this period many studies were published in human geography that took into account those methods. In that sense it is quite astonishing that we could only find few studies using factorial methods to detect emerging job centers, most of them fairly recent (Heikkila 1992, Shearmur & Coffey 2002b, Servais et al 2004), i.e. after they went into disrepute in large segments of human geography. This late arrival would certainly explain why those pioneering contributions, being too late, were not built upon; as we will also see, spatially explicit methods had already appeared then, which further relegated such aspatial methods on the side. Nevertheless, they remain highly interesting to us in that they do not ask the researcher much in terms of assumption: essentially, the human choice is reduced to the variables to enter in the analyses and the weight to assign them. In turn, those variables could very well be the ones already used in the preceding methods.

Recently, the advent of practically unlimited computing power has stimulated spatial analysis to a point not attained before. The main development has been the advent of computer-intensive spatially explicit methods, of which two have clearly taken hold. The first is the family of spatial autocorrelation aware methods, such as Anselin's ESDA and Fotheringham's GWR (Anselin

1995, Fotheringham et al 2002), the second is the spatial interpolation methods proposed around Servais and Riguelle in several works (Servais et al 2004, Riguelle et al 2004a, 2004b, 2007). The ESDA approach, in particular, seems to have it all: it is essentially based on a empirical method, detecting "spikes" in the spatial distribution of jobs (whether measured in absolute numbers, by density or intensity) while elegantly disposing of the threshold problem by assessing the significance of the deviation from the mean shown explicated by the spike. As those methods are also local they take into account the regional settings, in fact making the threshold vary spatially in function of the close environment. Essentially, the interpolation methods do exactly the same: by interpolating a surface based on points, they detect spikes then asses their significance; thus, they share the same advantages than the ESDA methods, i.e. the combination of the empirical start point with the disposition of the threshold problem, the latter being also able to vary spatially.

Convergence has been slowly building up in the latter years between the array of methods we just commented on. In particular, the recent advent of computer intensive, spatially aware methods have essentially resolved the threshold problem of the empiric methods and thus made them all the more suitable. In a more subtle manner, the advent of spatially aware methods does mark convergence with the classical bid-rent curve methods, since the bid-rent curve is not more than a stylized, 2-dimension reduced model of an interpolated surface. In a way then, the emergence of spatially explicit methods to detect urban centers and subcenters marks a definite progress.

3.3. Main empirical methods

3.3.1. Introduction

There is a large array of methods currently proposed in the literature to detect suburban centers, even if not taking into account the bid-rent methods, and even if, as we have also surmised, there is convergence towards a more unified approach to the detection of urban centers and subcenters. This in turn begs for the subject of robustness to be clarified: how different the results will be, is there a class of object that will be detected by all or most of the methods we will test, and if yes, what are the properties of those objects?

It is not our primary goal to devise a method to test various methodologies aimed at detecting suburban centers. However, even if consensus is slowly building up, it is interesting to test whether different methods, as applied to the same object, would give similar results. This would indicate first that the tested methods are attaining robustness and that they can be applied with confidence. This would also indicate that the urban and suburban job centers are quite well defined and get selected regardless of the methods. On the other hand, if different methods give widely different results, this will either mean that there is a problem of method robustness, or that the object is ill-defined so as to respond quite differently to different methods. The most probable outcome of this research will be in-between: the methods will broadly converge, and a good number of our objects will get selected regardless of the methods. This may allow us to discard methods that give divergent results, and also qualify urban centers and subcenters as core or marginal depending on their probability to be selected by the methods. The sheer results of the methods can also be used to discriminate between them. Indeed, getting results that can't be interpreted logically – results that just don't make sense – is a sure sign that something is amiss either with the data or with the method.

Our object of study provides for means to select some of those methods out. As we work at a larger scale than that of an individual metropolitan area, we surmise a polycentric urban structure. This eliminates all methods that are explicitly based on the monocentric model, i.e. all bid-rent curve methods. As we have said earlier, we could likewise base our study solely on the latest computer-intensive methods, since they seem to have resolved the most blatant defaults of the earlier empirical ones. On the other hand earlier methods provide with means to control the automatic methods. In a field where convergence is just happening but has not been recognized as such, it is of utmost importance to be able to control for spurious effects of such and such method. For this reason, our selection of methods is large, and includes both purely empirical methods proposed in the early 90's and computer-intensive methods proposed later on. Each of those will be described in full under its own paragraph.

The following methods will be considered:

- Giuliano-Small (cutoff & job density – non-dynamical)
- Forstall-Greene (cutoff & job intensity – non-dynamical)
- Garreau-Leinberger (cutoff, job intensity, job growth, primacy of the tertiary sector – includes dynamics)

3.3.2. Generic remarks and modifications

The following modifications have been systematically made to all of the methods we will test in order to serve better our purpose. First, when thresholds are present, they have been lowered to 1'000 jobs, 500 when considering only secondary or tertiary jobs. Three density levels have been considered: 25, 20 and 15 jobs per built hectare, corresponding approximately to 10, 8 and 6 jobs per acre; for sectoral studies, the densities taken are 20, 15 and 10 per ha – 8, 6 and 4 jobs per acre. Likewise, three job intensity levels: 1.25 jobs per active resident, resp. 1 and 0.9, have been considered. Thus, a place will be considered a center if it holds more than 1'000 jobs (general case) or 500 jobs (sectoral case), while fulfilling either the minimal density (Giuliano-Small) or intensity (Forstall-Greene).

Reasons for the aforementioned adaptations are as follows. The methods we intend to test were developed in a wholly different context than the one we intend to explore. They were devised to be applied to the biggest metropolitan areas of the world: Los Angeles for Giuliano-Small and Forstall-Greene, all major US metropolitan areas for Garreau-Leinberger. In all three instances, the main goal was to detect major centralities pertaining to one or many giant integrated metropolitan areas. Thus, as engineered by their authors, applied to Switzerland those methods would surely fail to detect any but the biggest centers: the big classical centers, maybe a handful of new emerging centers. However, our goal is to study at a fine scale such emergent job centers across a small territory - Switzerland's population is only half that of metropolitan LA - and the evolution of its urban network. Furthermore, the historical context of Switzerland is obviously quite different than America's. Switzerland, especially its low lying areas, is a very dense country where centrality can be very quick to emerge. In that sense, Switzerland strongly resembles areas of southern Germany of which it is a neighbor, and which provided the basic framework for Christaller to build his central places theory (Christaller 1933). In that context, Christaller envisioned an urban hierarchy which smallest members would count about 1'000 inhabitants, which translates to about 500 non-agricultural jobs, equivalent to the limits we have chosen for our smallest centers. Density and intensity levels have been likewise somewhat reduced from what they were in the original methods for similar reasons, reckoning that both measures depend strongly on center size - i.e. density and intensity grow higher as centers get larger. In fact, all sizes equal densities are far larger in Switzerland – and presumably in Europe, than in North America. Nevertheless the gap in size we impose on the methods is so wide (500 top 1000 jobs as compared to 10'000 to 25'000 jobs in the various original methods) that a decrease is warranted. By the way, density is still more than the lowest density considered for instance in Redfearn 2007, p. 534. Likewise, intensity levels have been decreased to about 85 jobs for 100 active residents for upstart locations, the idea being to detect sooner emerging centers; however nominal levels are maintained here for all other centers.

Densities have been computed on built-up acreage instead of on the whole communal area, as to eliminate fields, forests and lakes from the count. When applicable, built acreage has been interpolated from the area statistic of the Swiss Federal Statistical Office for 1965-1972, 1979-1985 and 1992-1997. For earlier times, the 1972 statistic of built-up areas has been taken, as the earlier statistics do not differentiate between built-up and unproductive areas, and are thus unreliable. It can be hypothesized, though, that job densities were at least as high before 1965 as they were in 1965, for in 1965 suburbanization and the generalization of the car were already taking place, resulting in lower job densities. So, figures for 1955 and 1939 have been altered as to give a mean national job density equal to the one computed for 1965.

The contiguity relationships have been set quite stringently: it is not sufficient to share a communal boundary to be considered contiguous. For two communes to be considered contiguous, built space, or better, activity areas should extend seamlessly across the border. Another limit is that major cities are never considered to be part of a bigger unit as they all show a strong dichotomy between their downtowns, dominated by activity, and an inner residential ring, such as there is always a separation between the central business district and the neighboring communes. Lastly, for a group to be considered contiguous, its road network should be unified – for example around a highway junction. Those relationships will be assessed on the basis of road and topographic maps of Switzerland, of which we have a vast access, both personally and through the EPFL.

It is to be noted that many of the detection methods apply indiscriminately to any employment core – central or otherwise. Those do not distinguish between central and suburban locations and derivatives must be found to differentiate between what should be considered a bona fide center, and what can be interpreted as a suburban center. For all those methods, the question of dynamics plays a big role into distinguishing between traditional cities and emerging suburban centers. The methods explicitly designed to detect suburban centers – Garreau-Leinberger and Shift-Share analysis – do this by incorporating the dynamical component into the detection method. The factorial design may likewise detect a dynamical component that can then be used to discriminate between cases. In theory, more traditional methods can also be applied, such as designing a set of centers as central cities – as we will do, or designing as subcenter any secondary center within a continuous built-up area or a given distance from a major center.

Lastly, even though our subject is clearly geared towards the tertiary sector, it is remarkable that most of the methods and indeed most of the literature on the subject do not differentiate between industrial and service-oriented activities. This may be due to the fact that most of the studies are fairly recent and made in economies that were already largely service-oriented; but in our case, industry dominated the economic landscape till the early 70's and therefore is likely to have dominated the urban network for the first part of our period of study. Therefore, we find it useful to test our methods on the whole non-agricultural economy in place of the tertiary sector, which was envisioned exclusively at first.

3.3.3. The Giuliano-Small method

3.3.3.1. Introductive remarks

For better or for worse, the Giuliano-Small method has established itself as the main empirical method to detect job centers. It was first proposed in Giuliano & Small 1991 on subcenters in the Los Angeles metropolitan area. In that paper, the authors acknowledged the fact that the urban network bears little resemblance to the monocentric model, and the growing corpus of theoretical research in the bid-rent curve school linking this phenomenon to economical forces; in their wake, the authors accepted that economical forces were responsible for the emergence of suburban centers. Giuliano & Small 1991 also noted the great variety of subcenters definitions and remarked that very often those were simply designated, picked by hand. Their goal was then to find a more objective method to detect suburban centers. As the data they were working on was from a single census (the 1980 edition), the method could not be dynamical. The authors also accepted the idea from McDonald 1987 that employment instead of population, and thus jobs instead of residents, were the measure of an emerging subcenter. Furthermore, they argued that since the essential advantage of a center is economies of scale and agglomeration, job density is the best indicator to measure those centers, better than job intensity since according to the same thought, whether residents are present or not does not have an influence of those economies of scale and agglomeration. No mention was made of any kind of distinction between industrial and service jobs. This is probably due to the fact that the LA industry was specialized towards high technology with hundreds of specialized, flexible, small-scale companies instead of a few giant plants; therefore, the gap between industrial and service occupations did not appear to be very important in such a context. Were it to be applied to another context such as a traditional steel mill industrial city, the distinction could have been made.

The method itself is straightforward: all spatial units (or groups of contiguous units) that show high job density are designated suburban centers if they pass a threshold of job numbers. In their article, Giuliano & Small adopted 10 jobs per acre (i.e. 25 jobs per ha) as density threshold, and 10'000 jobs as a cutoff in central areas, 7'000 in outer areas. Their method detected 32 urban centers in the LA area in 1980, 28 of which they deemed suburban centers. The four remaining ones were considered "traditional" centers, including downtown LA.

This method was run on Switzerland, taking on all non-agricultural jobs with an absolute threshold of 1'000 jobs and minimal job densities of 15, resp. 20 and 25 jobs per ha.

3.3.3.2. General findings

In all, for the whole period covering 1939 to 2005 we were able to reconstruct a grand total of 282 urban centers which counted more than 1'000 non-agricultural jobs each, and a job density of 15 jobs per built hectare (hereafter: jobs per ha). Of those, 150 were present in 1939, against 131 in 2005; but those two groups have only 68 units in common, of which 58 have been continuous members of the urban network. Thus, 82 urban units present in 1939 disappeared during the period under study, while 63 units appeared; a further 69 urban units appeared and then disappeared between 1939 and 2005. The last ten, as we already have seen, did the inverse: disappear and then reappear during this period. In short, about half of the 1939 urban network has disappeared; about half of the current urban network postdates 1939; and approximately the same number of units had the time to emerge and go down in-between. The Swiss urban network has indeed seen quite dramatic changes during the past 60 years.

Several periods can readily be identified when looking at it. Up until 1965, Switzerland went through a vigorous urbanization process, with the number of urban units climbing from 150 in 1939 to 173 in 1955 and a maximum of 195 in 1965. While some places dropped out of the network during this period, the main movement was one of accretion of new urban centers into the network, and of densification: during this time, the number of urban jobs nearly doubled (from 993 thousands to 1.833 million), such as the share of urban jobs in the total climbed from 64% to 69%. However, the share of jobs that were located in the densest places, those with more than 25 jobs per ha, peaked at 54% as soon as 1955; in 1965, this figure was down to 50%, signaling a start to the deconcentration process.

The decade leading to 1975 saw a very sharp inversion to the processes described: the urban network lost no less than 59 units, and the share of jobs situated in urban units reverted to 63%, while the share of jobs in dense cities continued to drop at 47%. The network as a whole retreated, dense and less dense parts alike, while the non-central jobs continued to gain, partly by the fact that former centers suddenly reverted to non-central status: essentially, the urban network shed most of its industrial cities. The following decade (1975-1985) saw a consolidation of the urban network resulting from the industrial crisis of the 70's, with a twist towards less dense settings. While the network didn't change enormously between 1975 and 1985, deconcentration started to occur: the densest cities saw their job share sink to 41%, while less dense centers went from 1 central job in 4 to 1 in 3. The six booming years preceding 1991 saw a renewed strengthening of the urban network, which gained 33 units to 169, the highest figure since 1965. All types of centers gained from this period, quite equally: the job share of the centers as a whole actually climbed back to around 66% of the total, while the densest centers kept their job share to 42%. In 1991, the urban network sheltered a maximum of 2.145 million jobs, more than 1.371 million of those in dense cities.

As in the early 70's, the urban network went through a complete reversal during the crisis years of the early and mid 90's. In four years (1991-1995), the urban network lost 46 units, while a powerful deconcentration process took place. For the first time, the share of jobs not contained in urban centers rose sharply from 35% to 41%, while the dense centers saw their job share slump to 38%. Centers lost around 310'000 jobs between 1991 and 1995, while edgeless locations gained more than 140'000 jobs. The short period between 1995 and 1998 saw a respite or a consolidation phase where not much happened in either direction, save a significant movement: for the first time in recent history, the number of jobs in non-central, edgeless locations declined in step with the whole of the urban network and indeed of the economy.

As after the economic crisis of the 70's, the brief rebound of the late 90's seems to correlate well with the redevelopment of the urban network at this time. Between 1998 and 2001, the urban network somewhat rebuilt itself by gaining 15 units. More significantly maybe, a certain reconcentration occurred: the urban centers gained around 170'000 jobs while edgeless locations remained below stability with a minute loss of 30'000 jobs. Reconcentration also occurred inside the urban network, the job shares of the densest centers creeping back to 40%. But again, turning economic conditions after 2001 seems to correspond to a new turn in the urban network, which saw a double movement of deconcentration with a renewed growth, both absolute and relative, of edgeless locations, and a reconcentration inside the urban network, the least dense centers bearing the brunt of the urban job loss of this period.

The general trend is clearly, if slowly, one of deconcentration. In 1965, nearly 70% of non-agricultural jobs were situated in centers, a figure down to just 60% in 2005, paralleled by the slow but steady rise of edgeless job locations since that date. In 1955, the majority of such jobs were situated in the densest centers of the country, against 40% in 2005. Where centers were overwhelmingly dense in 1939 – 80% of urban jobs were located in dense centers then – , a class of rather sprawling centers has emerged since then which now incorporates a third of the urban jobs.

While the general trend to deconcentration is a long term one, at shorter terms there is a very strong relationship between economic conditions and the dynamics of the urban system. In times of growth the urban network expands, getting more units, closer to one another. During recessions, it shrinks and loses units. Crises kill urban centers; booms create them. As we will see farther down, if some cities do rebound, for many, the exit from the urban network is definitive. They are replaced in the network by new locations, being more often than not suburban centers. In detail, when crises occur, they hit a disproportionate amount of local centers and industrial towns, peeling away at the classical Christallerian network, while economic booms tend to favor disproportionately the emergence of suburban centers. Thus, in the long run, a class of urban centers is slowly replaced by another one, and the urban network mutates.

Those ups and downs do not invalidate the general trend of a slow decrease of the number of urban units, a slow decrease in overall job density and an increase of the share of edgeless jobs. Deconcentration phases during economic recessions are sharper and more profound than reconcentration processes are in succeeding economic rebounds, as is clearly shown in graph 2 for the 70's and the 90's crises: during booms, the urban network does not recuperate all the density and number of units it lost during crises.

The findings made upon the Swiss urban network using our adaptation of the original Giuliano-Small method is as follows.

- By and large there has been a slow and steady evolution of the urban network, from a very complete Christallerian mesh towards a network composed of fewer but larger units, where close proximity is not as important as it used to be.

- The general trend has been one of deconcentration, which can take many forms. By and large centers lost of their importance in the urban network, at all levels of the urban hierarchy. They have been challenged more and more by initially non-central places, which were in chronological order industrial towns, then suburban centers and currently maybe exurban centers.

- The main departure of the 1939 christallerian network, which were the so-called industrial towns, all but vanished since then. Industrial towns are now practically irrelevant to the discussion of the urban network

- Touristic resorts have always been, and remain, a marginal part of the urban network, were it by number of units or by jobs. Their inclusion is irrelevant when it comes to discussing the urban network.

- Some suburban centers were already existing in 1939, but they weren't very significant at the time. Their number and significance grew regularly for the whole period under study, going from around 30'000 jobs in 1939 to 420'000 in 2005. Around 1960 they overtook in significance industrial towns; in 2000 they had more jobs that the lower levels of the classical urban network, a feat that industrial towns never achieved.

- More recently (1990 onwards) exurban centers have started to appear, essentially suburban center-like locations that can't be readily attached to a parent city but rise in metropolitan areas. To date their significance in the network is not high, especially in terms of job numbers; but their recent rise, when considered as markers, could be seen as indicative that metropolitan forces are at work on the Swiss territory.

- There is a strong correlation between economic conditions and the dynamics of the urban network. The general rule seems to be that economic growth periods tend to favor the development of the urban network, while economic crises do harm to it. However, differing parts of the urban network do not react the same way to economic ups and downs, as detailed hereafter:

- Suburban centers are very sensitive to economic conditions, and respond very well when they are favorable. Main periods of subcenter emergence have been during very positive economic periods (the 60's, late 1980s, around 2000).

- Conversely, industrial towns above all, small centers and later small and young subcenters are sensible to deteriorating economic conditions, times when they can easily revert to non-urban status.

- Big job centers, once established, are not subjected to economic conditions. Once a center, whether central, sub central or exurban, attains a certain size (around 12'000 jobs), it will remain in the urban network regardless of the economic conditions. Thus, the upper level of the urban network is fairly robust and sees fewer changes than the lower levels.

However, if one general conclusion can be inferred from the use of the Giuliano-Small is the slow but overwhelming rise of edgeless locations in the total of jobs. As a whole, the urban network did strengthen its position only up until 1965, when it represented almost 70% of the jobs. Since then, edgeless locations have gained more than 420'000 jobs, the exact number of jobs included in all current suburban and exurban centers. In 2005, edgeless locations represent almost 40% of the job total, and there are now as many jobs in locations that are described as not central of any kind as there are in the top level of the urban network, major subcenters included.

When partitioning the country in three categories (centers, subcenters and non-central locations), non-central locations represent 40% of the total against 46% for centers and just 14% for subcenters. It is true that the progression of sub-central locations is the most impressive of the lot and that in particular its ratio to classical centers has been on the rise, but it is also true that in general, the urban network as defined by the Giuliano-Small method has slowly dithered since

1965 while non-central places have gained in importance. Whether this is due to the accuracy of the method or not, remains to be seen. Arguably, in 2005, about 365'000 jobs, or 12% of all jobs, were located in non-central places that had been once part of the urban network as defined by Giuliano-Small methodology. That means that edgeless locations grew not only by themselves (which they certainly did), but also by extending on formerly central places that had lost their urban status. But even taking those 12% out of the equation, "true" edgeless locations, located in places that were never central still represent 28% of the total of jobs, or twice the subcenter figure.

One finding that would warrant further investigation is the dynamic of edgeless locations. Whereas the urban network's development correlates positively with economic conditions, the exact opposite is true for edgeless locations. That it to say, poor economic conditions seems to be fuelling urban deconcentration, job deconcentration, not only in relative terms (where edgeless locations are just the complement of urban locations) but also in absolute terms. Notably, it would be interesting to show if the jumps in edgeless job numbers registered between 1965 and 1975, 1991 and 1995 were only due to former urban centers reversing to edgeless status, or if there is more to it, i.e. edgeless locations actively benefiting from crisis conditions.

Up until 1965 the move was one of sheer concentration and expansion of a very much urban-centered urban network. Deconcentration started in the 1970s and favored both subcenters and non-central locations, with a numeric advantage to the former, implying a form of sprawling deconcentration. In the late 1980s, a process of "reconcentration" of sprawl, around cities and subcenters alike, took evidently place. However it was followed by a strong reversal movement during the early phases of the 1990s crisis. Since then, a clear correlation can be established between economic conditions and cycles of concentration and deconcentration, but a general trend is more difficult to decipher; it seems that from 1995 there is a broad equilibrium between downtowns, subcenters and edgeless locations. The classical urban network attained a plateau after 1965, and the urban and suburban centers reached theirs in 1991. Edgeless locations have in turn reached a summit shortly afterwards, and since the 1991-1995 rupture, it hasn't been clear whether we are in a period of concentration or deconcentration, and if we are indeed deconcentrating, whether we live a period of "concentrated deconcentration" that would favor subcenters of all kinds, or one of pure sprawl favoring edgeless locations.

As this is not a study about edgeless locations, we won't elaborate further on them; but their sheer significance in the system can't be ignored.

3.3.3.3. An assessment of the original Giuliano-Small method

As we have seen the Giuliano-Small method is a powerful one. It matches one of the main requirements of any method aimed at deciphering territorial realities by giving meaningful, interpretable results. At first sight it may seem too selective with less than one commune in twelve selected as urban center at any one time. It would certainly be true of the Giuliano-Small if their strict criteria were to be adhered to – designating only 30 to 40 communes as urban centers. As modified, at any one time between 150 and 200 communes are included as urban centers, and the figures we have in terms of distribution between central, sub-central and non-central locations.

But comparisons made in the literature regarding the partition between central, sub central and non-central locations actually show that the partition we get for 2005 (45-15-40) is credible, close to the ones calculated for ten major American metropolitan spaces at around the same time (Lang 2003, p. 77).

However, there are several weaknesses that are built in the method. The most important of them is that as such the method does not distinguish between different types of centers. The distinction we have put between what is a classical center and what is a subcenter were done subjectively, with the help of our knowledge of the territory, and taking into account such things as official status. The method detects centers, but does not allow for a quick distinction between them. Therefore, a subjective element is entered into the description we entered: we had to designate centers as classical, suburban, exurban.

The original Giuliano-Small method insists on job density as sole indicator, with job numbers, of a job centrality. It is certainly a sufficient condition: if a place is packed with jobs it certainly would qualify as center. However, it may be assumed that it is not a necessary condition: sprawling suburban or exurban centers taking advantage of sheer space are indeed eliminated by design – for example, the Littoral complex situated halfway between Lausanne and Geneva is not selected even though it groups close to 3'000 jobs in 2005; the Gäu logistical complex is also under evaluated, with only two communes selected. Another category of places is severely discriminated against by the method: the industrial towns. By definition industrial complexes require extensive areas to develop upon, which pushes their built area higher than other places, which in turn send their job density lower. In case of restructuration, if abandoned industrial areas are not reverted to non-built space, the density will sink below the limits we have established. This probably explains the strong bias of the method against industrial places in particular, and space-consuming activities in general.

A modified Giuliano-Small approach, the Forstall-Greene method, gets rid of the latter problem, although not of the first.

3.3.4. The Forstall & Greene method

3.3.4.1. Introductive remarks

The modified Giuliano-Small approach that we will describe now originated in a major paper by Forstall and Greene (Forstall & Greene 1997). After an extensive literature review in which they noted the wide spread of the methods, they remarked that by and large this inflorescence was largely due to specific data considerations regarding the particular object of study. In short, methods were widely scattered because authors were generally interested in one metropolitan area for which a very specific set of data was available. The author's aim was then to propose, in the north American context, a method that could be applicable to the whole of the country, regardless of the metropolitan area under consideration. This was attained by taking an universal territorial subdivision – the census tract, which is indeed available for the whole country.

Although they implemented what would be a universal method, they tested it on one metropolitan unit, and the same at that than Giuliano-Small seven years prior: Los Angeles. Other similarities with the Giuliano-Small approach are the use of the same cutoff criterion (10'000 jobs) and the same definition of what jobs should be included (all non-agricultural jobs). The main innovation proposed in their approach was to replace job density by job intensity. They justified this by noting that area would not always be a very sensible choice of benchmarking of the importance of a job center, noting for instance the problems posed by unproductive areas – they could not use a qualified space measure such as the built-up area, for lack of data. After comparing job and residential densities, they noted that while they were broadly correlated, at the local level they tended to be spatially segregated: space was specialized as residential or activity orientations.They also noted that a job center, by definition, should be specialized in some way as such and that the best measure of it would be that it would be importing rather than exporting commuters, which implies automatically a job intensity (or jobs on actives ratio) superior to 1. Furthermore, the data was relatively easy to infer from censuses.

To us, the Forstall-Greene method is a derivative of the Giuliano-Small method. The method itself is straightforward: all spatial units (or groups of contiguous units) that show high job intensity are designated suburban centers if they pass a threshold of job numbers. In their article, Forstall and Greene adopted a job intensity of 1.25 as intensity threshold to detect job center cores, to which all contiguous areas with a job intensity above 1 would be aggregated. The resulting area should then count at least 10’000 jobs. Their method detected 68 urban centers in the LA area in 1990, about twice the number than Giuliano and Small had found for the same area in 1980.

It is to note that working in 1997 on data from the 1990 census, the authors were very much rooted in their time. In particular, their method assumed that space was functionally segregated between job centers and residential areas and that the mere definition of a job center would show a significant departure from a job intensity of one. This is very much meant to study integrated metropolitan areas where this discrimination did already take place. It remains to be seen if this method does apply to moving spatial conditions, and in particular how it does react to near-autarkic job centers as the main swiss cities were prior to 1960.

As compared to the Giuliano-Small method, the Forstall-Greene method should detect far more exurban and industrial centers where the main competitive edge is cheap land, and thus where space consumption is high and job density low. It should in the contrary discriminate against dense residential areas where a sizeable amount of jobs exists.

3.3.4.2. General findings

As for the Giuliano-Small method, we have modified the cutoffs in order to better serve our study. Here, all communes showing job intensity higher than 1 and more than 1’000 non-agricultural jobs will be selected as job centers. Two categories will be studied, the job places with a job intensity above 1.25 being distinguished from those having job intensity between 1 and 1.25.

In all, for the whole period covering 1939 to 2005 we were able to reconstruct a grand total of 369 urban centers which counted more than 1’000 non-agricultural jobs each, and a job intensity (jobs on active ratio) over 1. As compared to the previous method, only 19 of the 282 units detected by the original Giuliano-Small method aren’t detected by Forstall-Greene, against a whopping 106 units detected by Forstall-Greene that are not considered central by Giuliano-Small.

The Forstall-Greene method detects 157 urban units in 1939, against 184 in 2005, 78 of those having been there in 1939 and in 2005, 61 of which have been continuous members of the urban network. Thus, 79 urban units present in 1939 disappeared during the period under study, while 106 units appeared; a further 89 urban units appeared and then disappeared between

1939 and 2005. The last 17 did disappear and then reappear during this period. While the Forstall-Greene method does indeed select more urban units than the original Giuliano-Small method, in terms of long term evolution of the urban network both methods give strikingly similar results, i.e. that there has been quite a major upheaval in the Swiss urban network between 1939 and 2005. Half of the 1939 urban network members disappeared since then, while two thirds of the 2005 urban network is constituted by additions to it, not counting a considerable number of occurrences having appeared and disappeared in between. The Forstall-Greene method does confirm general findings made with the Giuliano-Small method, i.e. that the Swiss urban network underwent massive changes during our period of study.

The history of the urban network shown by the Forstall-Greene method is likewise similar to the one depicted in the previous section. Up until 1965, Switzerland went through a vigorous urbanization process, with the number of urban units climbing from 157 in 1939 to 215 in 1955 and a maximum of 236 in 1965. As measured by Forstall-Greene, during this time, the number of urban jobs nearly doubled from 977 thousands to 1.868 million, figures very close to the ones of Giuliano-Small. The share of urban jobs in the total climbed from 63% to more than 70%.

The urban network sustained a major shock during the 70’s economic crisis, the urban network losing 78 units, and the urban share of the jobs going down from 70% to 60%. A very large number of specialized job centers disappeared at this time (49), while self-sustaining cities fared a bit better (29 losses). If anything, the urban crisis is shown even more sharply by the Forstall-Greene method than by the Giuliano-Small one. Most of the losses were supported by centers and industrial towns, while unlike all other urban types, in terms of job numbers if not in unit numbers terms, suburban and newly emergent exurban centers held their own during the 1970s crisis, the ones surviving accounting by their growth for the jobs lost by those that disappeared.

After 1975 the urban system experienced a rebound and the share of urban jobs in the total started to climb again, although at a far reduced rhythm. Between 1975 and 1985 the urban network gained 43 urban units to 201, and 35 other ones in the run-up to 1991. At this date, the number of urban units was 236 again, exactly as in 1965, but with a different structure where suburban and exurban locations were far more important than in 1965 while central and above all industrial places were fewer. In terms of job numbers, the urban network had become top-heavy, with a record number of jobs concentrated in major centers while the role played by lesser centers had been fading since 1965 and experiencing only a modest rebound between 1985 and 1991. At the same time, suburban and exurban centers sustained an extensive period of growth, such as more than doubling their numbers from 33 in 1975 to 69 in 1991. Similarly, in terms of discrimination between central and sub central or exurban locations, while there had always been a differential between centers and subcenters, to the advantage of the latter, they either grew or shrunk together. Between 1985 and 1991 however, for the first time classical centers saw their job numbers fall while suburban and exurban centers continued to grow. This trend has been confirmed since for all periods, bar one.

The one exception to the rule is the 1991-1995 period, when both central and sub central locations lost jobs, as did the whole urban network. The latter lost 40 units in just four years, a rate quite comparable to the one experienced during the 1970s. Centers sustained about half of the losses, a further fifth being lost by industrial towns. Suburban centers also lost a certain number of units. In general, urban location retreated massively during the 1990s economic crisis, as they had in the 1970s, both in absolute and in relative terms.

Subsequent history confirms a strong link between the economic situation and the development of the urban network: the network briefly rebounded between 1998 and 2001 as the economic situation got better, to flatten again between 2001 and 2005. The discrepancy between central and subcentral locations seems to have widened recently, as suburban and exurban locations hosted most of the urban growth while classical centers sled. Since at least 1985, suburban and exurban centers have become more important both in mass and in sheer numbers than tourist resorts and industrial towns, and thus have become major urban features besides classical centers.

However, despite their growth and even though their emergence signifies a major urban upheaval, in 2005 for every job hosted in designated suburban or exurban centers, there are four that are still located in classical urban centers. Admittedly, the job share of classical centers had never been as low as it was in 2005, where fewer than half of all jobs were located in the classical cities, a 20 point drop in 50 years; similarly, the share of suburban locations has risen fivefold between 1939 and 2005 to about 12,5% of all jobs. More generally though, according to Forstall-Greene, the urban history can be globally interpreted as a first period of urban expansion and strengthening culminating around 1960, followed by a slow and steady erosion of the urban network towards its fringes, with the advent first of new centralities in the midst of its suburbs, and secondly, if not above all, with the slow rise of edgeless locations and the diffusion into the whole territory not only of residences, but also of jobs. In 2005, close to 40% of all jobs were located in non central places.

The Forstall-Greene approach confirms findings made with the Giuliano-Small method, that there is a very strong correlation between the evolution of the urban network and the economic situation, and that favorable economic conditions tend to strengthen cities and the urban network whereas economic crises tend to favor dilution of centrality the urban network into the edgeless realm. Again we find that a strong economy is indeed favorable to cities whereas poor economic conditions are harmful to them.

3.3.4.3. Assessment and comparison with the Giuliano-Small method

As applied to Switzerland, the Forstall-Greene method gives broadly similar results to those of the Giuliano-Small method. Taken generally, the main difference between the two is that the Forstall-Greene method does select more units than the Giuliano-Small did. However, those units selected by Forstall-Greene are smaller in job numbers than the ones Giuliano-Small selected. The difference between the two being that Giuliano-Small emphasizes density whereas Forstall-Greene put an accent on job intensity, for suburban and exurban centers this difference can be interpreted as follows: there are more intense suburban centers than there are dense ones, but the dense suburban centers encompasses more jobs than the intense ones. More broadly put, there is a number of specialized suburban centers where density is rather low, especially in logistics and other spatially extensive activities, particularly present in exurban locations, which were not detected by Giuliano-Small because of this low density. Conversely, Giuliano-Small detected dense suburban centers that were located in very dense, predominantly residential areas such as inner suburban communities. In that sense then, both approaches seem to complement each other rather than to conflict; they detect dense, respectively intense locations.

In all, the urban network as described by a job intensity method is a rather skewed Christallerian network. First, there is quite a difference between the very dense urban network of Northern and Eastern Switzerland as compared with the loose network of Western Switzerland. Second, the network itself is skewed towards small but already intense locations, while the top tier of the network seems less intense. This is largely due to the fact that first commuting was not yet widespread in 1939, especially in the biggest cities. Then, commuting was only possible on short distances, according to slow means of transportation (foot, bicycle of streetcars). The probability to cross a communal boundary would not be high is large cities, esp. those that had recently incorporated suburban communities. Moreover, industrial plants were more prone to transform a small city into a job center as they would exhaust the local workforce supply much faster in a small place than in a large city with its larger workforce pool. For all these reasons, the Forstall-Greene method would not be very efficient at designing an urban network in such autarkic conditions. Of course, as spatial specialization took hold, the method should become far more efficient.

Thus, at a more general level, the late 50's and the early 60's according to Forstall-Greene were quite different from the period before, as if subcenter emergence started to be powerful enough to offset the effects of residential suburbanization. Clearly, the 50's and 60's were also times during which commuting became prevalent in major cities; in fact this is the time the method starts to register major centers as intense; it thus makes a lot more sense from then on than before, at least from an holistic point of view which would require a method to register correctly the whole array of urban subjects and not only parts of it. The fact is that from then on, both methods will give at least similar trends, if not results.

The Forstall-Greene approach gives results that are unique to it, though. Due to its reliance on job intensity, the method allows us some insights on how it developed over time and hence gives us an opportunity to write its history. In 1939, more than 80% of urban jobs were located in places where the ratio between jobs and active residents was close to one – indeed, rather autarkic places where workers lived close to their job places, a category that included all the big cities of Switzerland. At this time, only specialized small and medium-sized towns would show significant commuting, and they were rather marginal in the network, even if they were numerous (67 such places in 1939, Baden, Aarau, Olten and Zug taking the main spots). The situation remained broadly the same in 1955, with autarkic towns and cities still dominating the urban network, even if the number of jobs housed in job-specialized centers more than doubled to attain around 380'000 in 1955, one in five in total. The major upheaval occurred between 1955 and 1965, with all major urban centers starting to specialize as job centers and attracting commuters. As a consequence, in ten years the urban job market switched from one thoroughly dominated by autarkic cities, which included three quarters of the urban jobs, to one where specialized job centers grouped 60% of all urban jobs. This movement went on strengthening till 1985, when four out of five urban jobs were situated in specialized job centers; this proportion has held since.

These findings allow us to draw two conclusions. First, it is tempting to link the advent of job-specialized places with a more general suburbanization move. In fact, the advent of specialized job centers was mirrored by the rise of residential-oriented communities: both location types rose together, and did so spectacularly between 1955 and 1965, and at a more leisurely pace between 1965 and 1991. From 1985 on, it seems that the "autarkic" category stopped its slide; in terms of numbers, around 400'000 jobs, about 15% of the total, remain in centers that have a job intensity of approximately one. Those were clearly autarkic around 1965; it remains to be seen if it is still the case in 2005, or if such job intensities arise only by coincidence in communities where out-commuting active residents are closely replaced by in-commuting job holders.

More importantly, it can also be seen that the rise of job specialized places went hand in hand with the rise of edgeless locations numbers. While those two categories are opposed in terms of development as long as the economic context is concerned, centers gaining while the economy is good and edgeless thriving under poor economic conditions, the long-term trend is that they grow together. The same phenomenon that allowed cities to specialize as job centers also allowed for a growing number of jobs to locate just about anywhere. And while it can be hypothesized that long ago edgeless locations were above all small local centers, to this day edgeless locations have become truly edgeless, i.e. a diffuse pattern of jobs interspersed with habitat in extensive periurban and exurban locations, where they go undetected. In essence, spatial functional specialization went along with spatial diffusion and dispersion. And in fact, it is difficult to see based on these results what is the most significant phenomenon between the two. Is urban specialization more important than edgeless diffusion? At least it can be sustained that the reconcentration of diffusion on edge cities is not as significant as it can be sometimes seen in the literature. In fact, as of 2005 at least dispersion wins handsomely over reconcentration in new suburban or exurban centers: there are three times as many jobs in perfectly diffuse locations than there are in suburban centers.

The Forstall-Greene method is interesting in what it shows in terms of unit numbers and developments. As a general rule the Forstall-Greene method detected more units that the Giuliano-Small one throughout our period of study, but this preference is not evenly distributed between all center classes. Firstly, Forstall-Greene detects more cities than Giuliano-Small does, and this throughout the period under study. This seems to show that cities are easier to define as intense places than as dense places; in fact they are cities more as job centers than as dense places. The same explanation goes to explain why the Forstall-Greene method is more inclusive of industrial villages: those are generally commuter-intensive, but not dense places of work. By extension, and for the same reasons stillm, Forstall-Greene does detect more exurban cities than Giuliano-Small, and it detects them way earlier. In a sense this is logical: exurban cities grow about the same way and with a similar rationale than industrial towns: because they have a competitive edge – in the case of exurban centers we suspect it is their accessibility whereas for industrial villages, workforce availability was paramount – and because they have ample room for development. Thus, they underwent a form of development that was not geared towards density: plants and factories for industrial villages, commercial malls, warehouses and logistical centers for exurban centers. Both those activities would generate a lot of employment, but not in dense settings. Thus, Giuliano-Small would struggle to detect it when Forstall-Greene would get them easily, provided they started to get intense enough.

On the other hand, Forstall-Greene is less keen on suburban centers than Giuliano-Small. While it does register commuter-oriented suburban centers, it fails at detecting dense job centers as soon as they shelter also a dense population. The main finding here is that in Switzerland, during the period under study, a method favoring intensity register less centers than a method relying on job density. This is a surprising result as it shows that while classical, i.e. intensive but not dense - edge cities are indeed emerging in Switzerland as they do in the western hemisphere, another category of central places, not envisioned by the American tradition, has played a very important role in the deconcentration of the job center network in Switzerland. Since 1965, Giuliano-Small consistently shows more jobs in suburban centers than Forstall-Greene does. The difference is not so much in the numbers of units detected than in the size they then encompass: Giuliano-Small builds bigger suburban centers than Forstall-Greene. And while Forstall-Greene does detect a flurry of subcenters that Giuliano-Small does not, those are often very small and situated at the fringes of the urban network, between suburbia and exurbia, whereas the ones Giuliano-Small detects but which Forstall-Greene does not, while not very numerous, are quite massive and very close to their parent city: Chênes in Geneva (7'000 jobs in 2005), Muri and Ostermundigen near Berne (10'000 jobs between the two), Allschwil, Birsfelden and Reinach in Basle (20'000 jobs between the three), Kriens besides Lucerne (7'000 jobs), Wettingen near Baden (6'000 jobs) are all quite significant job centers.

It therefore seems that there are clearly two kinds of suburban centers in Switzerland, which depends strongly on the setting of the urban subcenter: close to the cities a peculiar kind of subcenter emerged, the dense, inner suburban center. While not very numerous they do play an essential role as they tend to be big. In certain agglomerations, like Basle and to a lesser extent Berne, they dominate. Besides this first category of suburban centers, the classical suburban centers which tend to be more noumerous, smaller and which are based not so much on job density than on job intensity: urban cores that are dedicated to economic function in a relatively low density setting. For this very reason they tend to be farther away for their centers, up to the point where they become truly exurban. It is worthy of note to point out that this transition can be continuous and take the form of radially-organized urban ribbons starting in the innermost parts of the suburban ring as dense suburban centers, then gradually morphing into intense centers while receding from the urban core. In particular, most major edge cities in the Zurich region do correspond to this scheme, notably the Limmattal edge city which extends from Altstetten to Spreitenbach much in this way, the lower Glattal edge city extending from a dense Oerlikon to a sprawling Kloten, or West Lausanne with its dense internal parts (Renens, Prilly) and its looser external parts (Crissier, Ecublens, Bussigny).

Therefore, as we have already surmised, it seems both methods are in fact complementing each other. They do detect for the major part the same objects, but they do diverge on the margin, one method geared towards detecting dense job clumps amidst dense, inner suburban residential areas (the Giuliano-Small method), while the other seems more adept at detecting small but intense job concentrations among the peripheries of the metropolitan areas. As said both methods essentially intersect; then whether we should consider the union of the two methods or their intersection is a matter of choice. It seems to us that a good definition of this rising phenomenon of emergence of suburban centers should be inclusive rather than exclusive, giving us the chance to study the phenomenon under all its facets. Therefore, our definition of suburban centers will consist in the union of the two methods.

3.3.5. The Garreau-Leinberger method

The Garreau-Leinberger method has been originally described in Garreau 1991, where it is used to define so-called Edge Cities, which in turn was derived from the work of Leinberger (Leinberger & Lockwood 1986). According to this method, an Edge City (as the author called suburban centers) should have 5 million sq ft of office space (about 500'000 sq m, or 50 ha), 600'000 sq ft of retail space (60'000 sq m, or 6 ha), more jobs than active residents, be perceived as a diverse and complete service-oriented place, and which had emerged since 1950. This last requirement sets this method apart from the two preceding ones as it refers to the dynamics of places. This condition stems out of the will to specifically detect subcenters and thus sorting between them and classical urban centers.

This method should then complement nicely the set of preceding methods, which were not aimed at sorting out between traditional and new urban centers and which in fact detected both. When using either the Giuliano-Small or the Forstall-Greene methods, we had to resort to prior knowledge to distinguish between urban, suburban, exurban centers and various other location types. While those were informed choices, they were choices nonetheless, and an element of subjectivity could not be eliminated from them: ultimately, we chose between what we considered urban centers and what we considered to be something else, and the method was not purely formalized. By using a method specifically aimed at selecting emerging centers from the ones preexisting, we may have access to a more formal way to distinguish between the classical, preexisting urban network and the emerging pattern, which in turn should complement, qualify and correct the typological attributions made by us in preceding sections.

As devised by Garreau and Leinberger, this method is strongly related to the Forstall-Greene method as both are based on job intensity. However we have shown that methods based on job density (such as Giuliano-Small) complement nicely. For this reason it appears to us that the Garreau-Leinberger should be modified as to allow also for detection of emerging dense suburban or exurban centers. Along with other modifications made along the lines of the ones applied previously to Giuliano-Small and Forstall-Greene, this means that the original Garreau-Leinberger method has been thoroughly modified as to create our own combined methods that mixes features from all three methods: the Giuliano-Small, the Forstall-Greene, and now the Garreau-Leinberger.

3.4. The combined method

3.4.1. Operating principle

The operating principle we chose to devise our combined method is to select all places of a certain size that exhibit the required thresholds, either in terms of density or intensity. The size requirement has been put at 1’000 full-time equivalent jobs, as for the Giuliano-Small and the Forstall-Greene methods. This is about 25 times smaller than the original Garreau threshold. In terms of intensity, two thresholds have been put into practice: 0.85 and 1 job per active resident. The original Garreau threshold is limited to 1; in our case some flexibility has been added to allow for detection of places below this threshold if they are in fact emerging, while the two other thresholds were already tested when applying the Forstall-Greene method. The density threshold which we used with the Giuliano-Small method has also been used here, namely 15 jobs per built hectare. As we have seen, this was not part of any Garreau-Leinberger threshold. While Garreau also postulated that his areas should be exclusively service-oriented, made of office and retail spaces, this requirement has been dropped as to allow for detection of industrial suburban and exurban centers. The distinction between secondary and tertiary jobs will be reinstated further down when the available methods are tested once again on secondary and tertiary jobs alone.

A specific feature of suburban or exurban centers is that they can extend over communal boundaries, much in the same way an agglomeration regroups many communes around one or more urban centers. In such instances, communes are being grouped together when functionally contiguous (i.e. when built areas are continuous across the communal boundary) and when each of the selected commune exhibits at least one measure of density or intensity, while the sum of jobs across the whole area reaches 1’000. As defined, the urban unit can then evolve by accreting or more rarely dropping communes.

3.4.2. Center definition

Any commune or group of communes which counts more than 1’000 non-agricultural jobs and either of the following two conditions: job intensity over 1, or job density of over 15 jobs per built hectare, will be considered a center.

Centers which hold at least 500 jobs either in the industrial or in the services sector provided they are dense or intense enough, i.e. at least 10 jobs per built hectare, or at least 1 job per active resident in the considered sector. This adds to our tally of centers very small but still significant units which are deeply specialized either in industry or in the service sector.

This combination of methods presents the following advantages. First and foremost, it allows distinguishing between classical and dynamical centers by a numerical method, whereas both the Giuliano-Small and the Forstall-Greene method could not do so and had to resort to prior knowledge or distinction between central and other places to designate what was an emerging center and what wasn’t. As applied, the combined method allows for a scrapping of this empiricist approach and instead allows for rigorous analysis between those useful categories (urban, suburban, exurban, etc…) to check if they correlate with dynamics or not. The method allows us also to go back to 1939, where the Garreau-Leinberger does not go back beyond 1955; of course, we have no dynamical center detected for 1939 but this suits our problematic which was to detect postwar movements, not prewar ones. And finally, the combination of all three methods will allow us to also quantify this third world of jobs beyond classical urban centers and new emerging centers: the realm of edgeless city.

3.4.3. Center classifications

3.4.3.1. Introduction

There are many types of centers: centers can be classified in several aspects and much can be learned by looking at them from different perspectives.

The classifications we put into place are as follows. The classical-dynamic dichotomy will be explored, as will also the geographical location of the centers with respect to the urban structure of the time, their economic orientation, be it industry, service-dominated, or in equilibrium, their form, that is whether they are dense, intense, both or neither, and lastly their size. Here are the classifications we will use further.

3.4.3.2. The inclusion of dynamics

Garreau and Leinberger didn’t give any operative criteria to deem a place as “new”; to them, an “edge city” or “urban village” could only be designated when a given center didn’t exist forty years earlier, i.e. around 1950. This can’t apply easily in Europe, where the settlement network is much older and where space tends to be scarce. Hence, the need for an operative definition based not on sheer emergence but on growth rate. To be considered new, as opposed as classical or preexisting, an urban place should exhibit, at some point in time, a growth rate significantly higher than the average growth rate of the region or the country. During our period of study, the annual growth rate of non-agricultural jobs varied between -1.57% (between 1991 and 1995) and 2.85% (between 2005 and 2008). It seemed to us that a significantly higher growth rate would be more than double of the national rate, which for 2005-2008 would amount to a bit above 5%. In order to avoid multiplication problems with very small or negative rates, we chose to select locations where the growth rate was at least 2.5% higher than the national average, giving effective growth rates for selection varying between a little below 1% between 1991 and 1995, and a little above 5% for 2005-2008. Once selected, a place remains in the network if the conditions of size and intensity or density remain valid, even if the growth rate declines. The idea is that at one point of time those dynamical centers mature and see their growth slow, which shouldn't eliminate them as long as they remain big and intense or dense enough. However, a dynamical center that lost its central characteristics for a period of time can reenter the network but has to show renewed dynamics if it is to be considered dynamical. Furthermore, if a center is dynamical, its intensity threshold drops from 1 to 0.85 jobs per active resident, in order to catch emerging structures a bit earlier.

The formal detection of dynamics is then as follows. If in the preceding intercensal period the annual job growth of a center exceeded by more than 2.5% the national average, it is deemed dynamical. It will remain designated as such as long as it can maintain itself in the network. Thus, if a center was deemed dynamical in the preceding intercensal period, and maintains itself in the network, it will retain its dynamical character. Centers failing those criteria are deemed "classical". If a center is dynamic, the job intensity requirement drops to 0.85 jobs per active resident. Centers can be thus classified in two different dynamics: classical and dynamic

3.4.3.3. Geographical location: from urban to edgeless

A rigorous way of distinguishing between centers types is introduced here, which is strictly based on the official urban delimitations in cities and agglomerations. An urban center is defined as being an agglomeration center, an official city or a district seat, as long as they are not part of an agglomeration of which they are not the center at the time of detection, or at most five years following it. A mixed urban-suburban center is a former city or a district seat which is included in an agglomeration, but not as its center, at the time of detection as a dynamical center, or at most five years following it. A suburban center is a formerly non central commune (or group of communes) which is part of an agglomeration at the time of, or at most five years following, its detection. An exurban center is a commune of a group of communes which were not part of any urban unit at the time of its detection or at least five years following it. Finally, centers were deemed touristic if they were deemed either touristic or institutional by the 2000 communal typology of the Federal Statistical Office (Schuler et al 2005). A considerable work had been done there to define what a touristic or institutional commune was, and there is no need to reinvent the definition here. Tourist resorts do not respond to the same economic stimuli and conditions than other places and thus that they do not fit in the urban network the same way other urban units do. Communes with institutions are likewise removed from such competition and were chosen to host institutions like boarding and international schools, hospitals - especially psychiatric institutions - penitentiaries, and nursing homes because they were out of the way, far afield. Such institutions often dominate the economy of those communes, which then do not respond to the same stimuli as the rest of the territory.

A non-urban place detected as a center is considered suburban or urban if it is subsequently included in an agglomeration (or deemed a city) at most five years after being detected as a dynamical center. Indeed, the agglomeration definition occurs only after population censuses are held, i.e. once every ten years. Thus, when following a census a commune is detected as a new city or suburban commune, it actually means that this community emerged as such at any point of time during the ten years preceding the census. In terms of probability it is thus as likely as not that if there is five years or less till the census which will designate it an urban or suburban commune, the community is already, in fact, such a place. The only case where this does not apply is for the 2005 census, for the obvious reason that the 2010 population census hasn't been held yet, and its results not known. Conversely, an urban center deemed exurban, i.e. which is not included in a city or agglomeration for at least five years after its emergence, remains designated as exurban even if subsequent urban growth engulfs it, the idea behind this determination being that such a center did indeed emerge beyond the urban network and that its inclusion in the urban agglomeration was not instrumental to its development.

Centers are thus classified in five different locations: urban, mixed urban-suburban, suburban, exurban and touristic. Everything which falls outside of those five categories is deemed edgeless space.

A center can change category between two censuses if it is genuinely dynamic during this time and if its location with regard to territorial definitions changes during the intercensal period.

3.4.3.4. Economic orientation: Industry and services

During the period under review, the economic landscape changed tremendously. In 1939, apart from a very meaningful primary sector, with 27% of the workforce, industry and services were close to be on par with about 35-37% of the workforce each, although, in terms of significance, industry was clearly dominating the economy: the services were built around it, to supply it. In 2008, the agricultural sector has dwindled to a mere 3% of the workforce, industry, after peaking in the 1950s, is now down to 29% of the workforce to 68% in the services, which are clearly dominating the economy, totally liberated from the industry's oversight. It is thus interesting how industry and services behave when confronted to centers of different classes, and how they evolve spatially with time.

A center will be deemed dominated by industry if the job part of industry is more than 10% higher than the services job part. Inversely, the center will be considered tertiary when the tertiary job share exceeds the industrial one by more than 10%. When both job shares are within 10% of one another, the center will be deemed in equilibrium. Centers that are included in the study according to their density or intensity in one sector only are naturally attributed to this sector. Of course, the shares are computed anew for each census.

Thus, a center can be of three orientations: industrial, service-oriented or in equilibrium.

3.4.3.5. Form: density and intensity

The two original methods we examined, Giuliano-Small and Forstall-Greene, were based either on the density concept and intensity concept. We have already seen that they gave differing results when we compared them after testing them in a general way, and as our method is an inclusive combination of the two, centers can be detected whether they are dense or intense. Of course, they can be both. It is of interest to see if entering a typology based on the interplay between intensity and density can lead us to some result.

The classification is organized as follows: a center is deemed dense if its job density exceeds 15 jobs per built ha, intense if its job ratio exceeds 1, complete if it meets both conditions. As centers can be detected while not fulfilling those conditions (dynamic centers can have a job intensity of 0.85, industrial or service centers a density of 10 jobs per ha), a fourth class “naught” is added.

Thus, a center can have four forms: dense, intense, complete or naught.

3.4.3.6. Size classes

It is evident that the study of size across other factors, and also in itself, is extremely useful to the understanding of the urban network form and evolution; it is an integral part of any rank-size study, such as the very numerous tentative to match Zipf’s law (Zipf 1949) to urban networks (for a review, see Nitsch 2004), as it is pivotal in Christaller’s theory (Christaller 1933). It can be readily showed that there is a strong link between Christaller and Zipf. If size classes are logarithmic, i.e. if their limits follow a power law (such as 500, 1000, 2000, 4000 and so on) then it can be shown that if Zipf’s law is respected, every class will have the same population. Christaller’s network is likewise proportional: every level up its hierarchy has the same population than the combined population of the cities it immediately dominates. For these reasons, even before we put centers on the map, it will be tremendously interesting to part them in a logarithmic size classification and see how jobs are apportioned across such a classification.

For this classification, we will start at the lowest number of jobs which can be considered in our study, i.e. 500; then this number will be doubled to create the first class, and then doubled again to create the second class, and so on till the biggest center is integrated. In terms of thousands of jobs, the limits are: 0.5, 1, 2, 4, 8, 16, 32, 64, 128 and 256. Up to 2008, no Swiss center, cluster or supercluster has ever crossed the 512’000 jobs mark.

3.4.4. Clusters and superclusters

A side effect of our method of construction of centers, especially suburban ones, would be that, because of rather stringent criteria to agglomerate communes to form centers, we are in fact artificially creating several units where there is only one. This could alter the analysis regarding the number of units and even more findings made by using rank-size type analysis. Along the same lines, Christaller-type studies could be hampered by artificial separations between downtowns and suburban areas, whereas Christaller did not separate those two entities. The effect could be to underestimate the actual influence of a center on the urban network by splitting it into downtowns and suburbs, while those two entities participate in common to the influence of the agglomeration unto it. In order to correct those potential problems, for purposes of rank-size and Christaller-like analyses, we have grouped our units into what we have called clusters and superclusters.

Clusters are formed by grouping all non-urban centers sharing a common border. The most common case is the grouping of several suburban units into a larger cluster. However at this stage, the partition between urban and suburban centers remains. The computation of clusters will give us the opportunity to check the actual size of large suburban complexes formed by several interconnected units. They will be used above all in rank-size type analyses.

Superclusters are formed by aggregating urban centers with their suburban units and clusters, as long as they are sharing a common border. Thus, urban centers are here reunited with their suburban outskirts and the true importance of agglomerations in the urban network. A common criticism made at Christaller in more moder settings is that it can't cope with suburbanization and metropolitan processes; however, it is of interest to check if Christallerian rules hold when all activity of an agglomeration or a metropolis is considered as a single point. Thus, the study of superclusters will allow us to test the resilence of underlying christallerian structure in the age of sprawl and metropolitan processes.

3.5. A verbal description of the data construction

The method we just described was applied to the eleven business censuses under review (1939 to 2008). In this chapter, the spatial unit of reference was the commune, as it stood in 2000. Results were thus computed for this spatial reference for all censuses under review, with the help of data from other sources, mainly population censuses to estimate active resident numbers, as well as population statistics to estimate probable evolution from 2000 on, 2000 being when the last population census was held in the country. Those first steps were calculated for the whole job population, as well as separately for each of the two sectors of interest (industry and services). From 1975 on, business censuses cover the whole spectrum of activities, including public administration and liberal services; but for censuses before 1975, public administration and some liberal services were deemed non-commercial and thus were not counted in the business censuses. However, those job-holders were indeed censed in the population census and distinguished as such, and as at the time most workers in public administrations and services were required to live in the community they served, we could infer them for the 1939, 1955 and 1965 censuses. The 1939 census presented special challenges, as at the communal level it gave only the number of non-agricultural jobs, without the public services jobs, and without distinguishing between industry and services. There numbers were inferred by looking at cantonal statistics, city statistics that were available for a host of greater centers, and another source available at the time, the Fabric Statistic which would hold all jobs hosted in factories, and for which data existed in 1937 and 1944. From these data a distribution of industrial jobs was made possible through communes, and then services could be inferred with the help of the 1941 population census.

Once communal results were computed, communes were selected if they were answering thresholds in at least one census. This was also done in parallel at the global level and independently for each of the economic sectors. Once these steps undertaken, communes were grouped in units if they were sharing their built or activities areas, or their road network, or if they revolved around a unique highway junction. This was undertaken separately for all three databases (all jobs, industrial and tertiary), however groupings were made in all three databases in order to get geographical groups as close as possible in all three databases.

Stringent criteria were used when grouping communes into units. In general, simple communal contiguity is not deemed a sufficient condition; dependence upon the same highway junction and thorough built area continuity across communal borders was usually required, and in case of doubt units were kept separate. This resulted in having several contiguous units defined in major suburban areas of the country. For example, five separate but contiguous units were thus created in the Glattal area (Rümlang, Kloten-Opfikon, Wallisellen-Dübendorf, Dietlikon-Brüttisellen and Volketswil), three in Western Lausanne (Renens-Prilly, Crissier-Bussigny and

Ecublens-Chavannes), and so on. The effect this stringent policy could have on findings, especially in terms of position in the urban network and in rank-size studies, has been treated above.

Once groupings made, the following statistics were computed for each unit: numbers of jobs (total, industrial and service), active residents, built-up area, from which job density, job intensity, rank in the urban network, and by comparison with the previous census, annual job growth rate. From this information the attribution of every center could then be made in terms of dynamics, location, orientation, form and size. The same operation is made on the specific industrial and service database, with the obvious omission of orientation.

3.6. Result presentation: from raw data to tables, graphs and maps

3.6.1. Switzerland as a space: tables and graphs

The information thus gathered allowed us first to group cases by the categories we discussed above, and then to map them. Those were the main ways we used to analyze the results of our data mining.

The first possibility to mine the data is to work with the five categories we implemented, namely:

- Location (urban, mixed, suburban, exurban and touristic)
- Dynamics (classical and dynamic)
- Orientation (industrial, service-oriented and in equilibrium)
- Form (dense, intense, complete and naught)
- Size (from under 1’000 jobs to more than 256’000 jobs)

Those classes can be then combined at will. For each grouping, several indicators can be computed, for each census. Those are:

- Number of units concerned
- Number of active residents
- Number of jobs
- Total built-up area
- Job density
- Job intensity
- Job annual growth rate on the last intercensal period
- Job share in the Swiss total
- Mean unit size, in number of jobs

The totals for Switzerland being known for all those quantities, it allows us to compute the importance of what’s left out of the urban network as we defined it, that is, of edgeless space, which then is examined as one of our categories. In parallel to the study of those categorical analyses, the center list is also studied directly for each census to look at the rank-size behavior of its constituents. The same will be done for lists of clusters and superclusters.

All combinations have been computed in a systematical manner; however only a small part of those will be studied in detail. Nevertheless, there is a staggering array of findings to be made just by looking at this very rich crop of tables issued from data mining.

3.6.2. Switzerland as a territory: maps and the geographer's art

Aspatial analysis, though, is only part of what's to be discovered. They represent findings that are general to the Swiss space. How, however, those findings express themselves in the Swiss territory can't be apprehended by looking solely at those tables: for this, centers need to be mapped, and their actual territorial relationships tested. The maps we will use will bear the centers according to their size, location, orientation and dynamics. In order to get as much information as possible from them, some other elements have been added to the maps, some for legibility and orientation purposes, such as a shaded relief, greater lakes and cantonal boundaries, and some as explanatory hints, such as the agglomeration perimeters and the highways completed at the time. Whole series of maps have been made and will be used to look specifically at the impact the following territorial patterns could have on the allure of the urban network:

- Urban network patterns (Christallerian or metropolitan)
- Center-periphery patterns at the national level (esp. once metropolitan processes come into play)
- Differential behavior according to agglomeration size
- Regional economic specialization, when applicable (industrial, rural, alpine)
- Strictly regional patterns, when applicable (both North-South and East-West)

The relationships between our categories and those different geographical groups will also be studied by looking at the map and by comparing results with theoretical models, chiefly Christaller's.

Now that we have described the way we intend to cover our subject, let's now take the plunge and discover what lies in the data.

4. A history of the Swiss urban network, 1939-2008

4.1. 1939: A Christallerian urban network

4.1.1. Aspatial results

4.1.1.1. Location and centrality: Christaller's world

The urban network in 1939 shows a classical structure, even if some departures from an idealistic Christallerian model can be found (*Chart 4-1*). A large majority of non-agricultural jobs – 1'108'000, 71.1% of the total – were located in one of the urban network's 255 units; the rest, about 451'000 jobs, were located in edgeless space. In terms of functional specialization at least, there was no huge difference between bona fide centers and edgeless locations. Job intensity in edgeless locations was around 80 jobs per 100 actives against just 112 jobs per 100 actives in central settings. In terms of density, though, things were very different: edgeless places were about three times sparser in jobs than centers, sporting a job density of about 10 jobs per built ha, against 28 jobs per built ha in centers. Edgeless locations represented the majority of the built-up areas of Switzerland, although only one in nearly four non-agricultural jobs. Thus, in 1939, job density was a far more relevant way to discriminate between urban and peripheral places than intensity - centers were centers primarily because they were dense places.

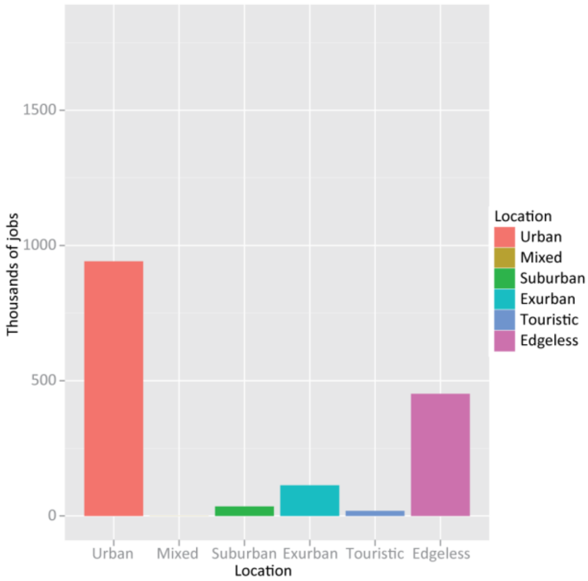


Chart 4-1: Job numbers by location, 1939

Of the 255 central places we found in 1939, 132 units were defined as urban by our method. They grouped about 941'000 jobs, or 60.3% of the national tally. The vast majority of those urban jobs were held in dense settings – the mean urban job density being around 34 jobs per hectare, while the job intensity remained quite low at just 1.1 jobs per active resident. In 1939, centers were far denser than intense and packed jobs as well as inhabitants in dense settings where people were working as well as living, in an age when daily commuting was not the norm. They also were rather big, at a mean size of 7'130 jobs per urban center.

The second most relevant category of locations at the time was that of the exurban centers. There were 91 of them in the 1939 urban network, most of them quite small with just 113'000 jobs between them, 7.3% of the total, or a mean size of just 1'250 jobs, six times smaller than the urban mean. Exurban centers tended to be somewhat more intense than urban centers at 126 jobs per 100 active residents, which can be explained by the fact that being smaller in size they were more likely to have workers coming from across communal boundaries than the larger cities. On the other hand, they were largely less dense than urban centers, at just 14 jobs per built ha against the 34 of urban settings. Again it seems that density was a better discriminator of job center type than intensity.

Suburban centers were rather scarce in 1939: we detected just 16 of them grouping 35'000 jobs, or just 2.3% of the total. This can be explained by the fact that agglomerations were very small at the time. The biggest suburban areas of the time had been for a part incorporated in their centers (Zurich, Berne and Geneva all underwent such annexations); in any case, the transition between urban and rural space was far more abrupt at the time, the result being that most implantations not made in central cities had far more chances to end up in exurban space than in the very condensed suburban areas around the centers. Suburban centers of the time were very close structurally from exurban centers, with a job density of 14 jobs per built ha, and an intensity of 107 jobs per 100 active residents. In terms of size though they were clearly bigger at a mean size of 2'200 jobs per unit, occupying a median position between urban and exurban centers.

There were also 16 touristic or institutional centers at the time, grouping just 19'000 jobs, or 1.2% of the total. Their size compared to that of exurban centers, their density that of edgeless space. However, their intensity was the highest of all, at 140 jobs per active resident, probably due to the fact that seasonal workers were not counted as active residents in the population census while their jobs were in the business one.

Even if suburban, exurban and touristic locations represented only a small portion of all jobs in 1939 they are interesting nonetheless, for they shared characteristics that are different from those of classical urban centers. For starters, they were all clearly less dense than urban centers, with a job density of about 13 jobs per built hectare for suburban and exurban centers, and around 10 for tourist resorts. Those centers clearly occupied an intermediate position between classical centers, which were more than twice as dense as them, and edgeless locations. On the other hand, if the rare existing suburban centers were exhibiting job intensities similar to those of classical centers, intensities in exurban and touristic centers were clearly higher, at around 1.2 and 1.4 jobs per active resident. Whereas classical cities did retain most of their workforce on site, those smaller exurban and touristic units already had to get their workforce from other places, were it through seasonal contracts in tourist resorts, or in villages nearby for exurban centers, where patterns of daily commuting were thus already in place in 1939.

4.1.1.2. Orientation: an urban economy geared towards industry and manufacture

172 units, or about two thirds of all 1939 urban centers, were dominated by the industrial sector, but they grouped way less than half of the central workforce with just 451'400 jobs or just under 30% of the total, giving them a mean size of 2'620 jobs per unit: lower than the urban mean size but higher than the suburban and above all the exurban mean size (*Chart 4-2*). The same can be said about density: those small industrial centers had theirs at 21 jobs per built ha, while their intensity, at 120 jobs per 100 active residents, compared with those of the exurban centers.

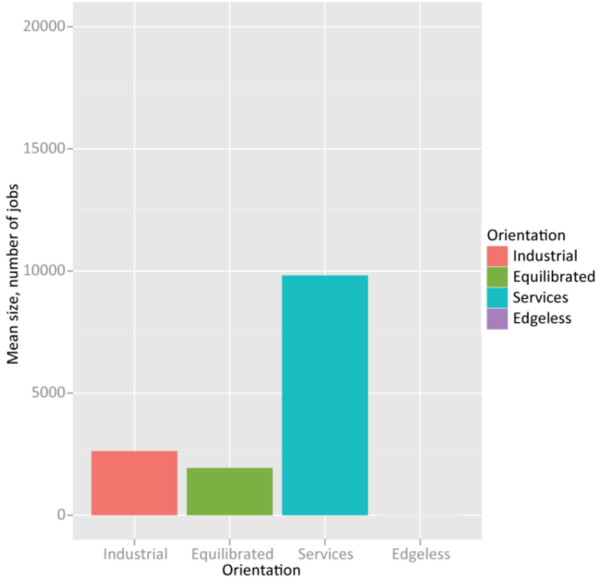


Chart 4-2 : Mean center size by orientation, 1939

The service centers were less in numbers (just 63 of them), however they encompassed more jobs (618'400, or just under 40% of the total); their mean size was very high at 9'820 jobs per center, higher than the urban center's mean, as was their job density (at 38 jobs per built ha). Their intensity was very close to those of the urban centers, just above unity.

Thus, it seems that a clear separation was in force between service and industrial places. Service centers were few, but very big and very dense, i.e. they were the top tier of the urban network, whereas the industrial centers, far more numerous, but far smaller and less dense, seem to represent the lower tier of the urban hierarchy.

4.1.1.3. Form: dense cities

A slim majority (134) of the 255 units we detected in 1939 was composed of complete units –both dense and intense. By definition they exhibited a rather high density at 38 jobs per built ha, while their intensity was less impressive at 113 jobs per 100 active residents. Not surprisingly, they tended to be big and grouped 929'800 jobs, or 59.6% of the national total. Their mean size of 6'940 jobs per unit was very much higher than the ones of the other categories and suggests that there was a strong link between size and both density and intensity (*Chart 4-3*).

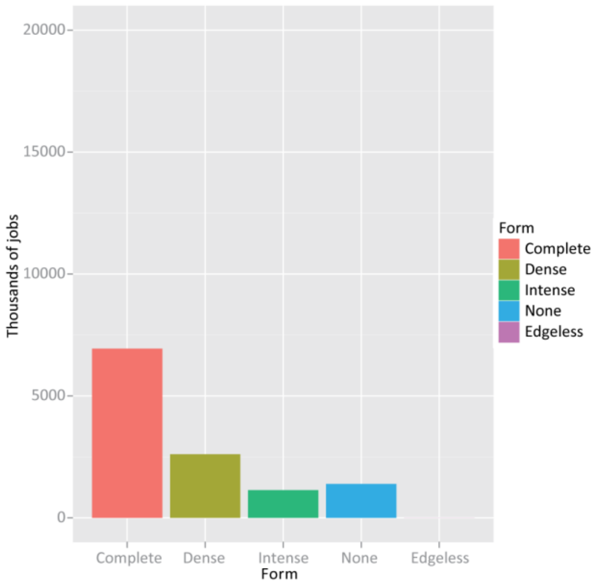


Chart 4-3 : Center mean size by form, 1939

88 units were classified as intense only, grouping exactly 100'000 jobs or 6.4% of the total. Their intensity wasn't that impressive at 112 jobs per 100 active residents, or the same

ratio than the complete sort. Furthermore, they tended to be very small, with a mean size of just 1'140 jobs per unit, and have an astonishingly low density at 8.7 jobs per built ha, or less than edgeless space. Such centers were included in the network solely on the basis of intensity, for their other characteristics would let them fall in the edgeless category.

The far less numerous dense centers were just 27, for 70'300 jobs or 4.5% of the total. They show intermediate qualities between complete and intense centers. As expected their intensity is lower than for the other two categories, although not by very much, at 92 jobs per 100 actives. Their density, however, is at 22 jobs per built ha, close than triple the density of the intense lot, while their mean size at 2'600 jobs per unit also occupies a median position between the complete units and the intense ones.

On the face of it, it seems that the complete units were established big central places, a large majority of them being urban centers, while two different categories of other objects appear. The intense units were composed of the lowest ranks of the urban hierarchy, numerous little centers with lots of space to host activities which needed it and which imported a sizeable part of their workforce from neighboring places; there were more intense places in exurban settings than in urban ones. On the other hand, dense units were clearly fewer but bigger, and more central in their settings; indeed, they were found above all in urban or suburban settings, where they were both residential and job centers. In that sense they seemed to represent something like degraded complete centers.

4.1.1.4. Size: the bigger, the denser

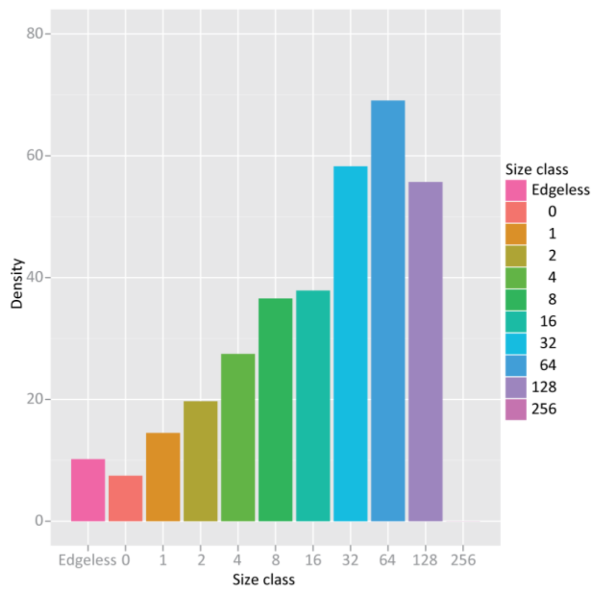


Chart 4-4 : Job density by center size class, 1939

The 255 central units fall into nine different size classes, the biggest being above 128'000 jobs and the smallest category being under 1'000 jobs (*Chart 4-4*). Delving into Zipf and Christaller's laws will be left to the next paragraph – here we are chiefly interested at looking how other qualities vary with the size of our units.

As expected, density varied very strongly with size. The smallest units, those with less than 1'000 jobs, exhibited a job density of only 7.5 jobs per built ha, lower than edgeless space, which indicates a strong specialization towards space-hungry activities. At the other end of the distribution, the five centers with more than 32'000 jobs exhibited a density in excess of 50 jobs per built ha, the progression being very regular between both ends of the distribution. Thus there was a strong link between size and density, the bigger a city was, the denser its jobs were packed.

However, such wasn't the case in terms of intensity (*Chart 4-5*). Intensity remained largely flat, or even decreased with size, being about 120 jobs per 100 active residents in centers with less than 16'000 jobs, while being around 105 jobs for 100 for bigger units. This unexpected result points at the fact that in 1939, commuting wasn't widespread and when present couldn't occur on large distances. Thus, large cities had to accommodate its workers on site, or at least inside generally large communal borders, leaving the possibility of inter-communal commutes to lesser, smaller, less extended centers. In a time, 1939, when the automobile had just started to expand in Europe, commuting patterns essentially relied on foot, bike and public transportation and its reach was quite short. And by the way, this explanation also goes a long way into explaining how bigger cities went so dense in the first place.

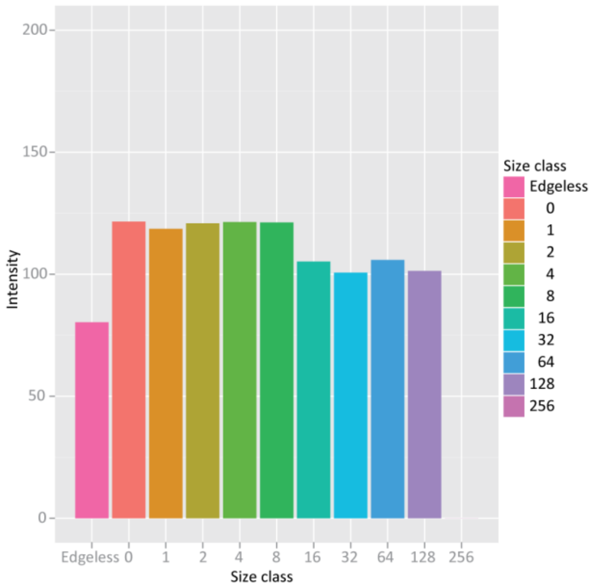


Chart 4-5: Job intensity by center size class, 1939

4.1.1.5. Rank-size and job numbers by size classes: hints at a Christallerian structure

Zipf's law as applied in urban geography postulated that an urban network in equilibrium would have the second largest city having half the size of the largest one, the third city a third of the largest city's size, and so on. It follows from this rank-size distribution that once border effects are taken into account, the relationship between the number of cities and their size is direct: there are twice as many cities of half a given size than there are cities of the given size. That in turn means that if units are distributed into size classes which limits are set to follow a geometric series, then the population of each class should be the same.

Independently, Christaller's central place theory postulates approximately the same, where regularity is to be found when progressing upwards or downwards into the urban network. Following the market principle, a center is mirrored by three lower-level centers of approximately a third its size each, and so on from national centers to local ones. By choosing other principles (transport or administrative), the numbers change but the regularity remains. Both ideas of size classes and of regular progression through the urban network are built in Christaller's theory; it can be shown very easily that as for Zipf's law, when size classes are built with size limits following a geometric progression, then the population of each size class should be approximately the same, regardless of border effects notable in the upper levels of the urban hierarchy.

It turns out then that Christaller and Zipf are closely related. A Christallerian network must follow Zipf's law; A zipf's law compliant network would share some fundamental characteristics with a Christallerian network, although Zipf's law doesn't say anything about the spatial distribution of its units. In a sense, Zipf's law is a result of a generalization of Christaller's theory.

In our work, this means that by looking at the behavior and population of our size classes we can already conclude on some questions we have regarding the form of our urban network.

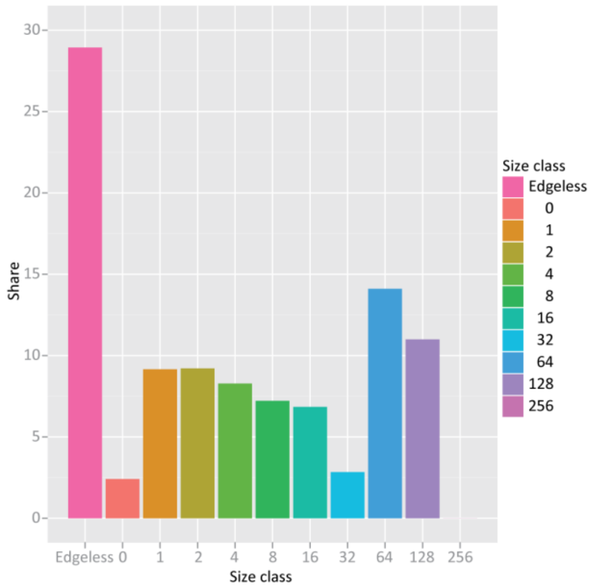


Chart 4-6: Job share by center size class, 1939

Looking at the size class distribution of our 1939 units (*Chart 4-6*), the following can be inferred. First, our lowest category (centers under 1'000 jobs) is severely depleted as it counts 59 centers, or only a quarter of what would be expected given the number of units in the next size class up; this very sudden drop can only partly be attributed to our method of selection, and it suggests that we are here in presence of the lower limit of the organized Christallerian network. The vast majority of similarly sized places throughout the country play no central role, whereas once a place counts more than 1'000 jobs it pretty much guarantees that it does indeed develop central qualities in terms of density or intensity, and plays a central role in the network.

Between 1'000 and 32'000 jobs the distribution of centers broadly follows a Zipf's law distribution. There are 103 centers with 1'000 to 2'000 jobs, 50 with 2'000 to 4'000, 24 with 4'000 to 8'000, 10 with 8'000 to 16'000 and 4 up to 32'000 jobs. In this large bracket the urban network follows the rule, which is a strong indication that the network is indeed Christallerian at those levels.

According to what we found in the median levels of the urban hierarchy, if it was to follow strictly a Christallerian network or a more general Zipf's law, the urban network should count 3 centers above 32'000 jobs, only one of which should bear more than 64'000 jobs, the three accounting for about 200'000 jobs. However, Switzerland in 1939 sported five centers above the 32'000 jobs limit, accounting together for 435'000 jobs. Astonishingly enough, Switzerland in 1939 was strongly top-heavy. The biggest center, Zurich, is double the expected size with 171'000 jobs, as are, and this is more surprising, at least three of the four following cities. It is as if the first five cities of the network had jumped one size class; in any case it strongly contradicts the notion that Switzerland is not a top-heavy urban network but a middle-heavy one. In fact, Zurich is not seen as a monster in the network because it has been joined by Geneva, Basle and Berne, all of which are also far bigger than warranted.

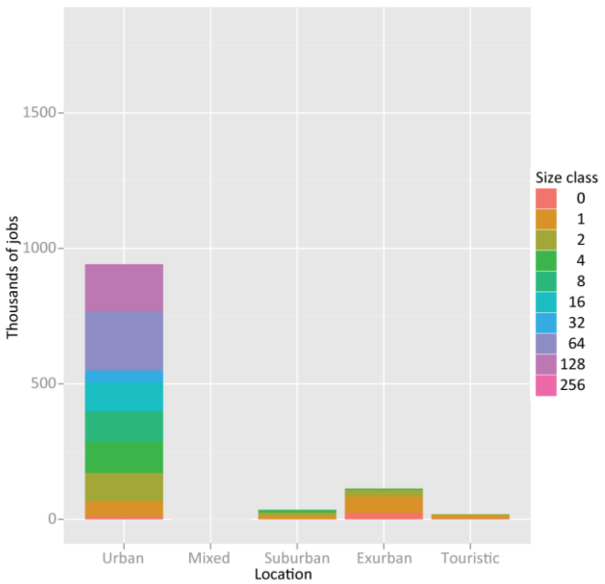


Chart 4-7: Job numbers by location and center size class, 1939

One could surmise that a Zipf-like rank-size relationship would only apply to urban centers, as suburban, exurban and touristic centers do not participate to the Christallerian network and its Zipf rank-size consequences (*Chart 4-7*). It could also be expected that as suburban centers rob some centrality from their parent centers and spread it into smaller centers, this would artificially make the urban networks bottom-heavy. However, in our case these arguments cannot hold, for first the network is top-heavy to start with and secondly because 1939 suburban centers are of small importance.

Looking into the relationship further, it can be shown that the characteristics we just delved on do indeed apply to the urban part of the network alone. Close to half the jobs in the urban centers are grouped in the three topmost classes (which together counts only five centers), the other six size classes of the network accounting for the rest. It can be seen that from 2'000 to 32'000 jobs the size classes have nearly the same job numbers, meaning that their rank-size distribution is very close to an ideal Zipf-like rank-size distribution. However, under 2'000 jobs the scarcity of centers is patent once exurban centers are removed from the tally: there is a lack of urban centers smaller than 2'000 jobs. In the 1'000 to 2'000 bracket, more jobs are located outside urban centers than in them. As most of those jobs are hosted in exurban centers, it could well mean that indeed, exurban centers fit in the urban network as bona fide members of the lowest stages of it. By the way, exurban centers also see their numbers drop once the 1'000 jobs threshold is crossed.

Thus, in 1939 it seems that while the fundamental organization of the urban network was Christallerian, or at least Zipf-like in its median levels, significant departures were already seen in both ends of the network. First, as compared to the mid-levels of the hierarchy, the network was strongly top-heavy: the first five cities of the country were very much bigger than expected. Secondly, at the other end of the network urban centers with less than 2'000 jobs tended to be scarce, a level at which they seemed to be supplemented by an equal number of exurban centers. The network seemed to dissolve once the 1'000 jobs threshold crossed, which would seem to give credit to the idea that the minimal size for a center would hover around 1'000 jobs.

4.1.1.6. Zips's law, clusters and superclusters: further hints towards Christaller and Zipf

A closer inspection of the rank-size distribution is given here, by comparing the allure of the rank-size curve in a log-log graph with that of a theoretical Zipf distribution with the same number of jobs than our network. The results confirm, but nuance, the previous finds (*Chart 4-8*). The actual 1939 rank-size curve departed the theoretical curve in three main places. The two topmost centers were actually in accordance to a Zipf distribution; however centers from the 3rd to the 10th position cities were larger than expected. From then to about the 40th rank – corresponding to the 4'000 to 20'000 jobs bracket, cities were consistently smaller than expected. Further down, the distribution is mirroring closely the Zipf distribution up until the 200th rank – about 1'000 jobs, from which a very sharp drop off is noted. The conclusion which can be made of this curve is that the network counts a dearth of mid-sized centers as opposed to an excess of bigger centers. Certainly the top-heaviness we

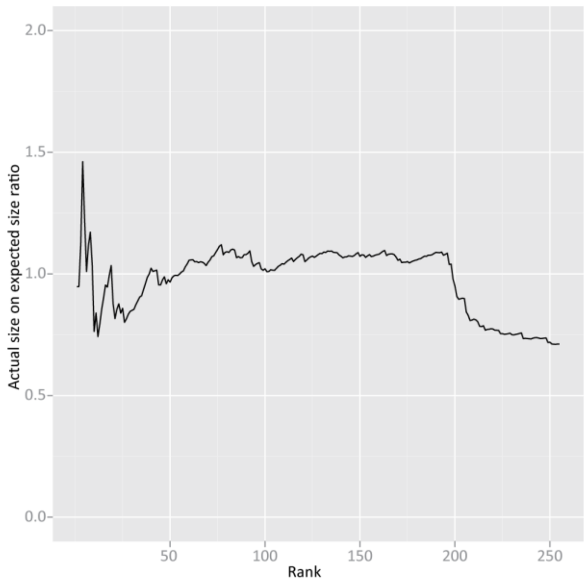


Chart 4-8: Units rank-size distribution compared to Zipf's law, 1939

pointed on in the last paragraph does not seem so impressive – in fact the two biggest centers are in line with expectations; however the fact is that the next centers in the network are bigger than expected till rank 9, while centers ranked 10 to 40 are smaller. Thus, the imbalance we detected in the previous part is still there, but presenting itself differently, by a paucity of mid-level cities more than as a overgrowth of the largest members of the network. At the other end, the study all but confirms the dearth of centers under 1'000 jobs.

In all it remains that the urban network is slanted towards bigger cities, which is a surprising result as Switzerland is a federal country, where the emergence of massive centers would be hampered while the promotion of the second tier of cities would be stimulated. In fact, part of the argument is true as the imbalance towards the top is the fact of ten centers instead of one. Zurich did not, at this stage, dominate the Swiss urban network. But all the same, the second tier of cities that should have emerged thanks to the boost received from the federal structure of the country did not seem to materialize. The passage from units to clusters does very little to the rank-size curve (*Chart 4-9*). As to the distribution of jobs by center size and locations, however, it can be seen that the agglomeration of non-central centers into clusters creates bigger units (of course) which tend to be more internal.

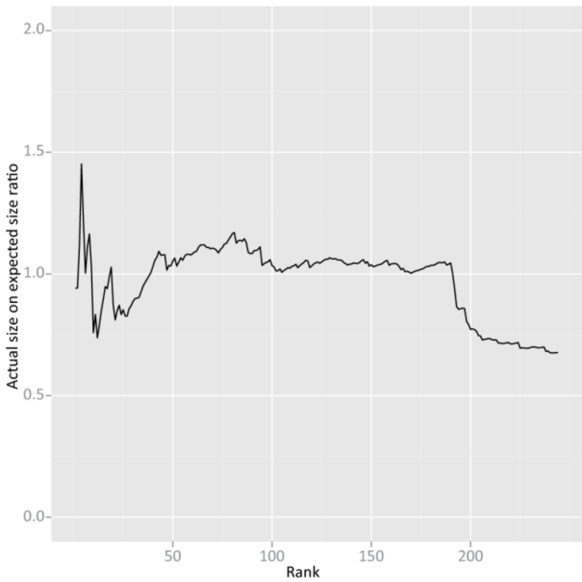


Chart 4-9: Cluster rank-size distribution compared to Zifp's law, 1939

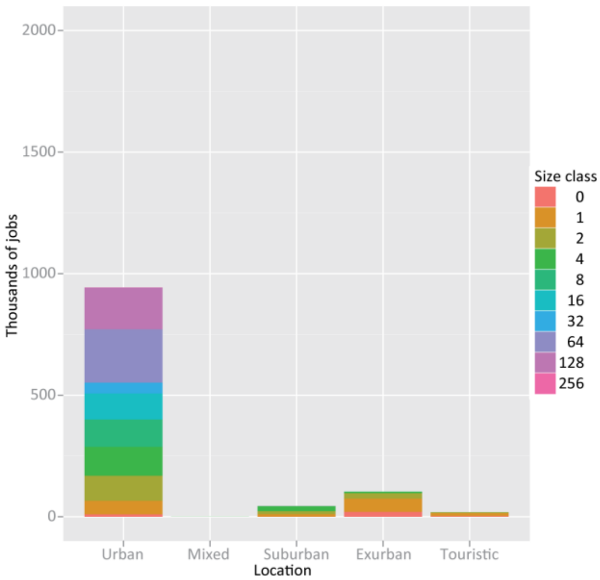


Chart 4-10: Job numbers by location and by cluster size class, 1939

As compared to the same distribution for units, suburban centers now hold more jobs, in bigger units. The mode for suburban clusters was for units from 4'000 to 8'000 jobs, far larger than the one for the remaining exurban units (*Chart 4-10*). Thus, there is a confirmation that suburban centers were occupying a median position, in terms of characteristics, between urban and exurban centers.

The supercluster rank-size distribution differed notably than the ones made at the unit and the cluster level, which hints at the fact that reuniting urban centers with their suburban or exurban outskirts significantly modify the network's assessment. The main changes were detected below the 10th rank; above that the curve had the same form than the ones of units and clusters, showing a strong overshoot between the 3rd and the 10th rank, meaning that the cities immediately behind the two biggest centers of the time (Zurich and Basle) were notably larger than expected. Further down the network followed rather closely a Zipf-like distribution, down the the 60th rank, which correspond to a center of about 3'000 jobs. Further down, there was a consistent undershoot of the curve, meaning that centers below the 60th rank hosted consistently less jobs than expected for a Zipf-like network. The drop became larger over the 150th rank (1'000 jobs). Uniting suburban and exurban centers with their central counterparts when they had one equilibrated the network, especially the upper middle levels of it, the 50 centers from 3'000 to 20'000 jobs. However they didn't allow for the correction of the upper level overshoot, which remained far above the expected value, and this progression was also made at the expense of the lower levels of the hierarchy. As seen through the supercluster rank-size distribution, Switzerland in 1939 had a top-heavy uirban network, while having weak local centers at the lower levels of its urban hierarchy. The urban network of Switzerland could well be Christallerian in organization, however with several departures from the ideal model. It seems that a fully grown Christallerian model concerned only the 60 first centers of the country, corresponding to a mean distance between them of about 20 km; the fundamental Christallerian network would be composed of full fledged urban centers distant of about 20 km from one another and which units would count at least 3'000 jobs. At the more local level, the structure of the enwtork is expected to wither a bit, either by an incomplete set of lower level centers, or center of smaller size than expected.

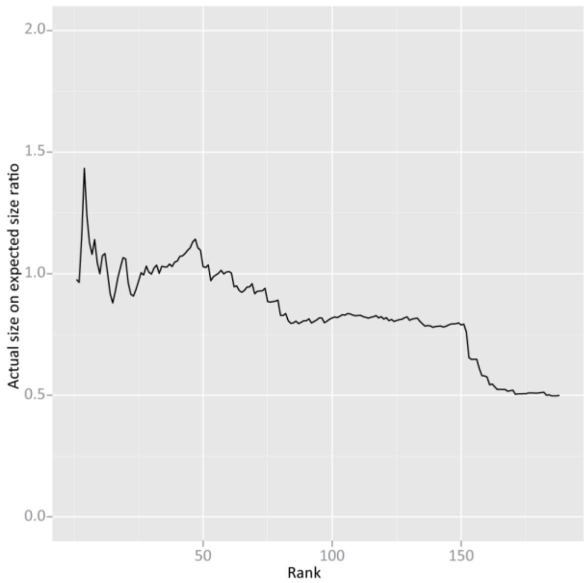


Chart 4-11: Supercluster rank-size distribution compared to Zipf's la, 1939

4.1.1.7. Aspatial conclusions: the urban world before suburbanization

The aspatial study of our 1939 network's characteristics gives the following results:

Job density was the main indicator of central quality in 1939; it varied very strongly according to center size.

Job intensity was less discriminating, although positive in all locations, which allows discriminating between central and edgeless space.

Broadly, the urban network did conform to a Christallerian network with two main departures from it, namely a relative excess of upper-level cities, and a dearth of lowest level units.

The number of non-urban job centers was already substantial at the time, with 123 units again 132 central ones, although most of them (91) were exurban centers which characteristics made them look like the members of the lowest levels of a classical urban hierarchy.

Urban centers held the vast majority of central jobs. Although numerous, non-urban job centers tended to be very small as compared to urban centers.

Suburban centers already existed at the time, with 16 units, however their significance in the urban network was small. They were exhibiting distinct characteristics; their structure resembled those of exurban centers, i.e. non-dense centers geared towards space-hungry activities. However, they were distinctly larger.

Exurban centers were very numerous, and generally very small, while their density was very low, indicating activities with large land consumption as compared to urban activities.

As early as 1939 then, non-urban centers were showing distinct characteristics that would define them: first, the possibility to spread more and to enjoy less cramped real estate conditions. Hence, a clear spread as compared with central conditions, since for a given number of jobs a non-urban location would provide more than twice as much built space. As compared with urban centers, non-urban ones, being suburban, exurban or touristic, were already sprawling. At the same time, all those centers showed a bias towards job specialization: not only jobs had more space than in central cities, but they tended to occupy most of the space: non-urban centers were already specializing, showing the highest intensities on hand in 1939. Thus, as early as 1939, they appeared to be sprawling, specialized job places. In all, they were already embryonic forms of what would define them 50 or 60 years later.

Where did those non-urban centers come from? A main goal of our work is to study the time of their emergence, but this first foray into our data show that in 1939, some 123 non-urban centers had already emerged. They had to do so before 1939, and very probably way before. Some, if not most, clearly date from the latter years of the 19th century. Furthermore, it seems implausible that they had just emerged prior to 1939, as this period was marked by a severe economic crisi, especially in the watchmaking and textile industries. We submit here that this rooster of centers were remnants of a generation of exurban centers that had emerged way before the start date of our study, probably between 1880 and 1910. This, in turn, means that there is a whole chapter of the Swiss urban history that remains to be unearthed, but this (sadly) is not the scope of this work. In the scope of our research, it means that what we are trying to retrieve is only the second generation of non-urban centers which emerged, after a first generation had done so about one century before, on the back of industrialization, harnessing of hydraulic power and advent of mass transportation through railway development.

In all, what have we learnt about the Swiss urban network as of 1939, as is detected by our combined method? First of all, the urban network dominates the country in terms of non-agricultural job numbers, by hosting two out of every three such jobs. The urban network, in turn, is clearly and very heavily dominated by a classical pattern of urban centers responding quite well to the rank-size law. Our method does separate very clearly between dense centers and sparse edgeless locations, which tends to show that job density, far more than job intensity, discriminated between center and periphery. Aside from this classical Christallerian network, a sizeable company of very small, mainly exurban centers exist that probably greatly predates 1939 and goes back to the end of the 19th century. Those, we surmise, are the remnants of a first wave of exurban center creation which took place mainly between 1880 and 1910, and which remains to be studied.

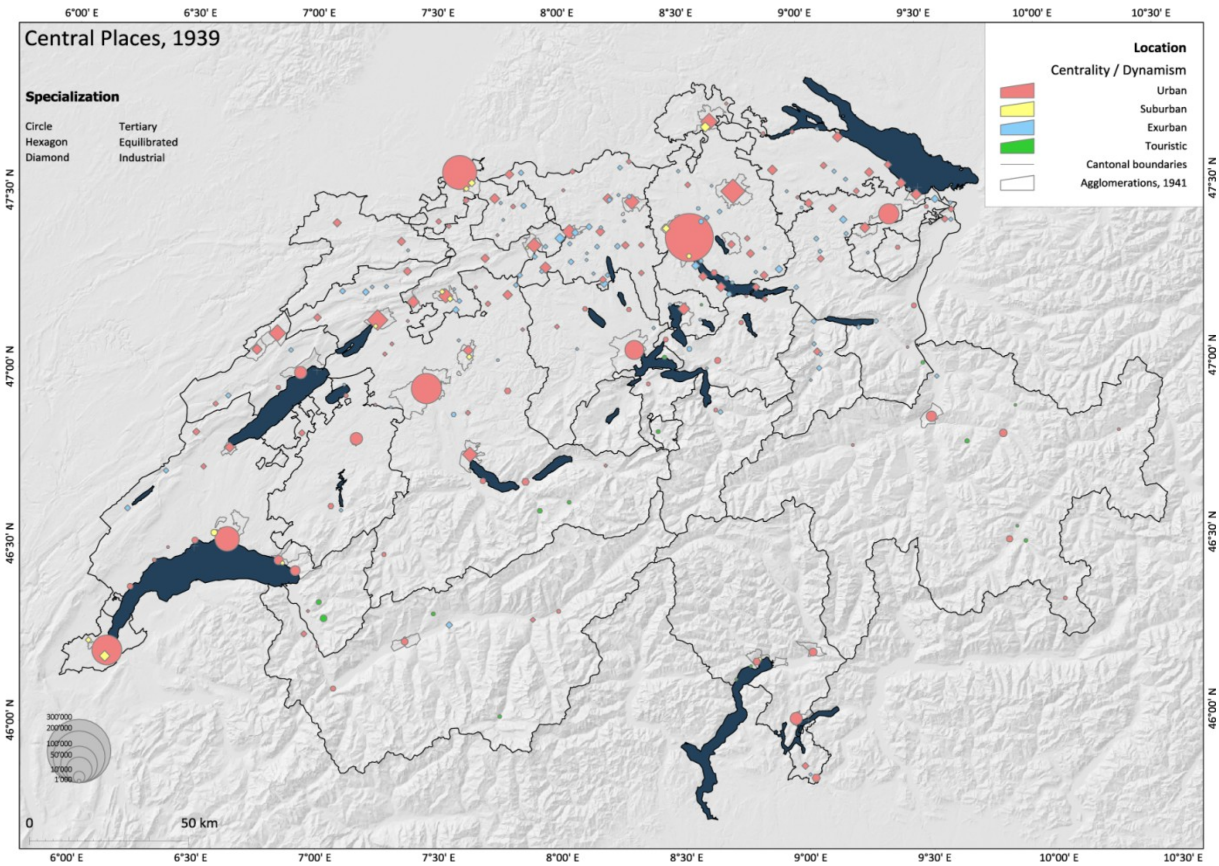
The picture we can have of the Swiss urban system of 1939, considered in general terms, is consistent enough that it seems to us that the combined method as applied to it is worthy of interest. In particular, the fact that the discrepancies in densities are so great between our different spatial categories that it seems to us implausible that they could arise by chance only. That is not the case with intensity; but we can interpret this relative paucity of differences in intensity between our different classes as being relevant to the fact that at this time, the territorial organization was not dominated so much by specialization than on sheer, crass mass and density.

4.1.2. Spatial patterns

4.1.2.1. The urban network pattern: Christaller adorned

132 urban centers were found in 1939 throughout Switzerland. On top of the urban network, the city of Zurich already held a unique status, and duly Christaller recognized it as one of its L-Centers (Christaller 1933, Map 4, which covers the northeastern quadrant of Switzerland), at the same level than Munich, Stuttgart and Frankfurt. It was complemented to the west by a first slate of three centers (Basle, Berne and Geneva), then by a second slate of four more centers (Lausanne, Lucerne, St-Gallen and Winterthur). Christaller designated Basle and St-Gallen as P-Centers, but demoted Winterthur to G-Center status, probably on count of its close proximity to Zurich; we feel that attributing P-Center status to the big three behind Zurich and including Lausanne as most important G-Center is probably closer to reality. Thus conceived, G-centers should be about eight in numbers and would include Biel/Bienne, Schaffhausen, and probably Neuchâtel, as well as Lugano and Chur despite of their small size because of the centrality they represent in vast territories. The next Christallerian level is the B-Level. According to theory they should be about twenty of them, represented according to Christaller by cities like Wil, Rorschach, Arbon, Aarau or Olten. To those one could easily add Fribourg, Solothurn, Vevey, La Chaux-de-Fonds, Baden, Zug, and Kreuzlingen. Christaller recognizes two further levels of centers down his hierarchy in Switzerland, the K-level centers (such as Delémont, Laufen, Liestal and Rheinfelden around Basle), of which we can find at least 30 to 40 examples in 1939 Switzerland, and the A-level centers, such as Bülach.

Of the 16 suburban centers that were counted in 1939 Switzerland, only two were of certain importance, Carouge outside Geneva and Neuhausen near Schaffhausen. Smaller units were found around Zurich, Basle and Solothurn (two each), Geneva also having a second unit, and around Lausanne, Vevey, Biel, Burgdorf, Olten, Baden, and Locarno. With the obvious exception of Berne, there seemed to be a relation between urban center size and the presence of suburban centers. 91 exurban centers were counted in 1939 in Switzerland. A cursory look at the map shows that most of them were concentrated in the industrial areas of German-speaking Switzerland. Western Switzerland had only 10 of them, most of which in the Jura Mountains, and only one appeared in Ticino. In contrast, the region situated inside the triangle Berne-Basle-Zurich counted a majority of them, and the same kind of density was observed again in eastern Switzerland. Those were the regions where the density of urban centers was already high. In short, exurban centers reinforced the urban network density where it was already high while not participating in elevating the network density in regions where it was low. In that sense, the notion that exurban centers are elements of the lowest levels of the classical Christallerian network of central places is clearly put to rest. What they may be remains to be told.



Map 4-1: Central places by size, location and orientation, 1939

On the map, two conclusions stand out. Firstly, the global arrangement of urban centers does indeed mimic a Christallerian network. In places where the topography doesn't interfere too much, such as the Aare valley as a whole, Christallerian regularities were quite evident throughout the country. That being said, irregularities are also evident – as they are indeed in southern Germany, as are also major variations in network density.

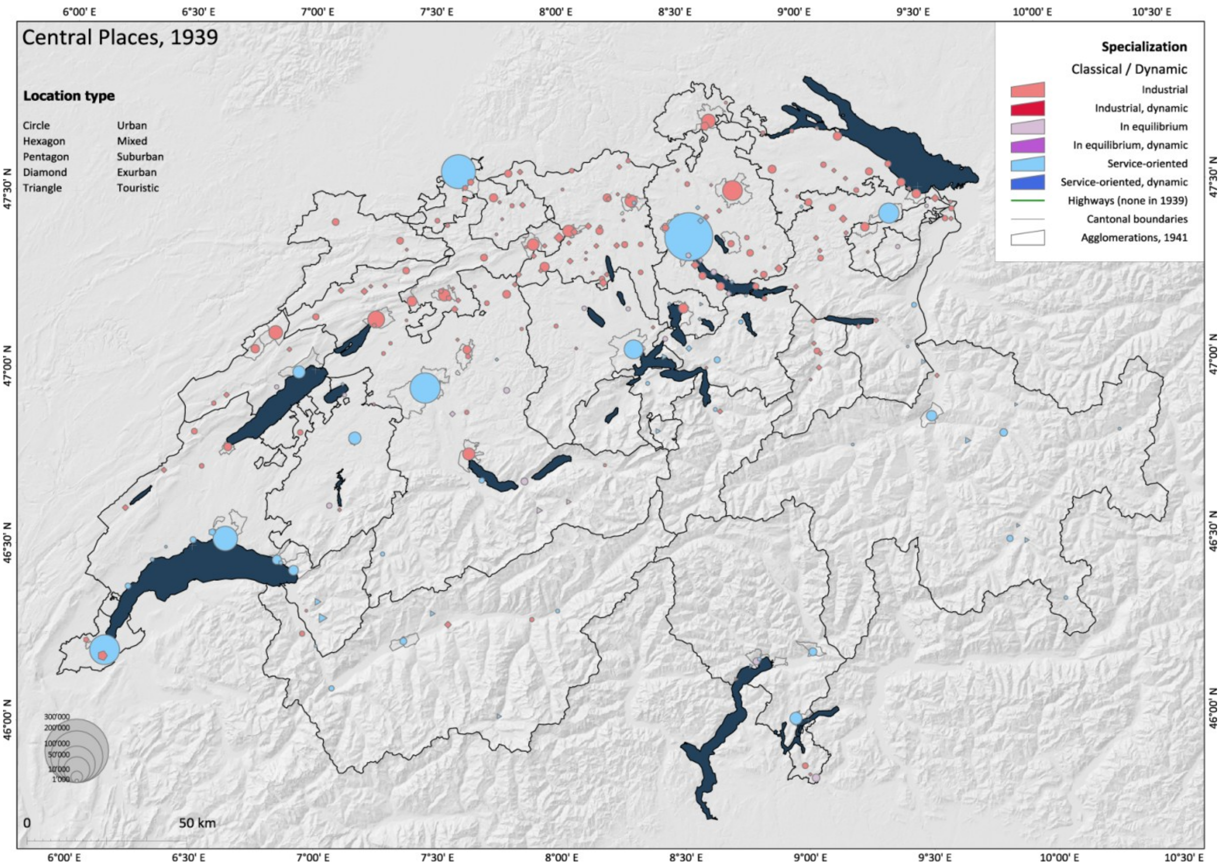
4.1.2.2. Center-periphery patterns at the national scale: urban centers, rural peripheries

If we take into account all 132 urban centers in 1939, we can estimate that each of them commanded a market area of about 110 sq km, corresponding to a circle with a radius of about 6 km. Thus, if the network was perfectly regularly placed on the 15'000 sq km of "usable" Switzerland, centers should have been located about 13 to 15 km from one another. This was clearly not the case everywhere. In particular, industrial regions of Switzerland had a far higher density, such as in most of the Jura Mountains, Basle, Aargau and St-Gallen, where the distance was much lower than 15 km: one registered for example five centers in the 30 km between Wil and St-Gallen, another case in point being Aargau. Meanwhile in western Switzerland much bigger distances were recorded along some axes: in Vaud, 30 km between Lausanne and Yverdon, 50 km between Lausanne and Payerne; in Fribourg, which had only three centers, against fourteen in similarly sized St-Gallen, Bulle was 25 km away from the closest center, making it the most isolated center of 1939 Switzerland except in the alpine regions where Brig, Chur and Poschiavo were even more isolated. Those larger distances were also found in rural-dominated regions of Switzerland such as Berne, Lucerne, northern Zurich and Thurgau. There is also a strong link between centrality at the national scale and density of the urban network. Central areas, situated in the Aar, Limmat and Thur/Sitter valleys, have a clearly denser urban network than rural, mountainous and outlying areas, notably rural western Switzerland.

4.1.2.3. Differences according to agglomeration size: service centers, rare and big

In 1939 already, there seemed to be dependence between agglomeration size and prevalence of suburban centers. However, this was partly due to a tautological cause: by definition, bigger agglomerations had more space to develop suburban centers. However, looking at proximity relations regardless of the suburban or exurban status of outlying centers seemed to show that the relationship between center size and the spurring of outlying centers wasn't as automatic as it may have seemed (*Map 4-2*). In particular, in some industrial regions relatively small centers like Aarau or Schaffhausen were adorned by comparatively massive subcenters. In fact, it seemed like smaller-level centers were more likely to develop mutually significant subcenters in 1939 as were the big centers, which for a part were probably developing them inside their communal limits.

In terms of specialization there was a very strong dependence on center size; at a time where industry was predominant in the economy, the biggest centers had already specialized towards the tertiary sector. The size threshold at which a center would turn towards services varied with the region, with peripheral regions having notably smaller thresholds for centers to turn service-oriented. Immediately behind them, however, practically all centers were industry-oriented, most clearly in the industrial core of the country, where between Berne, Basle and Zurich there were only industrial-oriented urban centers, leaving the impression of an urban network very clearly discriminated on size: to the biggest centers the service functions, to all other units in-



Map 4-2: Central places by size, orientation and location, 1939

dustrial dominance. As we have said though, regional effects seemed to promote smaller centers to service providers, most notably in Ticino and the Jura mountains.

4.1.2.4. Regional patterns: an industrial urban network

In all, there was a strong dependence between the allure of the urban network as a whole and regional imbalances in terms of economic specialization. All center types seemed to concentrate on industrial regions, whether central, where the urban network was very dense, or peripheral, where exurban centers formed a tight mesh. Suburban centers were also concentrating in industrial areas, with more than half of them situated in the industrial core of the country. As industrial regions were geographically quite well-defined, spanning from the Jura Mountains to the St-Gallen area, this translated to large regional imbalances, very clearly seen on the map.

Central industrial areas, from Biel / Solothurn to St-Gallen, sported the densest urban network of the country, with urban, suburban and exurban centers all strongly present. Towards outlying industrial areas, most notably the Jura Mountains and Eastern Switzerland's Oberlands, urban centers were notably sparser, and exurban centers did complete the Christallerian network seen elsewhere. However, exurban centers are even more numerous in core urban areas, which tend to disprove the idea that they act solely as the urban network's base level, as can be seen immediately.

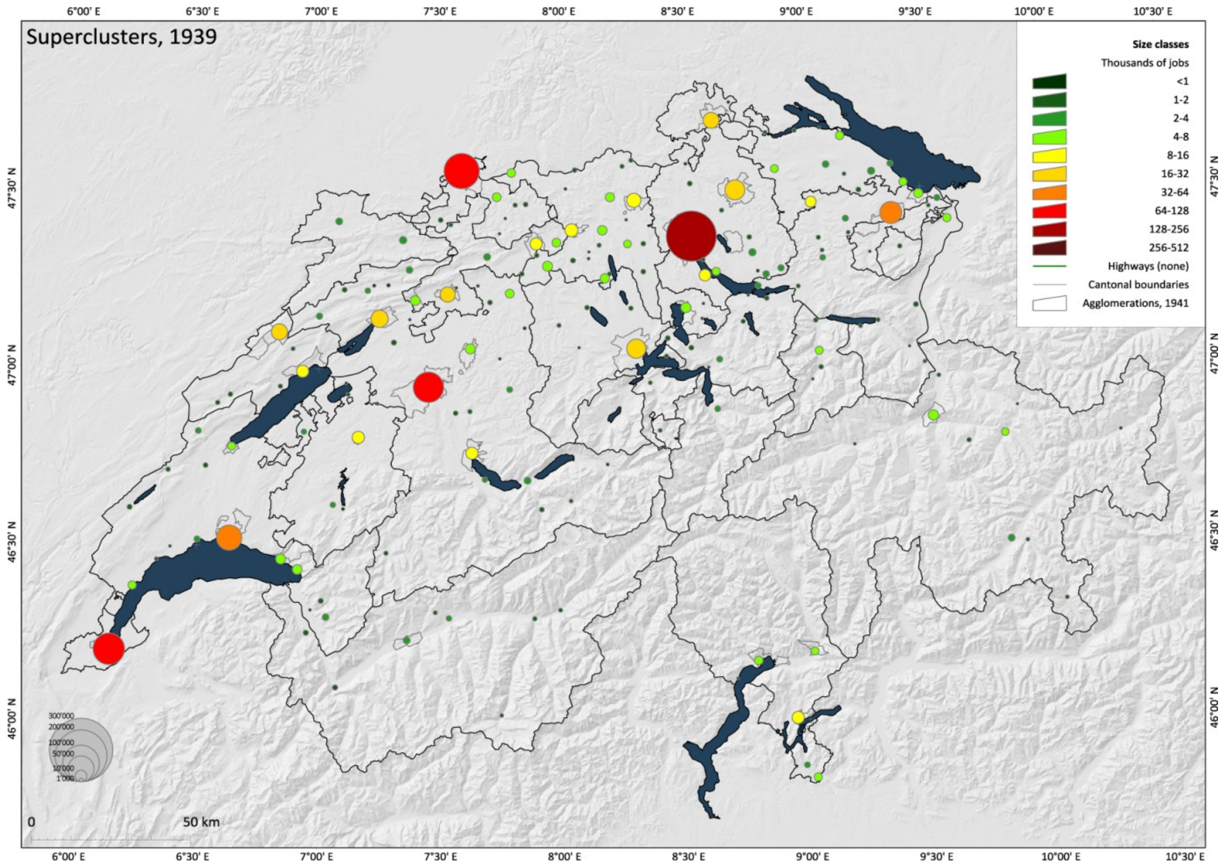
From Geneva to Lucerne, the urban network is far sparser than in the industrial core of the country, outlining a strong dichotomy between Switzerland's industrial areas, and this more rural part of the country. On the Alps other side, about the same network density can be seen in Ticino. Between the two, the network was even sparser in the alpine regions of the country, which showed essentially no centrality at these times. In those areas urban centers dominated completely the landscape, the biggest of which exhibiting suburban centers, while exurban centers were on the whole completely absent from those areas.

Thus, evident regional differences appear when looking at the territorial distribution of job centers throughout 1939 Switzerland, reflecting the strong duality of the Swiss economy of the time, when the core of the country was devolved to the core of the economy, i.e. industry, while the outlying parts of the country devolved themselves to rural activities. Hence, a territory rather clearly divided between both economic logics, which translated into quite different territorial structures between the industrial core of the country and the rural peripheries.

4.1.2.5. Mapping clusters and superclusters: Christaller, again

Between the Weber and Von Thünen spaces we just described, how did the Christallerian network hold itself? As for aspatial results, there is actually very little difference between the maps made at the unit and at the cluster levels. However, mapping the superclusters gave some insights as to the form of the Christallerian network, as superclusters ultimately represented urban centrality.

According to strict Christallerian theory, if the market principle was respected, for each center of a given level there should have been three centers of the immediate lower level, which in our case translates to one center in the immediate lower class and two on the next lower level. One can see that the upper part of the urban network held the Christallerian test quite well: Zurich was in fact adorned by three lesser centers (Berne, Basle and St-Gallen), while further west Geneva and Lausanne look like part of another similar system (*Map 4-3*).



Map 4-3: Superclusters by size, 1939

Further down the network things got more complicated, though. In German Switzerland the network held rather well further down, for example with Zurich as a greater center being adorned by three lesser centers (Lucerne, Winterthur, Schaffhausen), and as one could find lesser centers regularly planted in between greater ones. However, that held only in some parts of the country, notably in the Berne-Basel-Zurich triangle, and even there with some irregularities, like the lack of a greater center in the Olten-Aarau area. Good regularity could also be found in Ticino, where the four cities arranged themselves nicely. In western Switzerland and particularly in the greater Lake Geneva area, there was no suitable center to complete the upper level network formed by the Geneva-Lausanne couple, which appeared thus largely ovesized. The same remark held for some other rural areas such as Lucerne, which dominated its surroundings. In those two areas though, once the size gap considered, the rest of the network fitted rather nicely into place.

In all, despite those departures from the norm, it appears that a Christallerian network can be fitted onto 1939 Switzerland; the findings made when observing aspatial regularities in the network seem to hold. Imbalances noted in those aspatial forays seem to confirm that a size gap existed between the largest centers and the rest, a size gap clearer in the rural area of Switzerland than in the industrial core. Last, it has to be noted that Alpine Switzerland had no organized urban network yet. Large valleys (Rhine, Rhone) were adorned by string of small centers showing no strong hierarchical links.

4.1.2.6. Territorial conclusions: a classical urban network

The general shape of the Swiss urban network was as follows in 1939: it was Christallerian, even if a perturbed one, urban centers dominating the urban network, getting more than 941'000 of 1'108'000 central jobs in the country. It was accompanied by a great number of smallish exurban centers, which tended to develop above all in industrial regions and strongholds and which were thus not complementing the urban network as a lower-level Christallerian ladder, except maybe in outlying industrial regions. At the time, suburban centers were very few, although not always very small. These, too, seemed to prefer bigger centers in industrial regions for their development. Thus, because of those regional preferences, regional imbalances manifested themselves quite vividly, contrasting an northeastern half of Switzerland clearly more urban and more central than most of western Switzerland and other rural regions of the country (Lucerne, Thurgau). Last, if the Jura Mountains showed an appreciable level of urbanization following their strong industries, alpine regions were practically devoid of any sizeable centers.

4.2. 1955: an unlikely urban heyday

4.2.1. Aspatial results

4.2.1.1. Location and centrality: the apogee of urban centers

The urban network developed relentlessly during the ten years following WWII, adding both new units (73 of them) and new jobs (*Chart 4-12*). In 1955, the urban network counted in excess of 500'000 more jobs than in 1939. More importantly perhaps, the urban network share rose markedly from 71.1 % in 1939 to 77.1% in 1955. A major part of those progressions, about 75% of the total, were registered in classical urban centers, so that their share of the total number of jobs also rose, from 60.3% in 1939 to 63.1% in 1955. As in 1939, most of those central urban jobs were held in dense settings, such as the mean urban job density increased slightly at around 35 jobs per built hectare. Meanwhile, job intensity registered a significant progression, from 110 jobs per 100 active residents in 1939 to 120 in 1955. So, while centers remained dense, packed places, they had started to specialize as job centers and to attract more and more workers from the outside: daily commuting had started its rise to prominence.

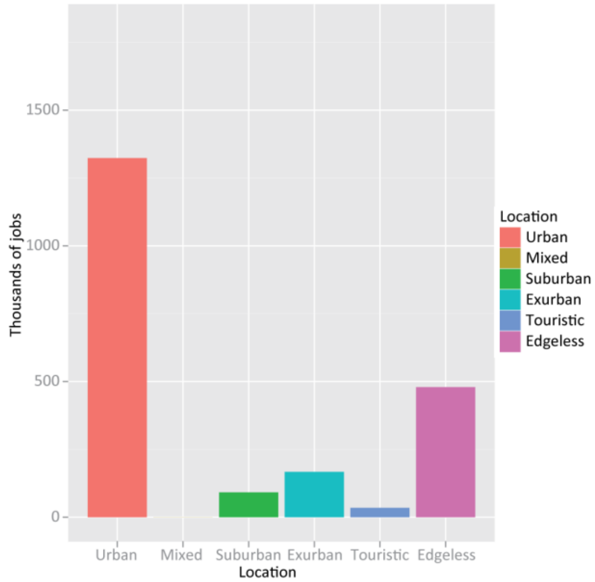


Chart 4-12: Job numbers by location, 1955

Between classical centers and edgeless locations, the non-urban center category saw its numbers grow from 123 in 1939 to 183 in 1955, and their job share went from 10.7% in 1939 to 14.0% in 1955. Two very different categories of objects explain this growth.

The first major addition to the subcenters is the appearance of 35 exurban centers that are technically to be linked to the 1880-1910 generation remnants we spoke about for 1939. Those 35 new centers in the network were not emerging in the sense of explosive growth between 1939 and 1955. At the latter date they remained very small: those 35 more exurban centers represented about 55'000 more jobs, a mean at around 1'600 jobs per center. Most likely they represent centers that were, either in terms of job numbers or in terms of job density or intensity, just below the threshold in 1939, and which were dredged up by the general climate of urban and economic growth and thus extracted from the edgeless realm. To further this claim we can also note that the gain in numbers was paid by some loss in substance: the very low job density remained at the same level of about 14 jobs per built ha, whereas the job intensity of exurban centers went down, from 124 to 119 jobs per 100 active residents.

The second category of new objects was the suburban centers one. Their numbers nearly doubled from 16 in 1939 to 31 in 1955, while the number of jobs they hosted was near treble the amount of 1939, at close to 100'000 jobs. As a category they remained behind exurban centers and their 160'000 jobs, while structurally they did not evolve much, remaining close to the exurban centers.

All types of centers progressed during the 1939-1955 period, both in absolute and in relative terms, which meant that the edgeless category lost a lot of importance at the same time. In absolute terms edgeless space grouped about 480'000 jobs in 1955, 30'000 more than in 1939; in relative terms though this meant a sharp drop, from 28.9% to 22.9%. Furthermore, this loss of importance was accompanied by strong structural losses, both in density (down 1.2 at 9.0 jobs per built ha) and above all in intensity, which went from 80 to 71 jobs per 100 active residents, mirroring the intensity rise experienced by urban centers. Edgeless space was clearly starting to specialize as residential space by 1955. The first consequence of this residential specialization is that there were now 200'000 more active residents in edgeless space than there were jobs there, double the figure of 1939, fueling the commuting flows of the country.

4.2.1.2. Dynamics: relentless growth

1955 is the first census which allows for computation of the network's dynamics. Of the 328 units composing the 1955 urban network, only 34 were deemed dynamical, which is a very low number. This can be explained by the fact that our definition constrained our units to grow by close to 5% annually during 16 years to be considered as dynamic places, certainly no small feat to achieve.

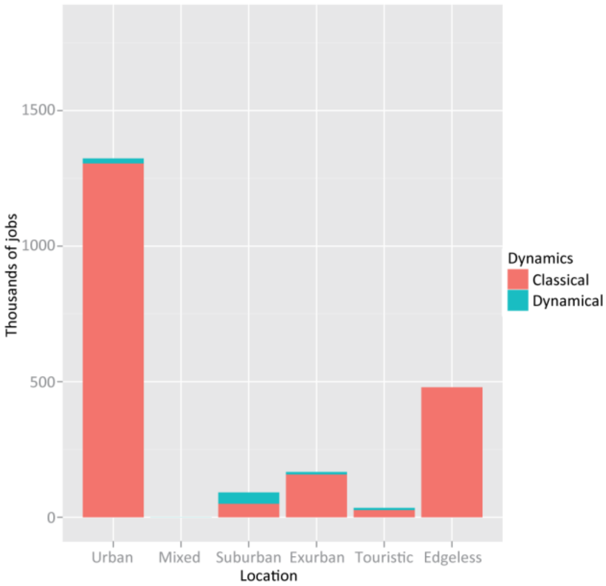


Chart 4-13: Jobs by location and dynamics, 1955

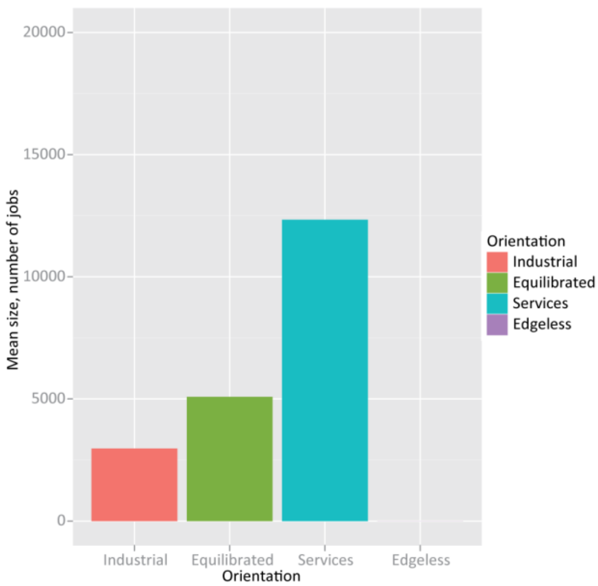


Chart 4-14: Mean center size by orientation, 1955

Structurally, dynamic places in 1955 were quite insignificant places with only 76'000 jobs. They were rather small, sparse but intense places, which linked them primarily to exurban centers places. At 2'560 jobs per unit, though, they were clearly bigger than those, which suggests that at least some of them were of a more central nature, were it suburban or urban. In fact more than half the jobs concerned were actually held in suburban centers, in which they represented in turn half of all jobs. Inconsequential as they were at the time, dynamic units were already important in one location type, that of suburban centers. Where they existed, suburban centers were far more likely to by dynamical units than any other location type. That set them apart nicely from other locations in general, and from exurban centers in particular.

4.2.1.3. Orientation: an industrial heyday?

No less than 240 units were slated as industrial in 1955, 68 more than in 1939, whereas service-oriented centers remained stable at 63 units, and equilibrated ones hardly progressed 5 units at 25. Thus, the sixteen years between

1939 and 1955 had been marked by a creeping industrialization of the country. Industry-dominated centers progressed massively, from 450'000 to 710'000 jobs between 1939 and 1955. Thus, even with the new centers the average size of industrial centers rose during the 1940s and the 1950s, from 2'620 jobs in 1939 to 2'970 in 1955. Industrial centers progressed both in numbers and in size during that time interval. Furthermore they did so without losing their structural strength, as both their density and intensity remained essentially the same. Logically, their job share in the national total increased, from 28.9% in 1939 to 34.0% in 1955. The 1940s and 1950s were industrial.

Service center numbers remained exactly the same in 1955 as compared to 1939, at 63 centers; however their job numbers progressed from 620'000 to 780'000 jobs during the same time, which meant that their average size climbed, from 9'820 to 12'340 jobs each. As a category, service centers grew by internal growth instead of piling up new units. This is further shown by the fact that structurally they strengthened, above all in terms of intensity (116 jobs for 100 actives, up from 104), but also in terms of density (from 39 to 41 jobs per built ha). The only mitigating sign is that as the small industrial progressed even more during these times, is that the job share of the service centers actually decreased a bit, from 39.6% to 37.1%, although that could be compensated by the sharp rise to prominence of equilibrated centers, which job share jumped up from 2.5% to 6.1% at this time. Equilibrated centers looked as a transitional form between the numerous small industrial centers and the few massive service centers. There were 25 of them with a mean size of 5'080 jobs per center.

4.2.1.4. Form: a complete urban network

Of the 328 units which form the urban network of 1955, a slim majority (168, 34 more than in 1939) were of complete form, as in 1939. Their intensity had steadily grown, from 113 jobs per 100 actives in 1939 to 122 in 1955, showcasing a specialization process already at work; meanwhile, the job density decreased slightly to establish itself at 37 jobs per built ha, down 1 point from 1939 (*Chart 4-15*). As a group they tended to grow bigger and their mean size jumped from 6'940 jobs in 1939 to 8'100 in 1955. Complete centers both grew in size and in numbers, and despite a strong overall growth of the national economy, complete centers job share also grew, from 59.6% in 1939 to an impressive 65.3% in 1955. In a sense, the whole urban network growth was taken by complete centers, which accredits the hypothesis that 1939-1955 was a period of concentration.

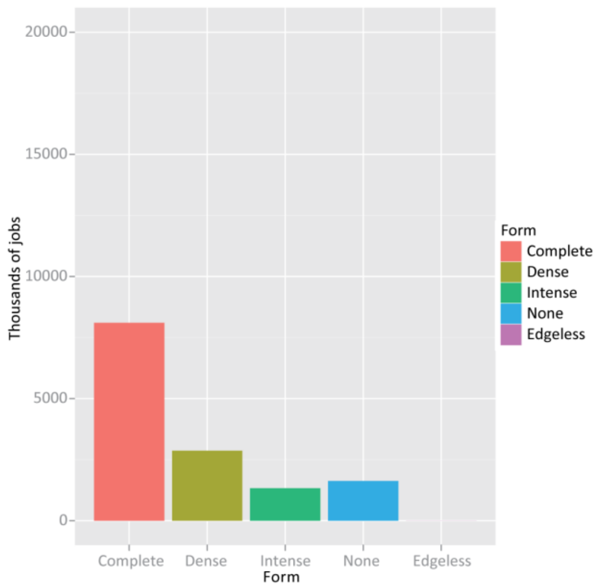


Chart 4-15: Center mean size by form, 1955

Intense only centers were 121 in 1955, against 88 in 1939, and grouped 161'000 jobs against 100'000 16 years earlier. Structurally they reinforced themselves a bit both in density – arguably at a very low level of 10 jobs per built ha – and in intensity – from 112 to 118 jobs per 100 active residents. Their mean size remained very low at 1'330 jobs. In all, this category seemed strongly linked to the exurban centers, at least in structural terms, whereas the complete centers looked distinctly urban.

There were seven dense centers less in 1955 – 20 – than in 1939, grouping fewer jobs, down 8'000 at 65'000. The remaining ones were bigger at 2'870 jobs each against 2'600 in 1939, which suggests that smaller centers were kicked out of this category. Obviously, the job/residential specialization that was under way at the time did not allow for those strange units to prosper. Concentration seemed to happen above all in cities and in exurban centers, while internal dense suburban centers were either morphing into something else or disappearing.

In all though, while clearly evolving, the network showed relative stability towards density and intensity.

4.2.1.5. Size: amidst growth, a density loss

The 328 units of the network fall in 9 classes, as in 1939. Density varied very strongly with size in 1955 as in 1939, however important variations were detected (*Chart 4-16*).

The most important move was that, as a whole, density strongly decreased when controlling for size for centers in the lower to mid ranges, from 2'000 to 16'000 jobs. As a rule, these losses amounted to about a quarter of the values registered in 1939. On either side of this big group though, density showed inverse tendencies: it grew significantly for centers under 1'000 jobs and remained stable for centers between 1'000 and 2'000 jobs. The job density of the smallest centers was now above that of edgeless space, to the contrary of the 1939 situation, and yet another sign that functional specialization was under way. At the other end of the spectrum, the biggest centers and at least some of their immediate followers were also showing a strengthening of their job density. All those results point to two distinct conclusions.

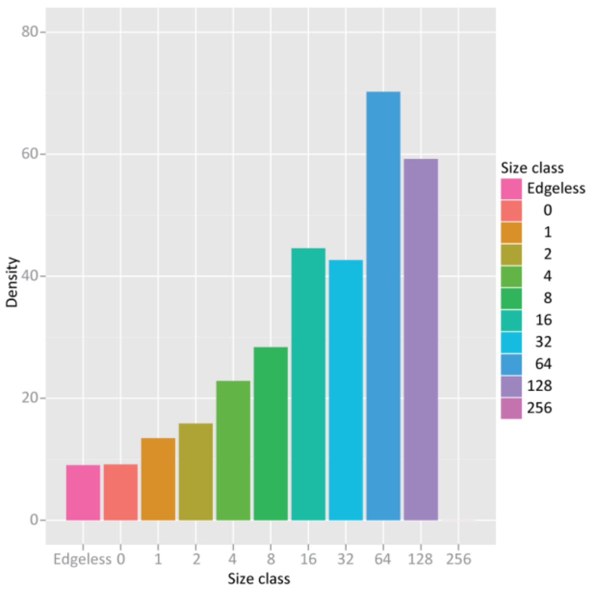


Chart 4-16: Job density by center size class, 1955

First, there was a separation between the highest order centers, which gained in density, and the rest of them, which lost. Seemingly, land-hungry activities were leaving the biggest centers while colonizing everything else in the network. Greater centers were specializing in high-density activities while all other centers were playing the land card – allowing for more space per job than before.

Secondly, the network expanded at its base by dredging up units formerly included in edgeless space, with the double effect to reinforce structures in the smallest size classes, those under 2'000 jobs, while depriving edgeless space of them and relegating it further to residential function.

Intensity jumped about 10 points across the board between 1930 and 1955, so that at the latter date all size classes showed definite above unity job intensity, which was not the case of the biggest centers in 1939 (*Chart 4-17*). The progression, though, varied according to size. The greatest centers, those above 64'000 jobs, saw a modest but real progression, which shows that even as extended as they were in 1955 their own labor force could not entirely serve their jobs markets anymore; they had become job centers needing outside commuters. Meanwhile, midsized centers, which were already rather intense in 1939, saw their intensity progress to about 130 jobs per 100 actives. Not only did they intensify, but this category started to expand towards bigger centers. The centers from 16'000 to 32'000 jobs, which were quite autarkic in 1939, boasted the highest intensity of all classes in 1955: they had suddenly started to draw big numbers of workers from across their communal boundaries. In all, what is also remarkable is that across the board intensities had closed in on one another, regardless of the class; for all size classes intensities were now ranging from 115 to 135.

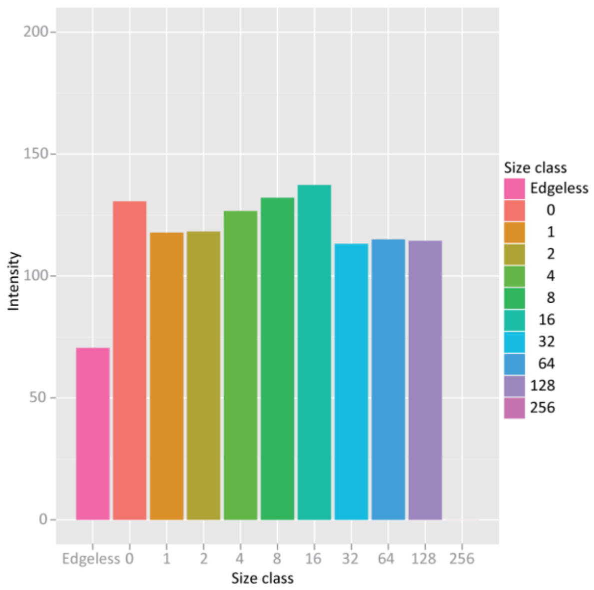


Chart 4-17: Job intensity by center size class, 1955

In all, the general rise in intensity corroborates other findings as to the specialization process that was under way between job-specializing centers, and residential specializing edgeless space.

4.2.1.6. Rank-size and job numbers by size classes: a first departure from Zipf

Looking at the size class distribution of our 1955 units shows a departure from the corresponding Zipf distribution (*Chart 4-18*). The most spectacular departure is the reinforcing of the top-heaviness of the urban network. Whereas the top three categories represented 27.9% of all jobs in 1939, which was already a sizeable excess from a Zipf distribution, those same three classes of centers above 32'000 jobs now grouped 35.8% of all non-agricultural jobs of the country. Therefore the network was now clearly out of balance, sporting seemingly far larger cities than expected.

On the other side of the network, the dearth of very small centers, already patent in 1939, remained, as they were only 71 centers below 1'000 jobs, against 119 from 1'000 to 2'000 jobs, and 75 centers from 2'000 to 4'000 jobs.

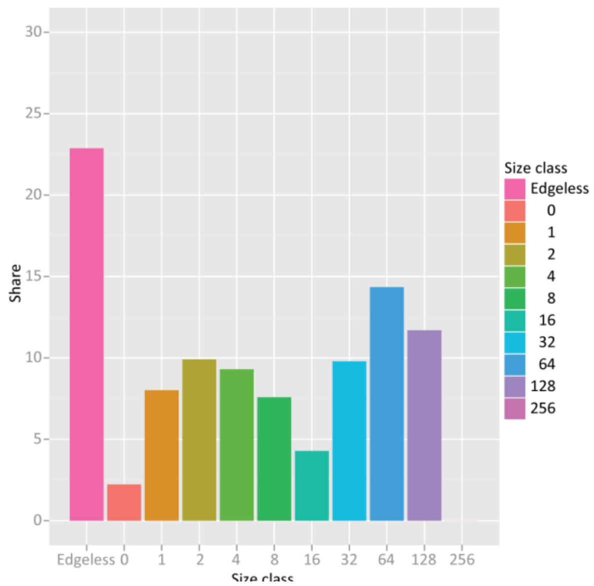


Chart 4-18: Job share by center size class, 1955

Given this last number, in a normal Zipf distribution one would expect about 300 smallest centers, and around 150 centers in the next category. The new phenomenon is that not only there was a lack of smallest centers, in 1955 as in 1939, but that this lack was progressing upwards and starting to contaminate the next class up.

Whereas in 1939 it was clearly possible to postulate a Zipf distribution in the lower and middle size classes, this is definitely more difficult in 1955. In any case, Zipf-like regularity can only be found for centers between 2'000 and 8'000 jobs; smaller size classes,, as we have seen, are depleted, as are in fact higher classes, in the 8'000 to 32'000 jobs bracket. In the two concerned classes, there are only a tad more than half as many centers as expected, and the combined job share of those classes is only 11.9%, well short of the expected 18%.

This first look at the form of the swiss urban network hints at major departures from the originally postulated Zipf-like distribution. The size distribution hints at a two-level urban network, one formed at the top by a group of about ten bigger centers which held in 1955 more than 32'000 jobs, and below by an abundance of cities sized from 2'000 to 8'000 jobs. Between the two levels the network is deficient, as it seems to be below 1'000 jobs for sure and possibly a little above.

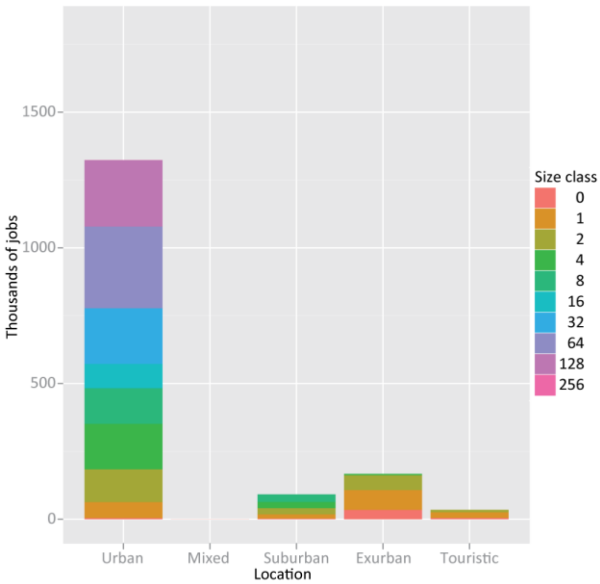


Chart 4-19: Job numbers by location and center size class, 1955

As in 1939 the general findings we made in the last paragraph do apply predominantly to the urban network alone. In the urban distribution the top three classes weigh very heavily on the whole of the network with more than half the jobs of the urban centers category, which count nine size classes (*Chart 4-19*). Of the regularity of the urban network found in 1939, only some elements, roughly the size classes between 2'000 and 16'000 jobs, seem to hold. Centers in the 8'000 to 16'000 jobs, which were quite numerous in 1939, were clearly deficient 16 years later, accrediting the idea that there was a dearth of midsized centers in Switzerland, in 1939 as in 1955, the location of which evolved with the urban network growth. In 1939, the hole in the network was situated in the 32'000 to 64'000 jobs bracket; in 1955, it had migrated down to the 16'000 to 32'000 jobs bracket. This was made possible by the growth of 1939 16- to 32 thousand jobs bracket centers into the next class up by 1955, which were not replaced by a similar phenomenon at the next stage down the urban network. Plus, the imbalances between classes in 1955 were clearly larger than in 1939. The urban network evolved away from a Zipf-like distribution, and probably from a pure Christallerian form.

Suburban centers grew heartily between 1939 and 1955, both in numbers and in size. Quite remarkably, at a time when the urban network evolved away from a Zipf-like size distribution, suburban centers size distribution was indeed very much Zipf like, especially above 2'000 jobs; the dearth of very small centers is even greater in suburban centers than in urban centers. Exurban centers also grew similarly, i.e. both in numbers and in size, and expanding up a Zipf-like distribution between 1'000 and 4'000 jobs, thus colonizing a new size class above 2'000 jobs. In that sense, the size distribution of exurban centers seemed to complement nicely the one of the urban centers. In 1955, the urban network seemed to be complemented in its lowest levels by a very urban-like network of exurban centers. It remains to be seen on the map if this hypothesis holds.

4.2.1.7. Zipf's law, clusters and superclusters: towards a dichotomy

The rank-size curve for the 1955 network was quite similar to the 1939 one, with larger than expected centers from the 3rd to the 10th position, then smaller than expected from the 10th to the 40th place, then a rather good agreement with the curve, and finally a severe drop of the curve under 1'000 jobs (*Chart 4-20*). This seemed to imply that the urban network grew along with its original imbalances. Indeed, inflexion points, while remaining generally at the same place in the hierarchy (3rd, 10th and about 40th rank) all corresponded to big rises in absolute numbers. Likewise, the big inflexion point formerly situated at exactly 1'000 jobs was now situated closer to the 1'100 job mark.

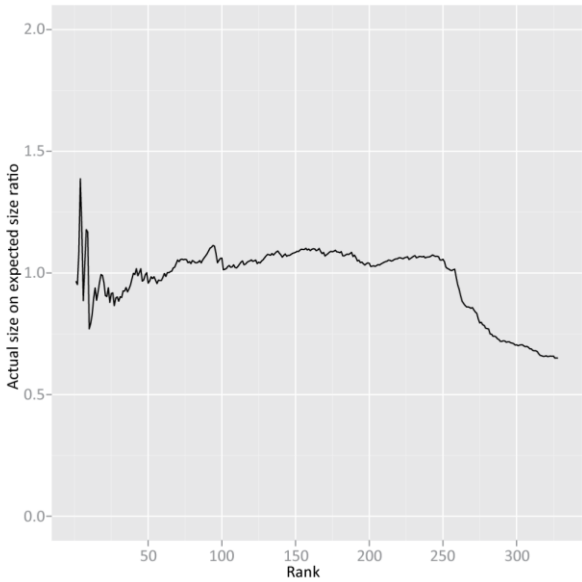


Chart 4-20: Units rank-size distribution compared to Zipf's law, 1955

As in 1939, the clusters rank-size curve is very similar to the units one (*Charts 4-21 & 4-22*). The distribution by size classes and location, at the cluster level, however, helps us to see clear differentiations between suburban and exurban centers. At the cluster level, suburban centers were very clearly top heavy with more than half of the jobs being in clusters larger than 4'000 jobs and practically none in clusters under 1'000 jobs. Exurban clusters were clearly remaining smallish, with a sizeable part of their jobs in

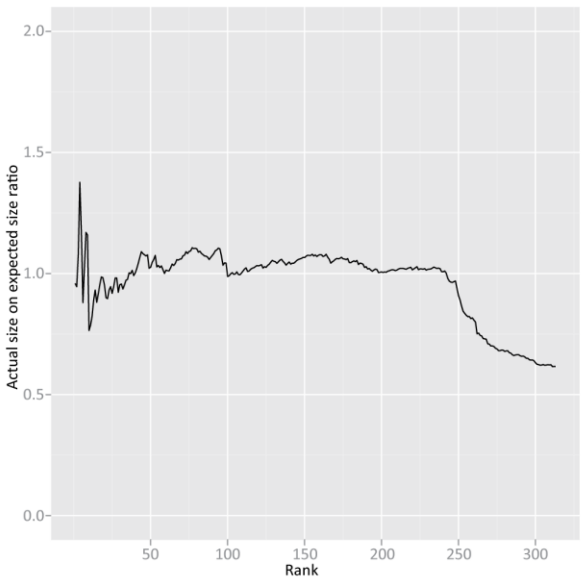


Chart 4-21: Cluster rank-size distribution compared to Zifp's law, 1955

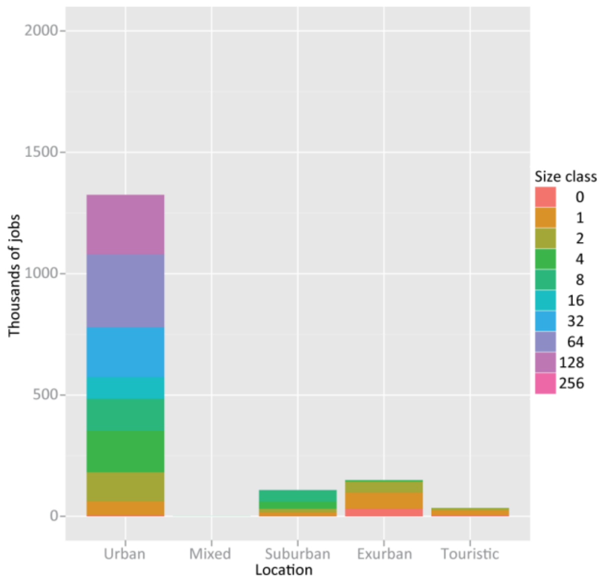


Chart 4-22: Job numbers by location and by cluster size class, 1955

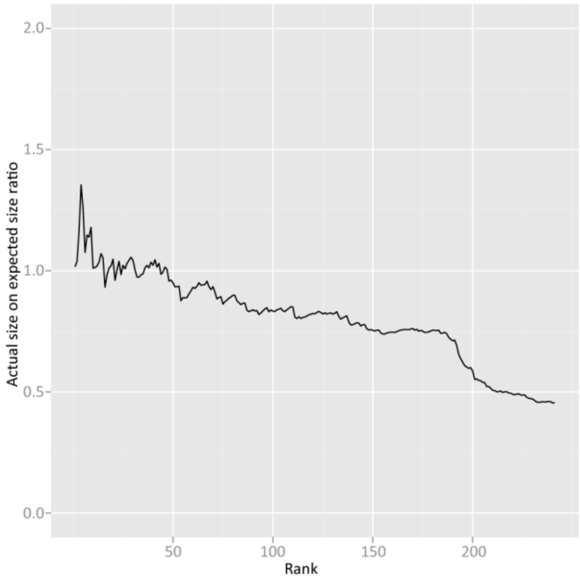


Chart 4-23: Supercluster rank-size distribution compared to Zipf's law, 1955

clusters under 1'000 jobs and practically none in clusters above 4'000 jobs. Thus, there was a clear size disparity emerging between suburban and exurban clusters. Suburban clusters were systematically larger than exurban ones. Being close to an urban center was helping non-urban centers to get bigger. The fact is that the growth of the larger urban centers was matched by the growth of their suburban counterparts, leaving behind smaller units of both the urban and exurban realm.

As in 1939, the supercluster rank-size distribution for 1955 differed notably than the ones made at the unit and the cluster level (*Chart 4-23*). The most striking change is that the supercluster rank-size distribution now showed a clear dichotomy between larger superclusters, those with more than 25'000 jobs, which were larger than expected in a Christallerian or Zipf-like network, and smaller superclusters, with less than 5'000 jobs, which were systematically smaller than expected. Between the two a zone of about 40 superclusters counting from 5'000 to 25'000 which still conformed to a Zipf-like rank-size distribution. Clearly, the urban system was reinforcing its tendency to favor larger centers while letting smaller centers wither.

4.2.1.8. Aspatial conclusions

The aspatial study of the 1955 network gives the following results:

The network relentlessly grew in size, numbers and job share during the 1939-1955 period. Edgeless space largely retreated in terms of job numbers and share.

The number of non-urban job centers grew strongly such as its total number, 183, overtook that of the urban centers (145). However, urban centers remained very much dominant in the network in terms of job numbers. The structure of the urban network was completed at the bottom end by those of the exurban centers.

Although numerous, non-urban job centers tended to be very small as compared to urban centers.

Suburban centers doubled their numbers to 29 units in 1955, and its significance in the network grew. As in 1939, their structure resembled those of exurban centers, i.e. non-dense centers geared towards space-hungry activities. However, they were distinctly larger, and clearly growing not only in numbers but also in size.

The exurban centers were playing the role of the local urban network: very numerous, generally very small, while their density was very low, indicating activities with large land consumption as compared to urban activities.

Job density was still quite discriminating as an indicator of urbanity. Its trend, though, was decreasing, showing a tendency to sprawl.

Job intensity was far more discriminating between central and edgeless space than in 1939 and started to be seen as a valid indicator to discriminate between job centers and residential space.

Dynamic units were of small importance, except in suburban centers, where they represented half of the jobs. Boom-centers were then primarily suburban, which set them apart quite nicely from both urban and exurban centers.

Growth in unit numbers and for a great part in job numbers was obtained above all by industrial units; the 1939-1955 period was one of industrial growth first.

Service centers were not more numerous in 1955 than in 1939; however, they were significantly larger.

Dense-only centers were going down as intense centers were going up. In a way, the urban system was evolving away from density and towards specialization.

Broadly, the urban network did conform to a Zipf-like network, while growing imbalances between its too large larger centers, and its too small smaller levels.

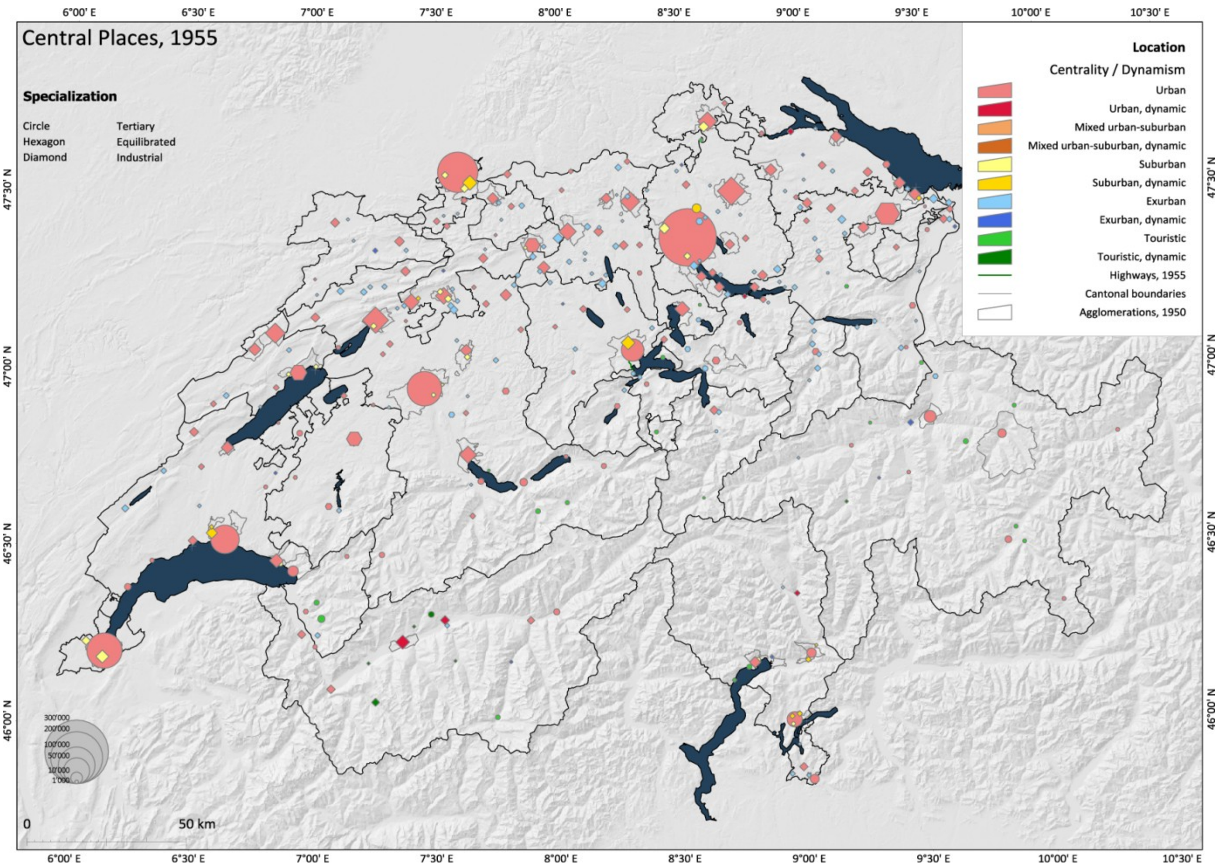
In all, the global structure of the urban network as observed by evolution was as follows. The whole network grew in size, although units added to it were essentially industry-oriented. The main casualty of this growth was edgeless space, which lost massively in job share, but also, in relative terms, the service centers. However a new category, equilibrated centers, showed that a transitional class of objects likely to cross from industrial to service-oriented was emerging in 1955.

In all the rank-size distribution seemed to hold its own well enough during the 1940s and the early 1950s, except that it was growing very much top-heavy and bottom-light. Departures from the Christallerian network were then to be expected. Then again, in 1955, a Christallerian network was still in place and most of the rare exceptions to it were still the remnants of a first wave of exurbanization of the economy which had occurred more than half a century before. At the same time, seeds and hints of what was coming were seen for the first time.

4.2.2. Spatial patterns

4.2.2.1. The urban network pattern: a tale of growth and stability

As we have already surmised, the period immediately following WWII was one of sheer growth of the urban network, without major changes in the network structures (*Map 4-4*). In all, growth was evident everywhere but particularly in two domains. First, the network saw its units grow, especially in the upper levels: the nine biggest centers of the country gained more than 210'000 jobs between 1939 and 1955, close to half the total growth of the country. Growth also occurred significantly in the next lower levels of the urban hierarchy, as many regional centers and cantonal capitals gained significant amounts of new jobs. This growth was far less effective in the



Map 4-4: Central places by size, location and orientation, 1955

lower levels of the urban hierarchy: local centers maintained themselves but hardly grew at all, while the number of new units, at least in the urban realm, was quite low. Interestingly, the densification of the network happened to take place predominantly in formerly ill-covered areas: the alpine cantons hosted new centers, showing either densification of the urban network, as in Valais, or penetration of the Christallerian network in formerly rural areas, as in Vaud, Berner Oberland, Ticino and Graubünden. Likewise, formerly poorly dotted areas saw the emergence of low level centers, such as in the Broye and Glâne regions of Vaud and Fribourg. Emergence of new centers in already densely covered areas was almost nil: Aargau and Thurgau gained none, Zurich lost even one center (Wetzikon), St-Gallen gained just two. The result was a reinforced Christallerian network, adorned with a slate of new local centers that appeared predominantly in areas where centers were formerly underrepresented. This seems to indicate that those new centers were relying on services, i.e. the tertiary sector, to develop.

The number of new units in the urban system grew markedly between 1939 and 1955, by 73 units to 328; those new units were not to be found, as we have seen, in the urban centers, which gained only 13 units, against 35 new exurban centers. Exurban centers went from 91 in 1939 to 126 in 1955. Many truly minuscule new units were to be found in very peripheral settings, such as high alpine valleys where they were ephemeral things linked to dam building. Likewise many new units, often more significant, were found in peripheral areas, especially industrial ones, such as in Eastern Switzerland (rural Thurgau, Upper and Prealpine Rhine valley, Toggenburg, Glarus) and the Jura Mountains. In more central areas, emergence of exurban centers was scarce, and when it happened it was intermingled with a surprising amount of exurban centers dro-pouts. Thus, all those apparitions have to be put in perspective with the fact that exurban cen-ters were far less stable than urban centers, a fair number of them disappearinmg between 1939 and 1955, essentially in the industrial heartland of the country, in Zurich and Aargau. In all, though, there's no doubt that exurban centers remained strongly linked to the industrial core, and thus expressed a strong dependency towards industry. As urban centers developed as ser-vice centers, exurban centers developed as industrial villages.

Between the two, suburban centers showed a marked progression. They were still few of them, although their numbers had doubled. Half of them were dynamic, the only category for which dynamics were important. The biggest units, which generally were also the most dynamic, adorned the biggest centers, which also showed strong growth. In that sense, suburban centers added to the growth of the most central of Swiss urban centers. Zurich, Basle and Lausanne all had big dynamic suburban centers (Kloten, Schweizerhalle and Renens-Malley), as did Lucerne (Emmen). Zurich, Basle and Lugano now counted three bona fide suburban centers, Geneva, Lausanne, Berne, Neuchâtel, Solothurn and Bellinzona two each, Vevey, Biel, Grenchen, Burgdorf, Olten, Lucerne, Brugg, Schaffhausen, Rorschach, and Locarno having one each.

In the midst of all this, what to make of the first apparition of dynamic centers? The first remark to be done is to state that their importance in the urban network was still small, at 3.7% of all jobs. Half of those were held in suburban centers, showing that the mostsignificant part of the establishment of new job centers occurred in suburban areas, already in 1955. Besides, five ci-ties had grown dynamically between 1939 and 1955. Those are Sion and Sierre in Valais, Freienbach in Schwyz, Steckborn in Thurgau and Biasca in Ticino. All were peripheral, three of them part of the new, expanding alpine urban network, which was virtually non-existent in 1939; two of them were in Valais, which evidently was developing the strongest in terms of get-ting an urban network.

4.2.2.2. Center-periphery patterns at the national scale: growth and network completion

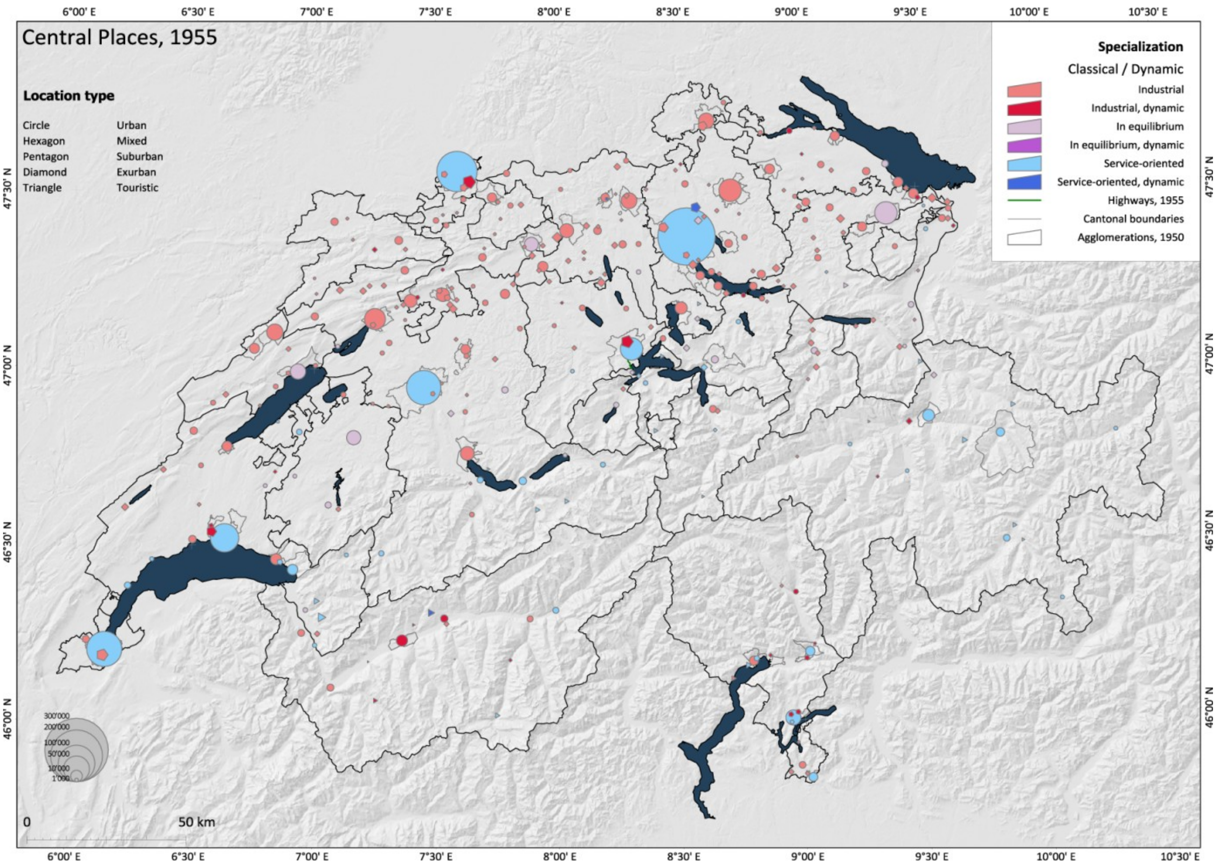
The most striking development of the urban network between 1939 and 1955 was the massive growth experienced by the largest centers of the country. As a first approximation, the 1939-1955 period corresponded to a reinforcement of central tendencies in the Swiss urban network. This was reinforced by the fact that the biggest and most dynamic suburban centers were partic-ipating of the same movement, aggregating around the largest centers of the time.

That being said, the development of the center network between 1939 and 1955 corresponded quite nicely to a Christallerian theory with most new centers established in areas formerly devo-id of them, notably mountainous areas. This population of new urban and above all exurban cen-ters meant that the great between-centers distances noted in 1939 in non-industrial plains

(Vaud, Fribourg, Berne and Lucerne) had disappeared: Moudon and Romont were now designated between Lausanne and Payerne, Fribourg had now five centers against three in 1939, and alpine areas had seen the most extensive development of its urban network, with the emergence for instance of Château d'Oex, Frutigen, St-Maurice, Biasca or Thusis. Thus, it can be said that both centers and peripheries gained from the period, at least far-out peripheries did. It may be that in-between regions situated between the centers and the true peripheries, the rand areas saw their significance dip a bit. If the city of Zurich and its suburbs progressed a lot, such wasn't the case of the rest of the Canton, or of Aargau.

4.2.2.3. Differences according to agglomeration size: a growing imbalance

As we have already noted several times, in 1955 there was a strong link between agglomeration size and growth, meaning that in general larger agglomerations grew faster than smaller ones. Furthermore, larger agglomerations were also hosting larger and faster-growing suburban cen-



Map 4-5: Central places by size, orientation and location, 1955

ters than the rest of the agglomerations. At the same time, the most peripheral regions of the country experienced a rapid urbanization process, meaning both strong growth of existing centers (Sion, Sierre…) and implementation of numerous new ones. Between those two levels though, things were more muted. In particular, smaller centers in densely urbanized areas progressed little, letting most of the growth happening in regional or larger centers.

Industrial development was the driving force behind the relentless growth of the urban system between 1939 and 1955, and it showed nicely on the 1955 map of centers according to their orientation (*Map 4-5*). If possible, industrial domination of the network at-large was even more pronounced than in 1939. The then dichotomy – the biggest centers devolved to services, all the rest to industry – still held, but industry made inroads into bigger centers: St-Gall, Neuchâtel and Fribourg reverted from service-oriented in 1939 to equilibrated in 1955, while the opposite move was only made by Olten – and then only because of its position as the main railway node of the country. Furthermore, most emerging centers were clearly industrial, particularly the sub-urban centers which either appeared or turned industrial during these times, justifying their official appellation of "industrial zones". Thus, 1955 really appeared as a paramount industrial age across Switzerland.

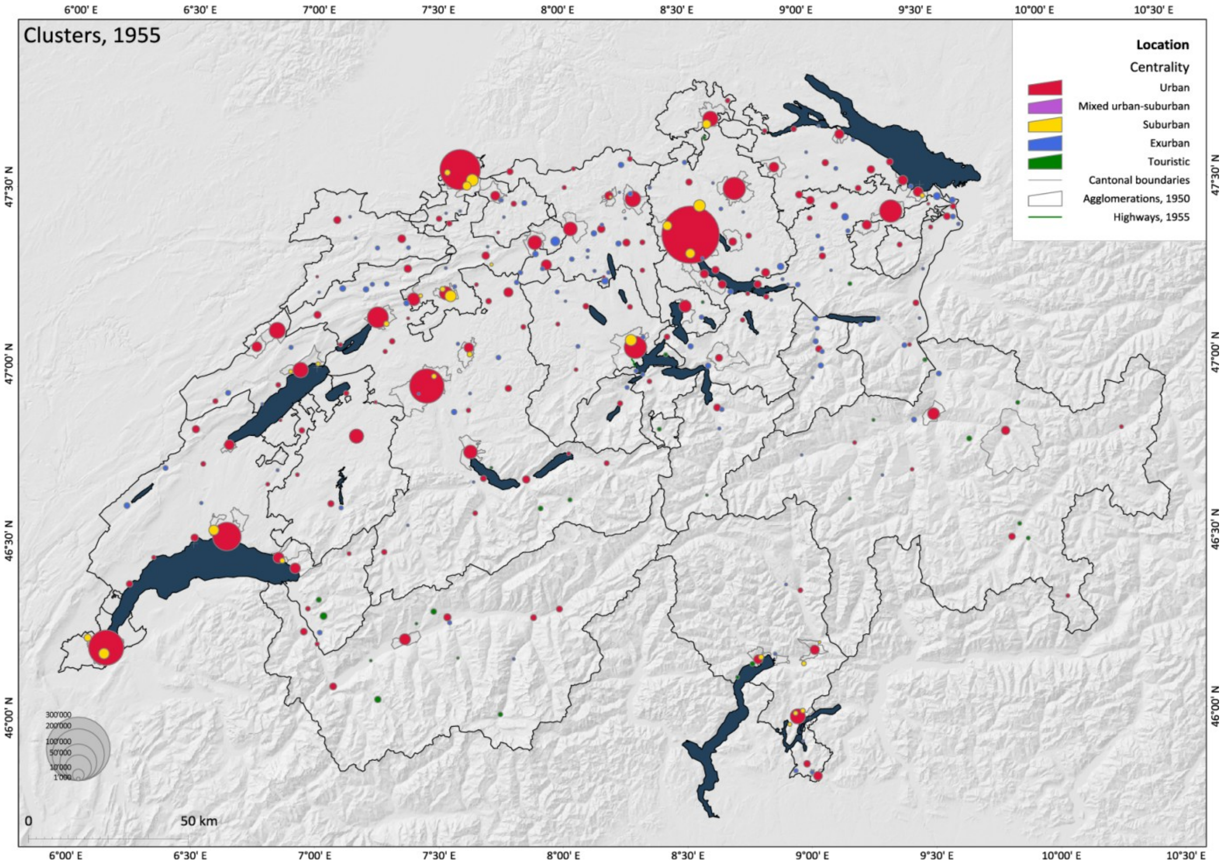
4.2.2.4. Regional patterns: peripheral regions catching up

The evolution of the urban network towards 1955 clearly showed regional imbalances. As we have already noted, very central regions, i.e. the major urban centers, saw their dominance increase during these times, whether they were situated in densely urbanized regions (Zurich and Basle) or not (Geneva, Lausanne and Berne). However, at other scales the network development was most impressive in outlying areas. The Alps, for example, showed a very strong urban growth, as did at a lesser scale the Jura Mountains and Eastern Switzerland, showing that industrial outlying areas were also pretty much concerned by growth. Furthermore, the Alps also experienced a renewal of its resort network with the emergence of several new destinations. The progression was clearly weaker, albeit not nil, in outlying rural areas such as rural Western and Central Switzerland, as it was indeed in central industrial areas once major centers were removed from the equation.

In all, the "double-bump" we saw earlier in terms of size distribution could be explained by the progression of the major centers along with the apparition of many peripheral ones, while mid- and low-level centers of central areas, especially industrial central areas, failed to keep the same pace.

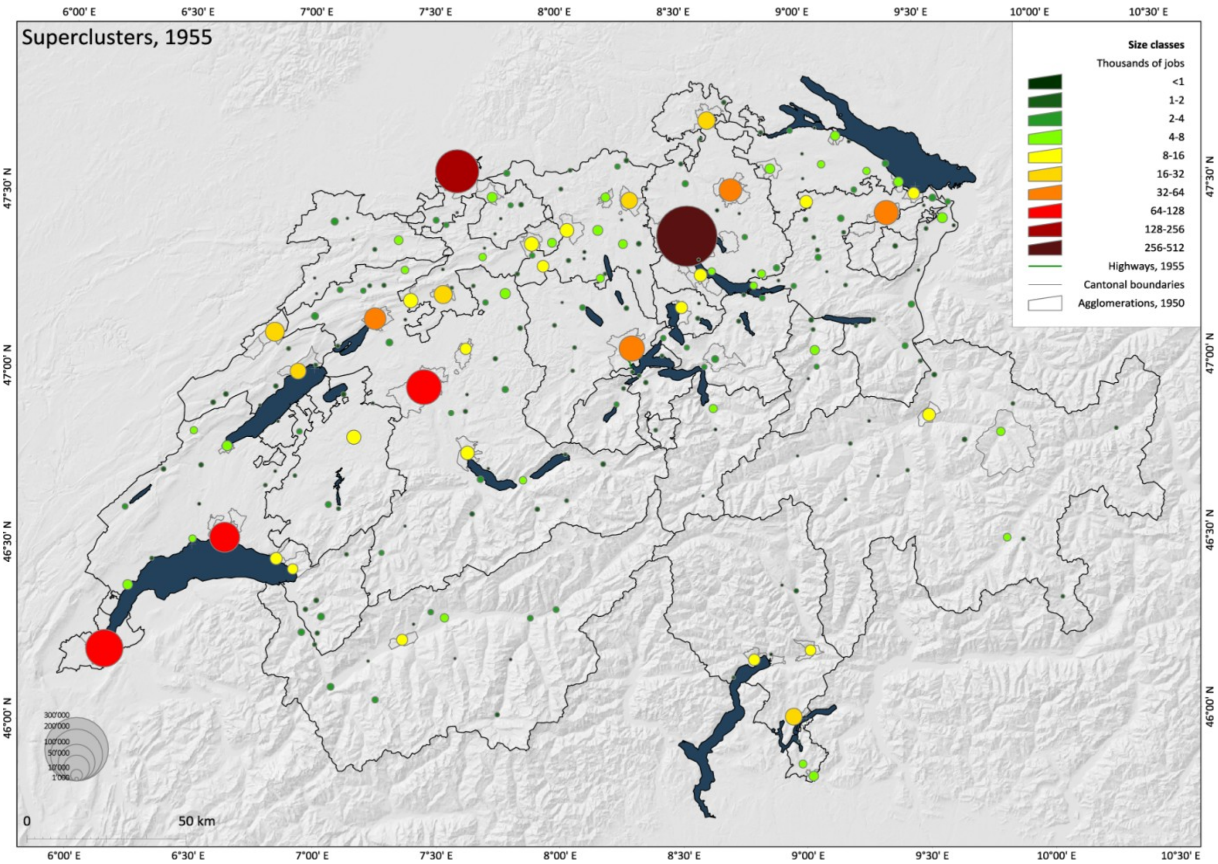
4.2.2.5. Mapping clusters and superclusters: the runaway growth of the largest centers

As for 1939, the units and cluster maps are very alike in 1955. However, the clustering of suburban centers started to be obvious in 1955 in a way it wasn't in 1939 (*Map 4-6*). This means that by 1955, suburban units had started to group themselves at strategic places around urban centers. Such groupings were evident in Zurich, a cluster of three units stood between the airport and the city, another one in its southwestern outskirts. The most evident cluster, though, was to be found in Solothurn where four industrial villages formed such a complex, which was close to matching their parent city.



Map 4-6: Clusters by size and location, 1955

At the supercluster level changes were less subtle (*Map 4-7*). First, the generalized urban growth seemed to benefit particularly the two biggest urban centers of the time, Zurich and Basle, which both progressed impressively. This growth, however, was matched by the three other major centers of Switzerland, as well as by a spate of regional centers, like Lucerne, Winterthur and Biel for the major ones, Lugano and Baden at the next lower level. As urban growth benefited all those centers, it meant that on the map, the upper levels of the Christallerian hierarchy found in 1939 were still very much in place by 1955, and it is at the lower levels of the urban hierarchy that a departure from a pure Christallerian network was noted. Major centers were not matched by a corresponding net of local centers as they were with regional ones, which is for example quite visible in Zurich. Likewise, many regional centers lacked such networks. This is for instance evident in the Jura Mountains, where the network of major centers there (Biel, Neuchâtel and La Chaux-de-Fonds) wasn't complemented by a network of corresponding Christallerian sub regional centers. Such a dearth of mid-level urban nodes was already noted when looking at general aspatial results, and which was now confirmed on the map, although it has to be noted that the geometry of the urban network still looked distinctly Christallerian; it was only the mutual relationships between job numbers that didn't hold.



Map 4-7: Superclusters by size, 1955

4.2.2.6. Territorial conclusions: the apex of the urban network

In all, the general picture for 1955 was one of reinforcing of the network of urban centers, by growth of its preexisting units, especially the largest ones, and by adding of new components into the network. This addition allowed the network to grow denser in places where it was deficient before and in that sense the network reinforcement is evident, and even more when considering that for a large part exurban centers look like a lower level complement of the network, in which they seem to fit correctly at the supercluster level. Between them, suburban centers remained a marginal albeit growing phenomenon. In regional terms, there was a strong tendency to urban development in the Alps and more generally in less-industrialized regions of the country, above all in Western Switzerland, which started to equilibrate the urban network and its components in the country.

A phenomenon was also just visible by comparing the 1939 and 1955 maps: the presence of big centers like Zurich seemed to inhibit central development in its immediate vicinity. One urban center disappeared in its realm, Wetzikon, and by and large cities in the immediate vicinity of Zurich were not showing any strong growth. This seemed to indicate that already in 1955, big cities started to have an impact at the scale of the Christallerian network: they had started to hamper the development of close centers, which wasn't postulated by Christallerian theory.

1955 still looked very much Christallerian, perhaps even more so than in 1939, despite the progresses made by suburban centers, a pumped-up version with fast growing major centers which in a way escaped the network by above, starting to exert influence on larger territories, hampering classical development of local centers in their vicinity, in fact starting to dismantle the regularity of a pure Christallerian network. It was an age of cities, and probably the birth of metropolitan processes.

4.3. 1965: the climax of the industrial age

4.3.1. Aspatial results

4.3.1.1. Location and centrality: an optimum

As the sixteen years which preceded it, the decade between 1955 and 1965 were marked by a strong economic growth, which implied also a strong population growth. In many respects this decade continued the trends already seen earlier in terms of urban network development (*Chart 4-24*). In all, unit numbers progressed rather strongly to attain 393 by 1965, or 65 more than in 1955, for exactly 500'000 more jobs. In all, the job share contained in the urban network rose slightly, from 77.1% in 1955 to 79.5% in 1965, meaning that edgeless space was still losing in quality as the network of centers reinforced itself. In absolute terms, all spatial categories gained jobs during this period.

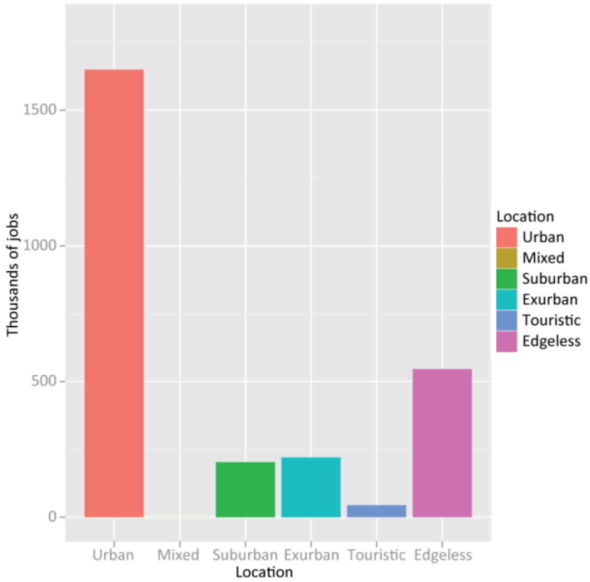


Chart 4-24: Job numbers by location, 1965

Urban centers still represented the majority of all job gained during the decade with slightly more than 325'000 more jobs than in 1955. However, very subtle signs of slowing were to be noted. First, this growth was entirely the result of internal growth of existing centers, as urban centers numbers remained very stable – only 6 more units at 151 in 1965. As a result, their mean size jumped from 9'130 jobs in 1955 to 10'920 in 1965. Secondly, and more importantly, the urban centers job share actually decreased during the decade, from 63.1% in 1955 to 62.0% ten years later. Structurally, as whole, urban centers continued their slow mutation from dense to intense places, losing a bit of density – from 34 to 33 jobs per built ha – but gaining decidedly in intensity – up 8 points to 128 jobs per 100 active residents. As a result, in absolute terms, the imbalance between jobs and actives grew massively during this period, from 225'000 more jobs than actives in urban centers in 1955 to 360'000 in 1965. By 1965, commuters were starting to flood urban centers.

Exurban centers were still growing by 1965. There were clearly more of them – 32 more, to 158 units, hosting a bit more than 50'000 more jobs to about 220'000 –, and their job share grew 0.3 point to 8.3% of the total. However, while still growing, exurban centers also showed signs of weakening during the same decade. Structurally, they clearly lost quality, losing appreciable amounts of density, furthermore from an already quite low starting point – from 14.0 to 12.1 jobs per ha, while remaining stable in terms of intensity. They also remained quite small, at a stable 1'300 jobs per unit.

The clear winners of the decade were the suburban centers. They gained 22 units to 53, more than doubled their job numbers from 92'000 to 202'000, correspondingly increasing their job share from 4.4% in 1955 to 7.6%, such as representing almost the same job share than the exurban centers. Their mean size also jumped appreciably, from 2'960 to 3'820 jobs per unit, further evolving away from exurban centers in terms of size. These progresses, however, were paid in terms of structure, as if growth was somewhat too rapid to keep pace in terms of density and intensity. Job density dropped sensibly 2 points to 13.5 jobs per built ha, while intensity failed to keep pace, even getting under parity. Suburban centers were gaining ground but losing structure, resembling big formless spaces.

Edgeless space still lost job shares – to a very low 20.5% in 1965, however its drop had been far less sensible during the decade under study than just before. Edgeless space continued to specialize as residential, and in terms of intensity it lost 5 points to 66 jobs per 100 active residents, and thus grew its actives surplus from 200'000 in 1955 to 285'000 in 1965, nearly compensating the corresponding imbalance rise of the urban centers and thus confirming the duality of the relationship between centers and periphery.

4.3.1.2. Dynamics: the emergence of dynamical centers

1965 is clearly the first year for which dynamic places ceased to be curious inconsequential things (*Chart 4-25*). There were now 104 units designated as such, against 34 in 1955, and altogether they now grouped 277'000 jobs, against 79'000 in 1955. By 1965, one in ten jobs in Switzerland was held in a place that had grown massively since 1939. Structurally, those places tended to be mid-sized, as their mean established at a bit less than 3'000 jobs each. Structurally, they were of lesser quality than established classical centers, exhibiting a rather low density – 15 jobs per built ha, and intensity – 113 jobs per 100 active residents.

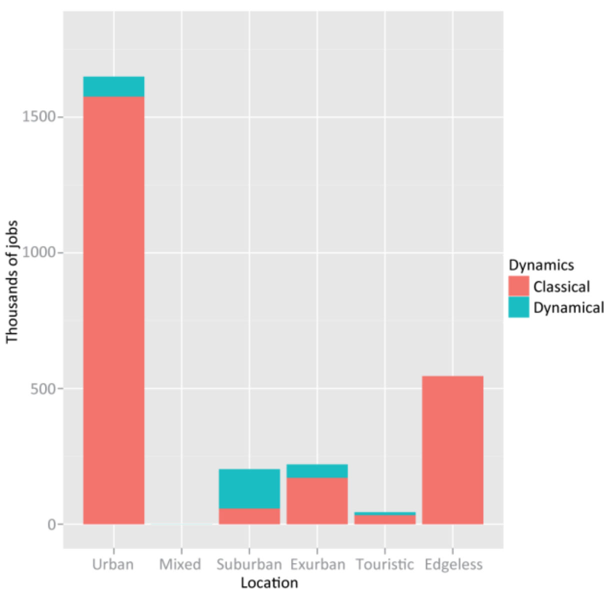


Chart 4-25: Jobs by location and dynamics, 1965

1965 was the age of burgeoning dynamical suburban centers, at a time when the threshold to reach this status was quite high at almost 5% of sustained mean annual growth. Their numbers were up from 12 in 1955 to 35 in 1965, and the number of jobs they hosted went up threefold to close to 150'000, which meant that they also grew in mean size, from 3'450 jobs in 1955 to close to 4'100 in 1965. However, there gains were paid by a certain loss of substance. While density went a bit up to reach 16 jobs per built hectare, intensities went significantly down to just 100 jobs per 100 active residents. This can be explained by the fact that they were emerging, showing strong growth rates but still very sprawling either in terms of density or intensity. A distinct type of place was thus emerging between 1955 and 1965, very different from the classical urban centers, a new category of job centers that were getting big in numbers and even more in area, sprawling, and nondescript as urban places.

The method also detects 45 dynamic exurban centers in 1965 – there were only 11 of them in 1955. Those tended to be far smaller than their suburban counterparts, with a mean size of about 1'000 jobs, even smaller in fact than the 113 exurban remnants. Furthermore, the dynamic exurban centers distinguish themselves by their extremely low density, at less than 10 jobs per built ha to the 13 of the exurban remnants and the 15 of the suburban centers, and their much higher intensity at 130 jobs per 100 active residents, against 116 in exurban remnants and 100 in suburban centers. Dynamical exurban centers were structurally far closer to the exurban remnants, of which they seemed to be a younger version – more sprawling, more intense, and dynamical, than to the big sprawl of the suburban centers.

17 cities were also detected as dynamical centers, 12 more than in 1955. While they share growth with suburban and exurban centers, they share other characteristics with classical centers, namely in terms of density, which, at 21 jobs per built ha, was still not up to the 35 of classical centers, but was much higher than either in suburban or exurban settings, and intensity, where, at 135 jobs per 100 active residents, the dynamical cities were above the classical centers. In 1965 dynamical cities were more cities than dynamic. At the same time, they represented only 2.8% of all jobs: while their importance shouldn't be understated in the category of emerging places, when compared to the whole class of cities, they were still anecdotal.

4.3.1.3. Orientation: a strong spatial division of labour

The industrial domination of the economy all but strengthened during the decade under review (*Charts 4-26 & 4-27*). Industrial centers saw their numbers grow by 43 units to 283, for 210'000 more jobs, such as 922'000 jobs were held in industrial-oriented centers by 1965, 34.7% of the

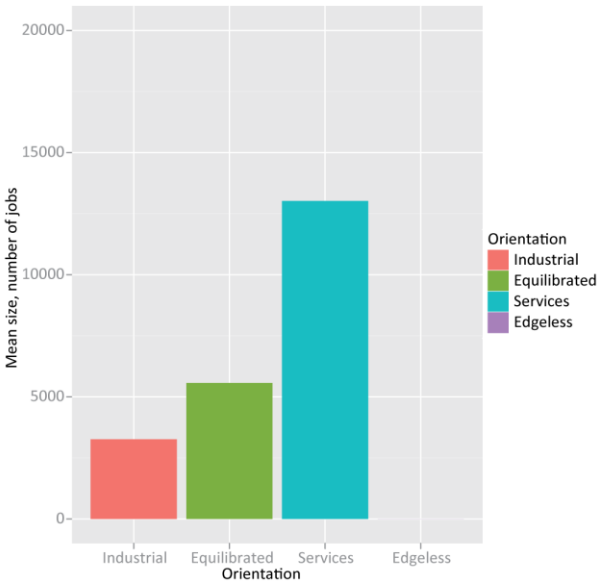


Chart 4-26: Mean center size by orientation, 1965

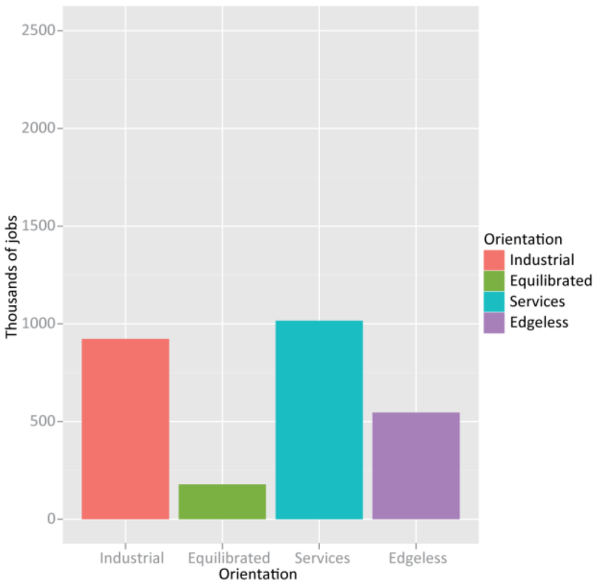


Chart 4-27: Number of jobs by orientation, 1965

total – up a bit from 1955 – and more than double the 1939 tally. Their average size also grew 10%, to 3'260 jobs per unit. For the first time however, they started to show some structural weaknesses, with both their density and their intensity getting sensibly down, 1.3 point at 18.4 jobs per built ha – still a good number for industry-oriented places – and 5 points at 120 jobs per 100 active residents. The 1950s had been industrial, the 1960s remained largely so.

Service-oriented centers numbers also grew during this period, by 15 units to 78, for 240'000 more jobs to 1'012'000 jobs held in such centers. Their job share thus grew even more than the industrial centers, to 38.1% of all non-agricultural jobs. More importantly, they underwent strong structural mutations: their intensity grew 11 points to 127 jobs per 100 actives, while their density shod 4 significant points at 37 jobs per built ha. Meanwhile, their mean size progressed a bit to 13'000 jobs per service center. In 1965 service centers were still formed predominantly of large, central, dense locations relying more and more on commuters.

Between the two the small category of equilibrated centers saw its mean size climb from 5'080 jobs per unit in 1955 to 5'560 in 1965, while its other characteristics fitted it nicely between industrial and service centers, accrediting the idea that they were transitional forms between the two. However, looking at the concomitant growth of both industrial and service centers, it could be said that such transition did not occur, or at least not significantly, between the two categories. Between 1955 and 1965, the center orientations remained broadly untouched.

4.3.1.4. Form: the rise of job intensity

There were marginally more complete, i.e. dense and intense centers in 1965 than ten years before – 172 against 169 (*Chart 4-28*). They were however grouping significantly more jobs, 260'000 to be precise, which translated to a significantly higher mean size than in 1955 – up 20% at 10'100 per unit. This move was somewhat matched by that of the dense centers, which numbered now 32 against 20 in 1955, which grouped twice as many jobs than in 1955 and which mean size also jumped significantly, from 2'870 to 3'560 jobs per unit. Meanwhile, intense-only centers also progressed, but not as much as the two aforementioned categories. In 1965, they held 215'000 jobs – a gain of 55'000 – in 152 centers, 31 more than in 1955. However their mean size hardly progressed and remained very low, at 1'420 jobs per center, which was about the same mean size, as in 1955, than the nil category, those centers exhibiting neither density nor intensity, of which there were now 37 units holding about 60'000 jobs.

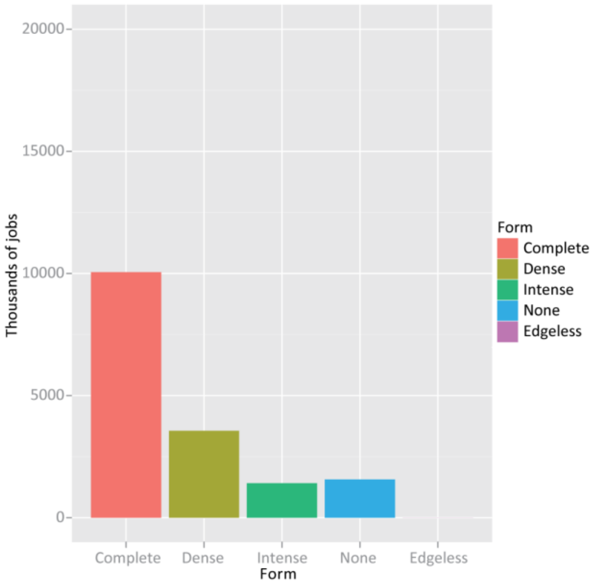


Chart 4-28: Center mean size by form, 1965

Structurally, there were no massive changes except the fact that complete centers intensified markedly, up 8 units at 130 jobs per active residents. In all, dense locations, whether intense of not, were getting bigger, complete centers getting both larger and more intense. Separation between density and intensity continued to grow, density more and more the characteristic of bigger, and probably more internal centers while intensity was the domain of smaller units with lots of space and its workforce in neighboring communities.

4.3.1.5. Size: commuter relations getting more important

The general trend in density between 1955 and 1965 was one of general if slight decrease across all size classes (*Chart 4-29*). By 1955 the middle sized centers had been the most affected, but by 1965 this move had spread, both downwards and upwards, such as the most significant losses were now recorded in the smallest classes, grouping centers up to 1'000 jobs, as well as bigger places, from 8'000 jobs up. Loss of density was also recorded in the biggest centers, signaling a reversal of the trends seen beforehand. By 1965, even the largest centers had started to lose density. This general decrease also meant that hierarchies between centers did not evolve during the period under study, with one glaring exception: during the same time, edgeless space density hardly moved at all, which meant that as in 1939, the smallest centers, those with less than 1'000 jobs, had a density distinctly lower than those of edgeless space. This seems to imply that the smaller centers of the network were strongly specializing into land-hungry specialties.

While density decreased across all size classes, job intensity behaved very differently according to size (*Chart 4-30*). The smaller centers, those with less than 16'000 jobs, saw their intensity decrease, while greater centers saw theirs increase, such as that in 1965 intensity was approximately the same across all center sizes, at about 120 to 125 jobs per 100 actives. This is a rather strange result. The growth of intensity in greater centers signaled that by 1965, big centers had started to rely more and more on commuters rather than on the job force inhabiting the center as it had be the case by then. However the loss of intensity experienced by smaller units is harder to interpret – it may be that many of them, however, were seeing their population grow at least as fast as their economies, which is very probable. Whatever the cause, we can see that by 1965, the old structure where intensity was confined on small places depending on neighboring villages for their workforce while larger centers were hosting their job force had started to be replaced by a more contemporary structure where intensity was at least equal across all center sizes.

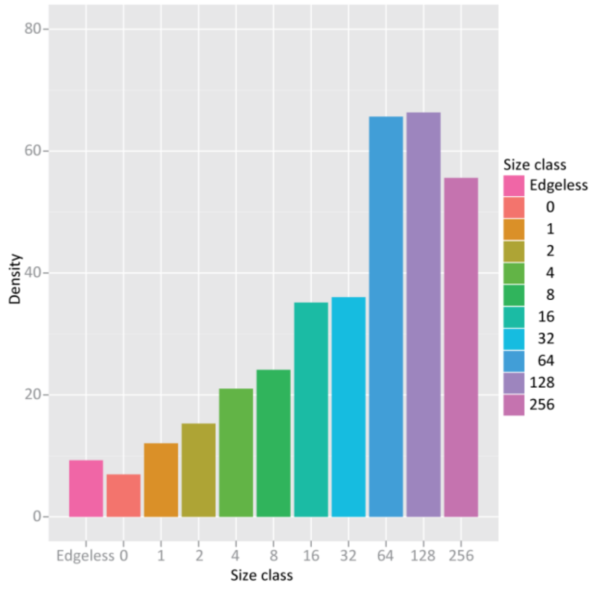


Chart 4-29: Job density by center size class, 1965

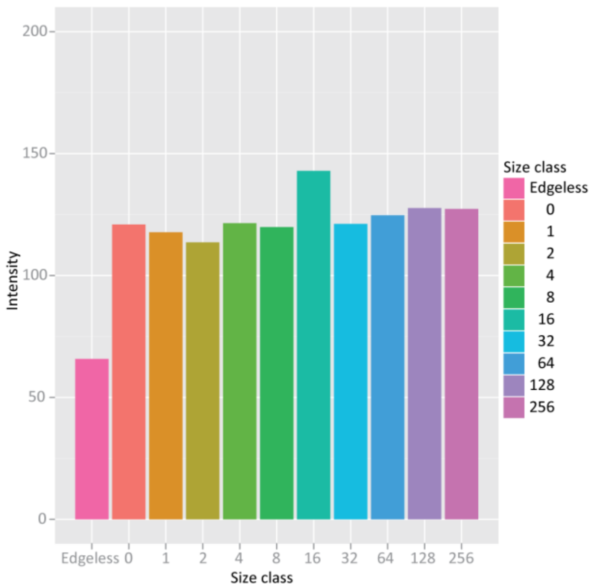


Chart 4-30: Job intensity by center size class, 1965

4.3.1.6. Rank-size and job numbers by size classes: back to Christallerian orthodoxy

The rank-size distribution as viewed by size classes in 1965 gave a surprising result: in all, the distribution, which had departed quite significantly from a Zipf-like distribution in 1955, converged again towards such a distribution by 1965 (*Chart 4-31*). Correspondingly, the top categories, those nine centers above 32'000 jobs, lost some job share, from 35.8% in 1955 to 34.1% in 1965, while spreading through four size classes. Conversely, the four next lower size classes, from 2'000 to 32'000 jobs saw their job share jump from 31.1% to 36.5% in ten years. At first sight, then, the network realigned itself on a Zipf-like rank-size relationship, which points to the possibility that it was getting back to a Christallerian form.

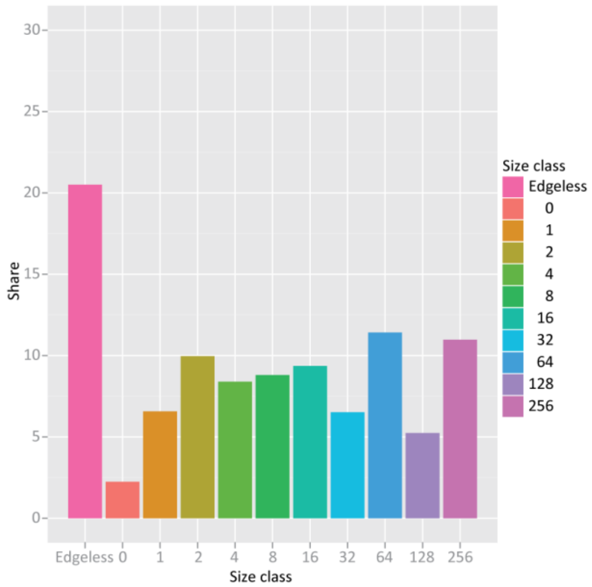


Chart 4-31: Job share by center size class, 1965

Under 2'000 jobs however, the lack of centers deepened during the 1955-1965 decade, further undermining the smallest centers of the christallerian network: with 10.6% of all jobs, the two smallest center classes grouped only half the jobs a pure Zipf-like network would allot them, the lack being particularly clear under the 1'000 jobs threshold. Thus, it may well have been that Christallerian forms were reemerging in the network, but it wouldn't have been a complete resurgence, for it would concern only centers above 2'000 centers. This, in turn, implied that Christallerian structures were maintained at regional or national scales, but were dissolving at local spaces. Local centers were retreating in favor of regional and national ones.

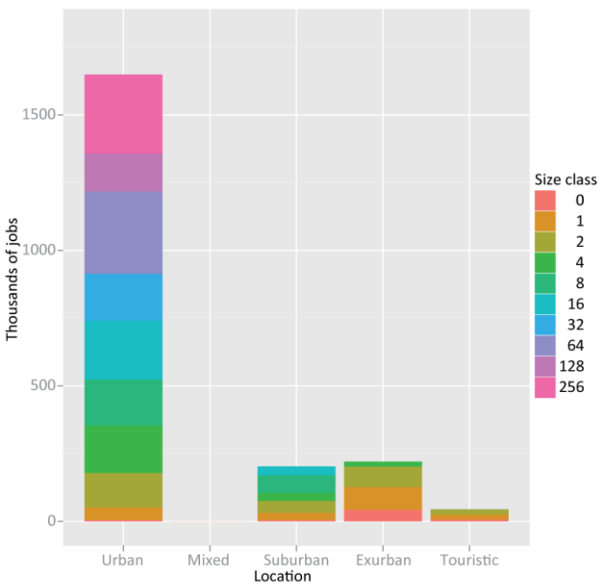


Chart 4-32: Job numbers by location and center size class, 1965

When looking at the distribution of jobs by size class and by location, one can see that at least in urban centers, in 1965 a relatively good equilibrium existed between size classes, except for the two smallest ones (*Chart 4-32*). A comparison between 1955 and 1965 would show that urban centers grew significantly, but only from the top: most of the growth had been brought by urban centers larger than 8'000 jobs, of which there were only 37. Those 37 centers underwent a growth of about 25% during this period, against mere stability for lesser urban centers. However, this growth contributed to equilibrate the network by filling the big gap in mid-sized regional centers that was present in 1955. Thus, the urban center network regained a Christallerian, Zipf-like form by sheer growth. It has to be noted, though, that the urban network remained quite top-heavy, as suburban centers started to count quite a number of mid-sized units, as we will see shortly. In 1965, urban centers above the 32'000 jobs threshold held more than half of all urban center jobs.

Suburban centers also grew predominantly by the top during the same period, with half of the more than 200'000 jobs which they now held in large units, holding 8'000 jobs or more. Likewise, most of the growth of suburban centers were brought by those larger units, although suburban centers grew whatever their size; the growth was about the same in all size classes, thus inflating without modifying substantially the rank-size distribution already seen in 1955, which, however, was already quite top-heavy.

Exurban centers grew largely less than the two other locations during the decade and their size distribution remained largely unaltered. They still were in all very small, with a sizeable chunk of their job share held in units with less than 1'000 jobs, a category in which they were now very dominant.

4.3.1.7. Zipf's law, clusters and superclusters: Superclusters getting big

The study of the rank-size curve for 1965 globally confirms the findings made in the preceding section, that is, the urban network tended, as a whole, to converge back towards a Zipf-like rank-size distribution in 1965 (*Chart 4-33*). Thus departures are less evident on the 1965 graph than on the graph of 1955. In particular, the dearth of jobs in the mid-sized job centers which was noted in 1955 had all but disappeared by 1965, while in the lower levels of the hierarchy the little job surplus observed in 1955 was found again in 1965.

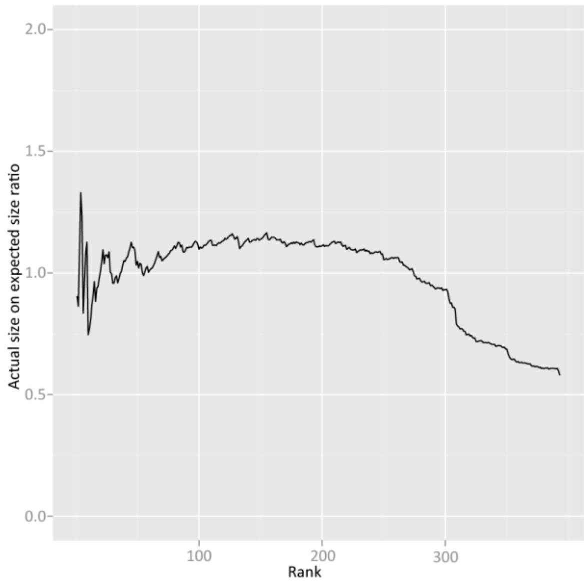


Chart 4-33: Units rank-size distribution compared to Zipf's law, 1965

In conformity with preceding finds, the inflexion point where the dearth of small centers started to be evident still climbed, with a first inflection point at about 1'600 jobs, and a second one, more pronounced, at about 1'200 jobs.

In 1965 differences started to appear between the rank-size curves done at the unit and at the cluster level (*Chart 4-34*). This meant that clusters of suburban and exurban units gained importance in the assessment of the network. In this case, the changes resulted in a rather strong uplift of the curve around the 15'000 to 20'000 jobs mark, meaning that at least several clusters were reaching this size. This bumping of the curve was noticeable down to the 5'000 jobs level. Conversely, lower levels were depleted of the units that had been grouped into clusters and the curve was thus depressed downwards from the 5'000 jobs mark. The inflexion point was situated ever higher, now at the 1'600 jobs level.

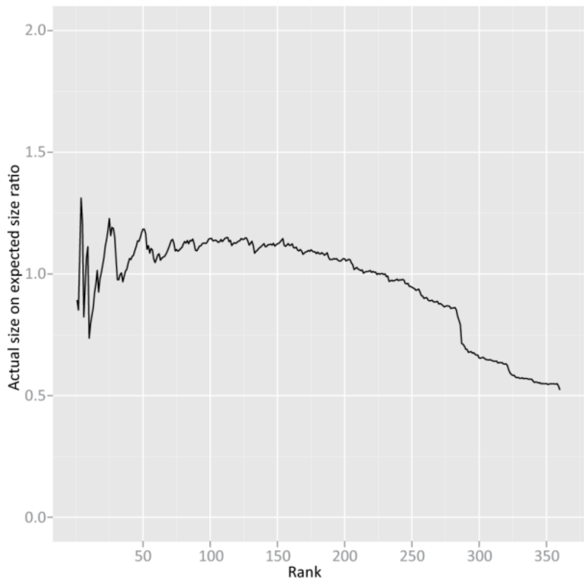


Chart 4-34: Cluster rank-size distribution compared to Zifp's law, 1965

At the cluster level, the distribution by location and size mimicked the one made at the unit level, with an even more pronounced difference between suburban and exurban clusters (*Chart 4-35*). Clusterization had two major effects. First, it took away from exurban centers some units which were clustered with adjacent suburban units, and considered suburban space. Exurban units of

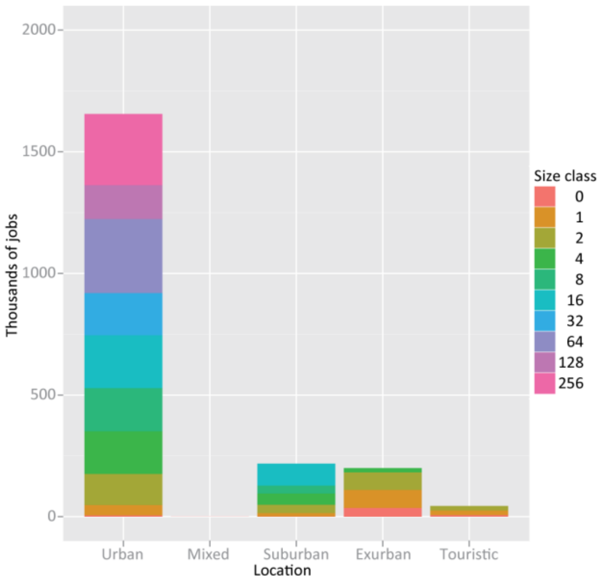


Chart 4-35: Job numbers by location and by cluster size class, 1965

all sizes were concerned and when comparing the two graphs it can be seen that all size classes suffered a diminution of their job numbers. Secondly, clustering occurred above all in suburban space. There was no significant change in the size distribution of exurban centers, whether considered at the unit or at the cluster level, while the difference was indeed major when considering suburban units and clusters, where the top class, those clusters with more than 16'000 jobs, was counting about half of all the jobs contained in suburban clusters. Thus, differentiation between suburban and exurban space was still growing, suburban clusters getting larger and larger, exurban clusters remaining very small and still completing the urban center network at its lowest levels.

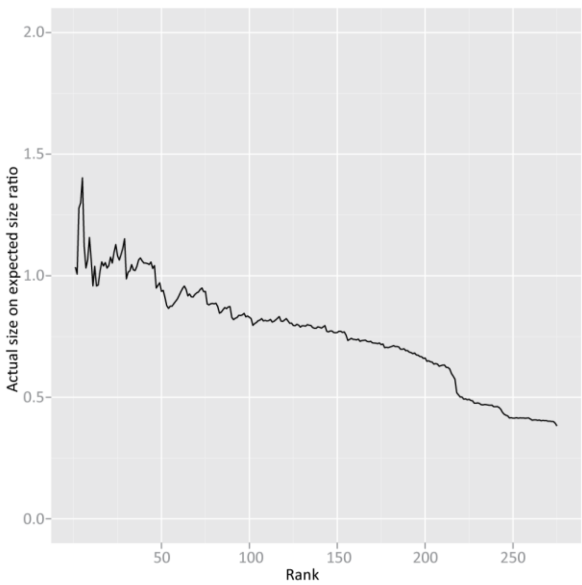


Chart 4-36: Supercluster rank-size distribution compared to Zipf's law, 1965

The rank-size curve considered at the supercluster level in 1965 shows the same characteristics than the one of 1955, only more so (*Chart 4-36*). Except for the two largest superclusters (Zurich and Basle), which size were in line with expectations, the largest superclusters were very significantly larger than expected; this bulge is noticeable down to about the 10th largest city – a limit we have often found up until now in the study of the 1965 census. Conversely, the network seemed depleted of smaller centers and from about the 50th rank, corresponding to about 7'000 jobs, the centers were systematically smaller than expected, this tendency growing regularly when going down to the lowest levels of the network, where centers were of only half their expected size.

4.3.1.8. Aspatial conclusions

The ten years following 1955 can be conceived as a continuation of the trends already seen burgeoning between 1939 and 1955: a general reinforcement of the urban network accompanied by the development of new urban forms. Taken altogether, the urban network of 1965 gained 75 units from 1955, at 393, and in ten years added 500'000 new jobs to reach 2'116'000. The growth rates seen between 1939 and 1955 went on for another decade, which by and large profited to the urban network, which job share rose slightly from an already very high 77.1% in 1955 to 79.5% in 1965. As for the preceding period, the biggest share of the job gains were made in classical centers, but the share that urban centers represented went significantly down: if about 75% of the 1939-1955 gains were registered in classical urban centers, this figure was down to about 60% for the 1955-1965 period; two new jobs out of five were now gained elsewhere. Densities in the traditional urban network remained essentially unchanged from 1955 to 1965, while again job intensity went significantly up, a genuine continuation of the trend already seen in 1955: specialization of cities as job centers progressed unhinged up to 1965.

In terms of structure the classical Christallerian urban network started to evolve a bit. The sheer growth experienced by the network had actually helped to restore a size distribution more alike a Christallerian one as compared to 1955, but at the same time the network went on to lose its smaller units, growing primarily by the top, by the largest cities. Another sign of this is that if the whole network saw its job share progress up to 1965, such wasn't the case of the share taken by classical cities, which went actually down, from 63.1% of the total in 1955 to 62.0% in 1965. Admittedly, the fall is quite small but is significant: it means that classical urban centers had started to lose job shares to other urban forms.

Classical cities didn't lose to edgeless locations up to 1965. Edgeless locations gained only 66'000 jobs between 1955 and 1965, a rather meager share of the 565'000 jobs then gained by Switzerland, and accordingly, its job share diminished again, from 22.9% in 1955 to 20.5% in 1965. At the same time edgeless locations continued to lose heavily in terms of job intensity, which implied a relentless march towards residential specialization for edgeless locations: there were now close to 285'000 more actives residents than jobs in edgeless locations, up from about 200'000 ten years earlier.

The non-urban centers category grew substantially up to 1965 as it had done before, and its job share grew from 14.0% in 1955 to 17.5% in 1965; but the similarities end there between the two periods. Between 1955 and 1965, most of this growth was due to the emergence of big dynamical suburban centers, and they were sole responsible for the small loss of preeminence of the classical centers. Exurban centers stagnated during those ten years. They remained small, while losing density at a fast rate. On the other hand, they managed to maintain their job intensity, which is significant: it meant that during this period, old exurban locations shifted from being dense and intense to being intense only. In a way, they had started to mutate to look more like dynamical suburban centers.

The distribution of dynamic centers per location is telling: while dynamic centers were found in all categories, they dominated in one, that of suburban centers. Amongst them, dynamic centers were in majority, holding the most jobs, and structurally of higher quality than classical suburban centers, which they were supplanting. This sheds light on our previous find, about the fact that structurally suburban centers were not holding their own: it was very possible that it was because they were genuinely emerging places.

In other location types, though, dynamic centers started to make a difference, holding 73'000 urban jobs, and 50'000 exurban ones, close to a third of the exurban total.

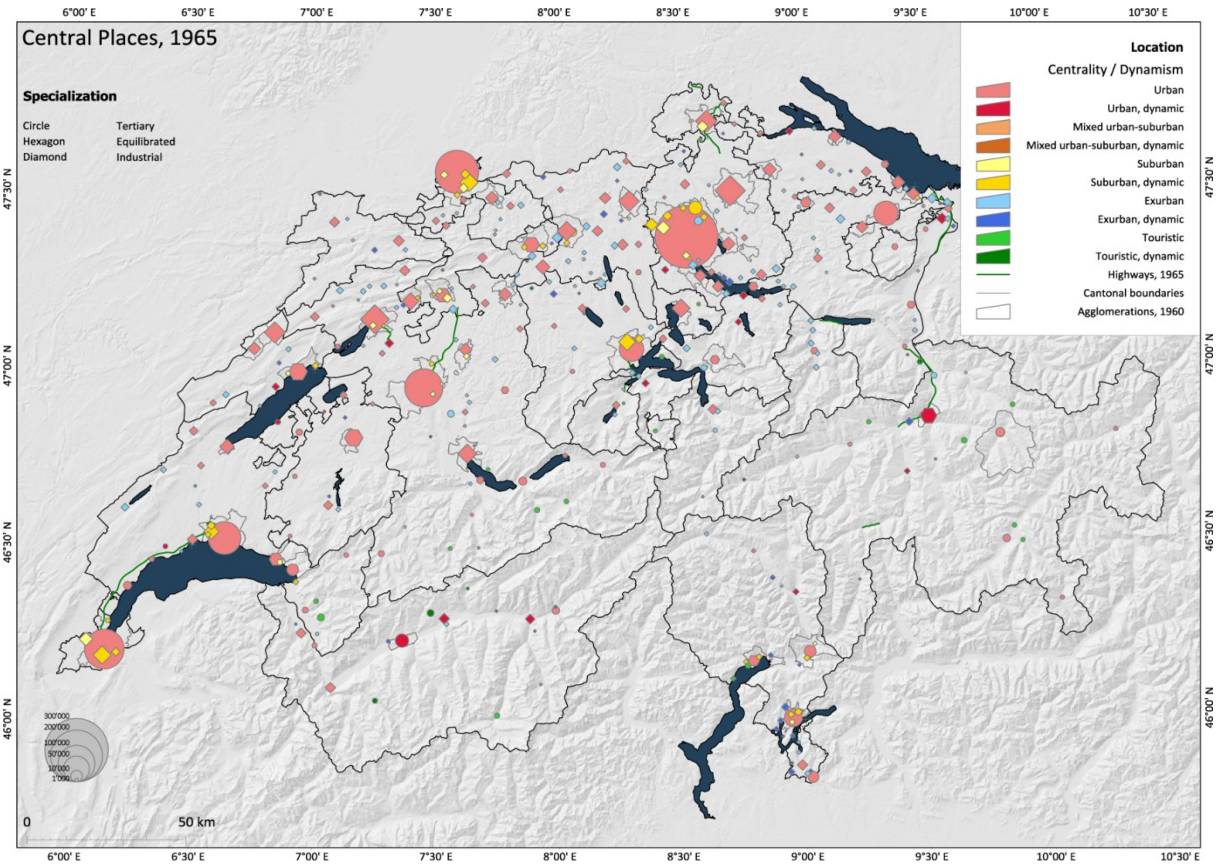
The economy attained an industrial optimum by 1965, with close to three quarters of all centers being dominated by the secondary sector – however, structurally, industrial centers were starting to show signs of weakness. At the same time, service centers, although few, were getting far bigger such as they grouped still more jobs than industrial centers.

All things being equal, 1965 still looked a lot like 1955: a towering Christallerian urban network was still very much in place, reinforcing itself and lording over a slowly decaying array of exurban remnants coming from the previous century. The network showed the growing poser of bigger centers as compared to the lowest levels of the hierarchy, which were clearly depleting, as if the range of goods was such that bigger centers could start to compete with local ones for even the most basic goods. Likewise, things were starting to happen, notably in the suburban realm, where a new category of big, sprawling objects had overrun the very few remnants of centuries past, and which job numbers weren't negligible anymore.

4.3.2. Spatial patterns

4.3.2.1. The urban network pattern: an optimal network

On the map, the 1955-1965 period is clearly one marked by two complementary phenomena: one of sheer growth of existing units, as well as one of apparition of new units (*Map 4-8*). These characteristics are very much alike those already noted for 1955 and in that sense there was a clear continuity from the end of WWII and 1965.



Map 4-8: Central places by size, location and orientation, 1965

As before, bigger centers tended to profit more from the growth than smaller ones. All major cities significantly grew between 1955 and 1965, the growth being particularly spectacular in non-industrial regions. Thus, Geneva, Lausanne and Berne grew more than Zurich and above all Basle. The same can be seen at the next lower level, with service-oriented cities like Neuchâtel, Lugano or Zug growing more than industrial ones like La Chaux-de-Fonds, Winterthur or St-

Gallen. In fact the same conclusion can be made at all levels of the urban centers, in a systematic way service centers tended to grow more than industrial ones.

The network as a whole counted 75 more units in 1965 than in 1955; but very few of these new units were urban centers; most of them were either exurban centers, or suburban ones. The few new urban centers which appeared during the 1955-1965 period were small local centers of peripheral or rural regions – Aubonne, Châtel-St-Denis, Courtelary, Affoltern am Albis, Diessenhofen, Faido –, apparitions very much like the ones having happened before 1955, and as such a continuation of the completion of the urban network structure. Most of those new centers were of course very small in size. Many exurban centers also appeared during this period, although many others disappeared. Looking at the map, it was difficult to understand what differentiated the appearing centers from the disappearing ones – especially in rural and peripheral areas they looked distinctly similar. In the rest of the country apparitions generally signaled the emergence of industrial villages – Lucens, Steg VS, Tramelan, Triengen, Birr-Lupfig…–, the location of which showed a propensity to colonizing formerly devoid areas such as the western Mittelland plains or mountainous areas. Ticino proved to be a case of its own, with a sudden and massive emergence of exurban centers situated just outside agglomeration limits, and which looked a lot like suburban centers elsewhere.

In general, at this stage, it is difficult to link that find to a natural development of the Christallerian network or if those emergences were just the result of companies choosing to locate in new places rather than to restructure existing places. The fact is that there wasn't a progression of the network in densely urbanized places, whilst there was in outlying areas.

Many new centers were of the suburban form, which is certainly not a Christallerian result. Most of the growth happened around major centers, all of which, except Berne, saw their suburban centers grow explosively. Geneva added a third center, Chênes, and a fourth, Versoix, to its two booming ones of Carouge and Cointrin; Lausanne saw a third unit, Ecublens-Chavannes, join Renens and Crissier-Bussigny. Berne saw the emergence of its third – small – suburban center in Moosseedorf, contemporary to the advent of the highway in this sector in the late 1960s. In Basle, Birsfelden and Reinach BL joined Schweizerhalle, Münchenstein and Allschwil, in Zurich Rümlang and Dietlikon appeared around Kloten, while in Dietikon the Limmattal saw the emergence of a second pole along Schlieren, as in the Furttal, Regensdorf burgeoned. But such massive sprouting seemed to be limited to those four cities, with the possible exceptuion of Lucerne, which already sported a massive suburban center in Emmen and which added a second one in Ebikon by 1965. Most of the other units were either already existing, or still very small. Of note are new apparitions around Vevey and Montreux (one each), and Biel (Brügg). Very generally though, new suburban centers were to be found most likely around the largest centers of the country.

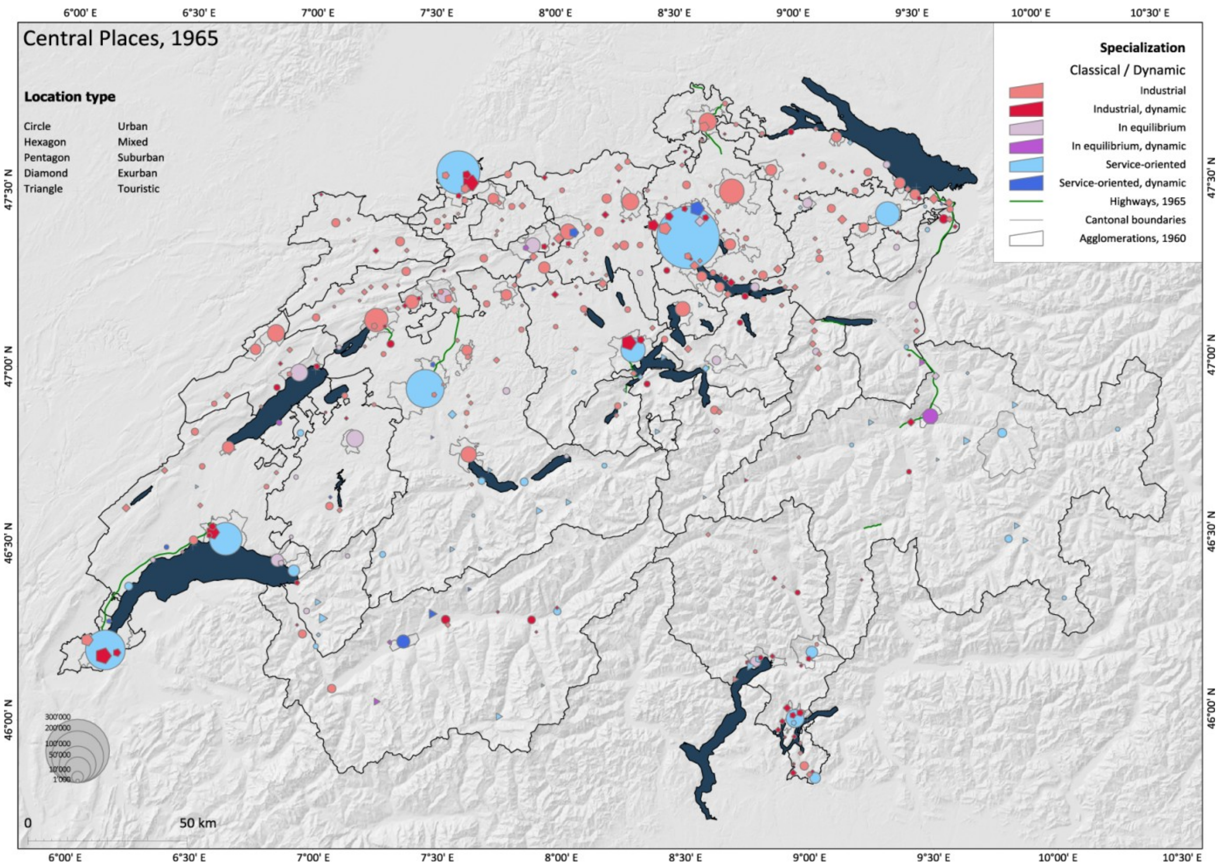
4.3.2.2. Center-periphery patterns at the national scale: perturbations of the Christallerian order

1955 to 1965 was clearly a prolongation of the preceding period with regard to the center-periphery patterns: a concomitant move of centrality reinforcement through sheer growth of the major centers, and a penetration of areas formerly devoid of urban centers in the peripheral and rural areas. As such, the Christallerian network seemed to be reinforced, at least in its territorial foundations. As we have seen however, it was starting to get seriously out of balance in terms of rank-size distribution, with big centers getting bigger and small units slowly withering away.

On top of those developments, suburban centers developed in a way that was perturbing the classical Christallerian network by adding sizeable units very close to existing major centers. Those emergences couldn't be reconciled with classical Christallerian theory, unless considered as extensions of those centers, a way to consider them that we in fact study when creating superclusters. But barring that possibility, a Christallerian view of the urban network couldn't be complete anymore by 1965.

4.3.2.3. Differences according to agglomeration size: service centers getting bigger

As we have already seen, there is a very strong dependency between agglomeration size and the size, number and growth rate of suburban centers. By 1965, suburban centers were clearly reinforcing the upmost levels of the urban hierarchy, concentrating a large majority of its new jobs on just seven agglomerations. As without their contributions, the urban network was already top-heavy, the fact is that the development of suburban centers around greater centers further deepened imbalances between great and lesser centers in the network. From this vantage point, Christaller was less and less respected.



Map 4-9: Central places by size, orientation and location, 1965

1965 really represented the pinnacle of industrial dominance in the Swiss economy (*Map 4-9*). The strong growth observed since 1955 benefited both sectors equally, which meant that by and large former structures were not fundamentally modified by it. However, most dynamical centers which emerged during the decade were indeed industrial, as notably were most suburban centers. Thus, it was as if structural labor division was at play in larger centers, service activities dominating the downtowns and urban centers, while industrial activities relocated in the suburbs. In many places that was exactly what was happening.

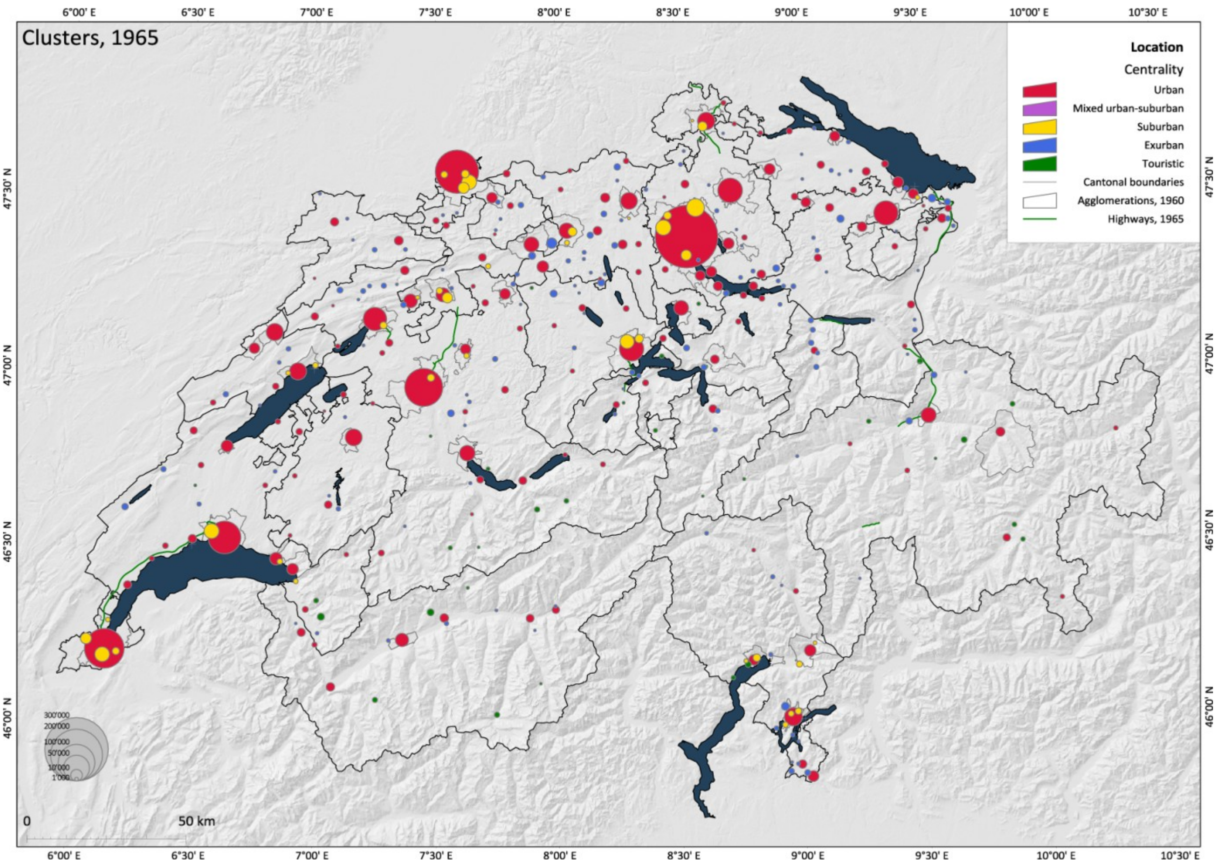
Worthy of note were several counter-examples: Kloten was already dominated by transport activities, while commercial ones were dominant in Buchs-Suhr off Aarau, and in Moosseedorf north of Berne.

4.3.2.4. Regional patterns: pleniutude and breathlessness of an industrial optimum

In the subject of regional differences as for others, the period under study seemed to be a continuation of the preceding one, with extensions of the urban network in formerly rural and peripheral areas. However, a keen eye could see new discriminations creep in. In particular, urban growth was not happening everywhere with the same strength, and industrial regions clearly lagged behind "new" urban regions in that regard. In particular, this was a rather somber period for Eastern Switzerland, where hardly a city showed strong growth, and where no suburban center emerged. The same happened in the Jura Mountains and in an attenuated way in Aargau where the exurban center network appeared very fragile. Conversely, former rural areas were urbanizing fast, notably in and south of the Alps, along Lake Geneva, and in formerly very rural cantons like Vaud, Fribourg, Berne, Lucerne and the whole of Central Switzerland, as it was also favoring the immediate outskirts of major cities, particularly around Zurich. Development was clearly favoring "new" places against old ones. Whether this was a catching-up effect, or the sign of a real shift in prominence remained to be confirmed.

4.3.2.5. Mapping clusters and superclusters: the very selective emergence of suburban clusters

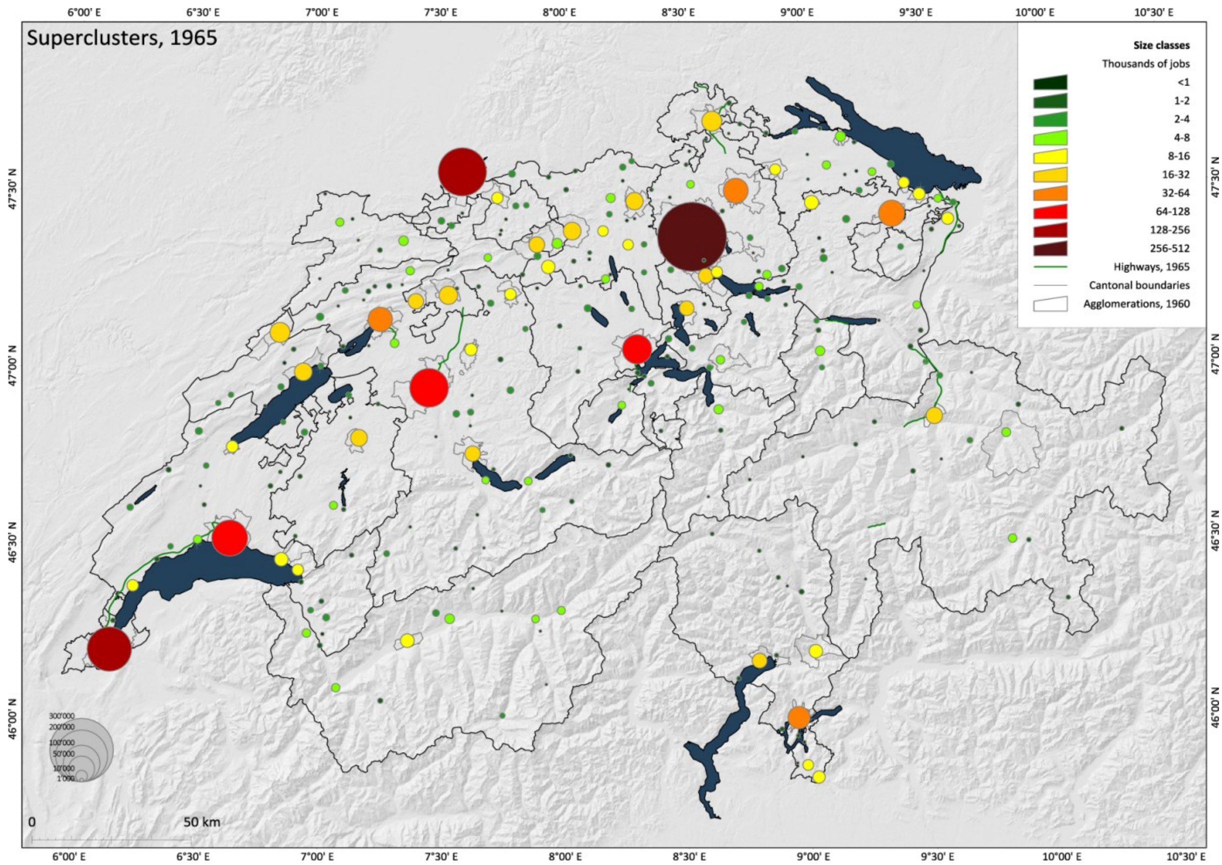
Clustering mainly suburban units in 1965 allows us to distinguish the major concentrations of non-central job centers (*Map 4-10*). Not surprisingly, those appeared and prospered above all,



Map 4-10: Clusters by size and location, 1965

even exclusively around the six major centers of the country. The biggest cluster of the country with 23'600 jobs was in the Glattal, around the Kloten airport. Zurich sported a second major cluster in the Limmattal, with 17'300 jobs. Both those clusters had more than doubled their job numbers since 1955. Othe major clusters included Carouge-Praille with 16'100 jobs, Western Lausanne with 16'600 jobs, Schweizerhalle with 16'300 jobs, and Emmenbrücke with 14'500 jobs. As we already pointed out, major clusters were limited to major centers and no suburban cluster elsewhere could match the numbers we already mentioned. That being said, some lesser centers sported considerable suburban clusters, like Solothurn, which stagnating but big cluster was already mentioned in 1955, and which counted close to 7'800 jobs, Schaffhausen with the 4'500 jobs hosted in Neuhausen, and Aarau, which gained a cluster in Buchs which counted 5'700 jobs. But for one center which sported a subcenter in 1965, many centers, indeed the vast majority of them, did not. That is certainly telling something about the quality of the places where those subcenters concentrated: the biggest places of the country.

That the clusters were, well, clustering around major centers only meant that those centers would progress even more as superclusters than as units (*Map 4-11*). Accordingly, all major superclusters progressed greatly during the period under review, while in general terms the rest of the network didn't follow. There were exceptions, of course, to this no progress rule, and some lesser superclusters and regions fared better. The most striking progresses were made in Ticino, where the entire urban network sprang into life. The same phenomenon was visible in the Alps, with the impressive rise of Chur as Southeastern Switzerland undisputed center, as well as the concomitant rise of several cities in Valais. Elsewhere, growth was more muted, and more disparate. Several superclusters underwent massive rise, like Lucerne and Zug in Central



Map 4-11: Superclusters by size, 1965

Switzerland, Grenchen in the Jura piedmont. However, entire regions do not show such growth, the most important of which being Eastern Switzerland which hardly saw anything grow big between 1939 and 1965, or Aargau, perhaps more understandably as it was by far the most urban region of the country in 1939. In Western Switzerland, Geneva and Lausanne grew strongly but still quite alone, which furthered the imbalance between the two centers and their local and regional network. These finds could be extended in fact to Berne – especially in the Mittelland and Oberland parts of the canton – and Lucerne. In other parts of Switzerland the Christallerian structure held up better at the upper and mid levels, which is illustrated by the general rise of the urban structure of regional importance in German-speaking Switzerland, and the emergence of such structures in the Alpine cantons and Ticino.

In all, though, the growth seen at the upper and middle levels of the urban hierarchy wasn't replicated in the lower levels. Imbalances seen in western Switzerland between the upper and the middle levels of the hierarchy were seen in the rest of the country between those middle levels and the lower ones. Everywhere, the dearth of small centers to accompany big and rising centers was becoming evident.

4.3.2.6. Territorial conclusions: the urban optimum and the early signs of its demise

1965 probably marks at the same time the apex of a certain territorial organization of the country, and the first real evidence that profound restructuring was under way in its territorial organization.

The lecture of the maps clearly points to an apex for the Christallerian network. Again, the largest centers were growing and asserting their weight on the whole network. The upper part of the Christallerian network seemed to hold its own quite well, either looking at units, or at superclusters. However, when looking at statistical elements of this network, things started to look distinctly awry. First of all, the urban network failed to gain much new units by 1965. Moreover, the whole system looked more and more top-heavy, with small centers stagnating or decaying while the upper levels of the hierarchy grew explosively. Most of the centers went through a growth period, and in general, cities grew. What is remarkable is that they were not followed by new urban centers destined to occupy the lowest ladders of the Christallerian network. Thus, the whole network grew by getting larger units, but it failed to replicate at lower levels. It is as if it was now suspended in the air.

Meanwhile, exurban centers showed instability. While their numbers progressed, there were extensive changes in the list. All factored, the changes to the parallel network of exurban centers were extensive. Furthermore, they do not show a reinforcement of this network, despite the growth period Switzerland just experienced. In all, these variations showed signs of frailty. Most of the exurban centers remained very small, with just one attaining 5'000 jobs (Schönenwerd). Eastern Switzerland seemed the most affected by disappearances, notably in Toggenburg, and for the first time many exurban centers started to appear in predominantly rural or alpine regions. The most significant threat to the Christallerian order was the massive emergence of edge cities. Dynamical suburban centers completely replaced traditional ones in the urban landscape, quadrupling their share of the total jobs. In all, dynamical edge cities, either by internal growth or by emergence of new units, grew by about 13% annually during the decade.

In all, the situation in 1965 with regard to general structures and evolution seemed to be twofold. On the face of it, the map seemed to show a reinforcement of the Christallerian network.

Clearly, the biggest cities grew bigger. However, the lower levels of the urban hierarchy stagnated. Under the 5'000 jobs threshold, cities numbers started to decline, and the structures started to decay. Meanwhile, units outside the Christallerian network prospered, either the exurban units with an all-included job growth rate of 3% per year, or of course the advent of suburban centers, with their explosive growth. In terms of territorial distribution, the 1955-1965 period was one of a general equilibrium and stability. In parallel, growth portended a return to some Christallerian stability, and formerly non-urban regions were able to build a regional network and thus join urban Switzerland. But imbalances were present. While the industry was clearly at the helm of a still booming economy at the time, paradoxically the growth was far more potent outside industrial Switzerland – the service centers, rural plains of Western and Central Switzerland, the Alps and Ticino – than in the industrial heartland of Jura, Aargau, Zurich and Eastern Switzerland. Thus subtle imbalances appeared in the back end of a very strong and long period of growth, which woukld become plainly visible afterwards.

4.4. 1975: the fall of industry

4.4.1. Aspatial results

4.4.1.1. Location and centrality: urbanity challenged

The 1975 census showed that massive changes had happened in the urban network in the years preceding it, and that 1975 (or more likely 1973-1974) represented a turning point in the urban history of the country (*Chart 4-37*). The shock was very brutal as it probably happened on less than three years out of the ten separating the two censuses. First of all, about one in eight urban units disappeared from the network, leaving 342 urban units in 1975 against 393 ten years earlier. Those 342 urban units grouped a bit less jobs than the then 393 urban units did in 1965, down 75'000 jobs to 2'042'000 jobs. However, during the same period the total number of jobs in Switzerland actually grew a little, which means that as a whole the urban network took a beating during those years. In fact, the single most important movement of this period is the steady decrease of the urban network job share, from 79.5% in 1965 to 75.4% in 1975, and the corresponding big rise of the edgeless locations, from 20.5% to 24.6%, and from 546'000 to 666'000 jobs.

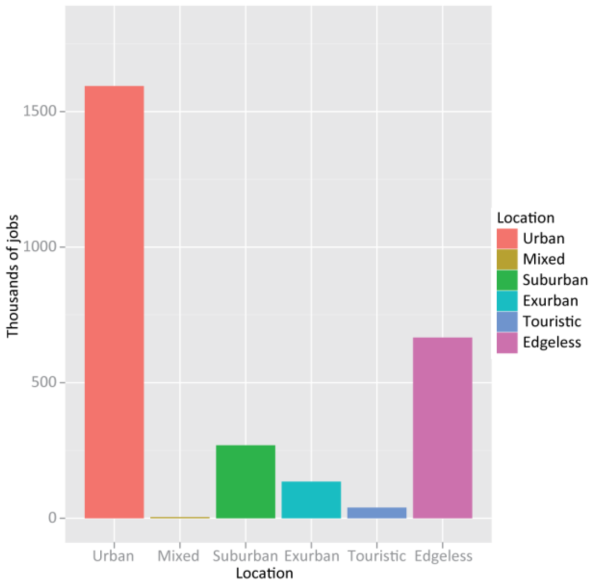


Chart 4-37: Job numbers by location, 1975

Urban centers suffered significant losses in the 1973 oil shock. They lost 11 units and more than 50'000 jobs during this period, while their job share plunged to 58.9%, down from 62.0% in 1965 (*Chart 4-38*). Most of the lost units were small: the jobs losses represent about 5'000 jobs per unit lost, with a resulting network of cities which mean size actually grew from less than 10'900 to 11'400 jobs per city. There are three ways by which a place could lose its center status: by dropping below the threshold, by losing enough job density and by losing enough job intensity. Clearly, the fact that above all small units were affected by the cut shows that the size effect did play a role. However, a survey shows that for the most part, the casualties did not drop from the urban network because they had become too small: they dropped from the network because they were not urban enough anymore, losing essential ground in terms both of

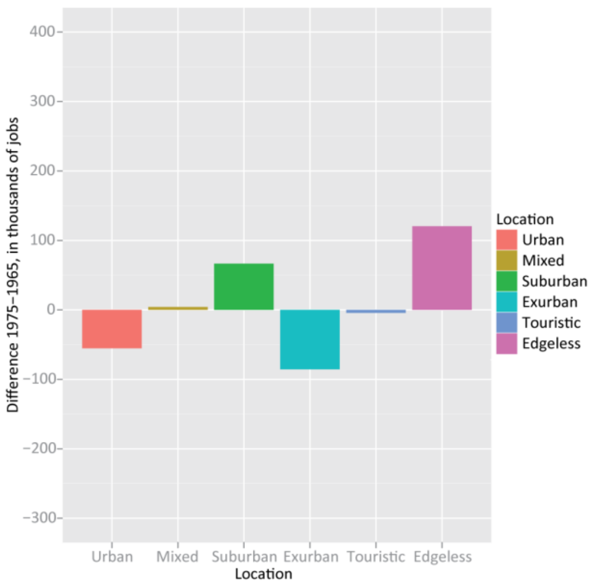


Chart 4-38: Job numbers difference by location, 1975-1965

density and of intensity. The urban centers which remained, though, saw relatively few changes. Their job density dropped significantly from 34 to 31 jobs per built ha, a clear testimony of the job losses they experienced. At the same time, their overall job intensity actually rose from 128 to 131 jobs per 100 active residents. In that sense, it can be said that by shedding essentially weak units, the urban network certainly became slimmer, but without losing much substance. What they lost, and for the first time, were active residents: the urban network of 1975 counted about 57'000 less active residents than in 1965, a drop more profound than the job losses. As well as slimming down, urban centers were slowly specializing as job centers.

The biggest casualties of the 1973 oil shock and crisis were the exurban centers. Exurban centers lost one third of their members and about 35% of their jobs between 1965 and 1975. In terms of raw numbers their job losses, at around 85'000 jobs, are similar to the ones registered by classical centers, but in terms of relative importance the effect of the urban network is essentially that as a relevant category, exurban centers disappeared from the urban network in 1975. A quick survey shows that for the most part those exurban remnants that went out of the urban network at this time went down on all three counts: as they were very small to start with, any significant job loss was susceptible to get them under the job threshold. The same reasoning can be made concerning the job intensity numbers, which in most cases went also down sufficiently to cross the 1 job per active resident mark. Last, their job density was already very low in 1965 and could not be counted upon to remain in the urban network. That being said, all exurban centers suffered greatly during these times. Their mean size – from 1'300 to 1'200 jobs per unit –, their mean density – from 12 to 9 jobs per built ha – and their mean intensity – from 119 to 112 jobs per 100 active residents – all went significantly down during the crisis. It is as if they were suffering a fatal blow and starting to disappear.

Suburban centers weren't as affected by the shock than other categories. Their numbers grew 8 units to 61 in 1975, admittedly a small growth, while their job numbers gained 66'000 units in ten years – to be compared to the 45'000 jobs gained by the whole economy. Of course, their job share progressed greatly, from 7.6% in 1965 to 9.9% in 1975. Clearly, suburban centers showed great resilience during the economical crisis; however they paid for it in terms of structure. Their mean size grew to a bit above 4'000 jobs per unit, and their density remained stable at about 16 jobs per unit; however, their intensity went significantly down to only 95 jobs per 100 active residents, which means that as they developed as job centers most suburban centers were also developing as residential places. In any case, they weren't contributing significantly to the job imbalances that the country had to cope with. Job centers they were becoming, but still just accommodating the job needs of its own workforce. Conversely, they were now clearly ahead of exurban centers as the most significant center category after the urban centers. And they still had a positive dynamic.

As already said, as scores of cities and exurban remnants exited the ranks of the urban network and became edgeless places, the edgeless realm saw a great progression of its numbers, both absolute and relative. It can certainly be said that in terms of urban form, economic crises do profit the edgeless, unorganized, non-urban places. One could have anticipated that the incorporation into edgeless space of about sixty just demoted cities, much denser and more intense than outlying edgeless space, should have strengthened the edgeless space as a whole. But that wasn't the case: during the 1965-1975 decade, edgeless space suffered dramatic losses both in density from 9.3 to 7.5 jobs per built ha, and in intensity, from 66 to 57 jobs per 100 active residents. In fact, even if it grew as a job place, edgeless space grew even more as a specialized residential space. As a result, even with the job growth it experienced during the decade, the imbalance between jobs and active residents in edgeless space exploded from about 284'000 in 1965 to a staggering 497'000 in 1975.

4.4.1.2. Dynamics: the death of the suburban and exurban remnants

For the first time in 1975, there were striking, massive differences between classical and dynamical places (*Chart 4-39*). As we just saw, urban and exurban centers went clearly down, while suburban centers still showed some progression. But this observation should be mitigated by their dynamic status, for in all three categories, dynamical places actually saw their numbers grow.

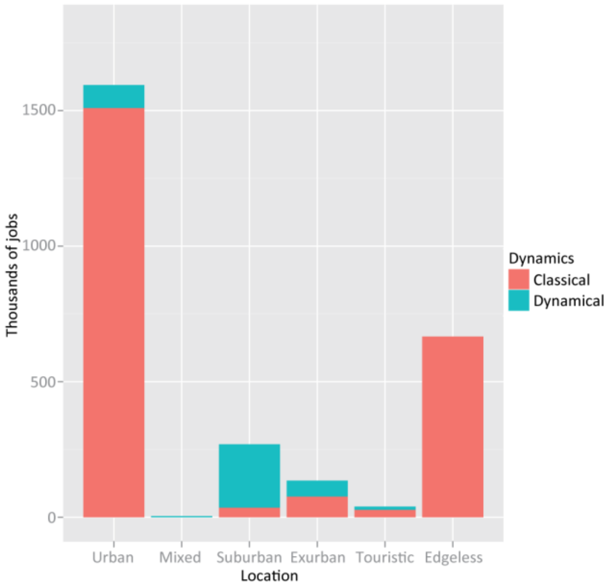


Chart 4-39: Jobs by location and dynamics, 1975

Dynamical urban centers still represented only a small part of all urban centers, but they had maintained their numbers. They tended to be far smaller than established ones, accrediting the idea that dynamical urban centers were to be found primarily in smaller units. Their mean size was very similar to that of suburban centers, a remark also truer of their structure: by 1975, dynamical urban centers looked a lot like suburban centers.

Dynamical centers were already the dominant suburban center form in 1965, and by 1975 they were close to be exclusive. Of the 61 suburban centers, 50 were now dynamical, and they hosted close to 85% of the jobs hosted in suburban centers. Dynamical suburban centers gained 89'000 jobs during this decade, double the national total, while classical suburban centers lost close to half their units and one third of their jobs. Likewise, while as a whole exurban centers were severely affected by the crisis, but not the dynamical category, which saw its numbers grow slightly. By 1975, there were almost as many dynamical exurban centers – 47, than there were classical ones remaining – 60, they were grouping almost as many jobs. Structurally they were very different than classical exurban centers, both less dense and more intense. Thus, there were now two distinct populations of exurban centers: the classical one, dwindling fast, showing relatively high densities and low intensities, which pointed to self-contained dense places, and a second population of new growing exurban units, being rather intense but not dense at all, pointing to land use intensive activities – warehousing comes to mind – and drawing their workforce from nearby places.

Thus, the following conclusions can be made: 1975 is clearly the first census for which dynamic places ceased to be curious inconsequential units. Most of this growth is to be attributed to dynamical suburban centers. Behind classical cities, dynamical suburban centers were now replacing the exurban centers in second place in terms of significance in the urban network. At a time where all other urban categories were losing ground, dynamical suburban centers grew, in numbers and in size. In terms of substance they also held their ground quite well, actually increasing a bit their density at about 18 jobs per built ha, while losing some ground in terms of intensity, at almost exactly one job per active resident, down from 1.04 in 1965. Clearly, the suburban center ranks were growing above all by the addition of units that were growing to become centers but weren't quite there yet, a fact that was also helped by the fact that the growth threshold to be considered dynamical in 1975 was significantly down at a bit less than 3% of sustained annual growth, against 5% for preceding periods.

Besides the clear emergence of dynamical suburban centers, the fact that it was suddenly very easy to distinguish between dynamical and classical centers meant that besides dynamical suburban and exurban centers, there was a class of suburban and exurban objects that shared the location, but not the dynamics, and not the structures of their successful neighbors. Those were the classical suburban and exurban centers, probably inherited of earlier times, remnants of another age, of an industrial age that was starting to recede, and by 1975 they were retreating very fast and very brutally. Up until 1965, suburban and exurban remnants had held their own quite neatly, but they were the chief victims of the 1973 economical crisis. For the most part, from 1975 on, the suburban and exurban units that are in the network were new.

4.4.1.3. Orientation: the end of the industrial age

1975 marked the end of the industrial age and correspondingly, nowhere are the changes more evident than when looking at the centers economical orientation (*Charts 4-40 & 4-41*). Industrial centers lost more than a third of their numbers – from 283 to 181 – and about 390'000 jobs between 1965 and 1975. Whereas in 1965 they were on par with service centers in terms of job numbers, by 1975 their job numbers were down to a bit more of a third of those of service centers. Furthermore, their other characteristics were also going down: their mean size decreased – although of only a small amount – and they lost both job density, from 18 to 15 jobs per built ha, and intensity, from 120 to 109 jobs per 100 active residents. Industrial centers lost massively in absolute numbers, and significantly on structural qualities. They were going down.

Meanwhile, service centers went the other way. They gained 51 units to 129, getting closer to

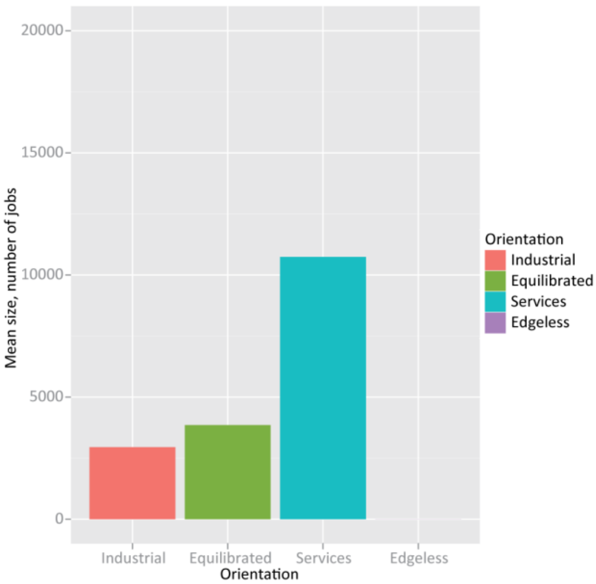


Chart 4-40: Mean center size by orientation, 1975

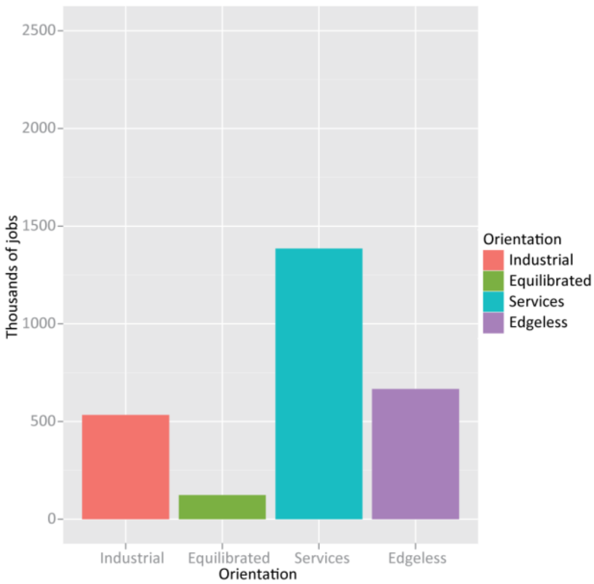


Chart 4-41: Number of jobs by orientation, 1975

the number of industrial centers: when there were only one service center for four industrial ones in 1955, they were now two for three. They gained 370'000 jobs to 1'385'000, and gained a little in intensity. However they lost in mean size and in mean job density, an effect of the arrival in the service center class of smaller and less dense units which were dominated by industry since then. The fact is that the changes that went in industrial and service centers were symmetrical, hinting at a massive transfer of centers from industrial domination to a service orientation. The intermediate category – the equilibrated centers – underwent massive changes in structures but not in numbers; bigger, denser centers had been replaced by smaller, sparser ones, another clear hint of a transfer of centers from industrial to service-oriented, besides an absolute loss of centers which was entirely supported by industrial centers. In all, industrial centers lost on both sides: they lost centers to edgeless space – real disappearances – as well as to equilibrated and service centers.

4.4.1.4. Form: a general loss of urbanity

1975 marked a major decrease in urban quality of centers, and this shows clearly when studying the central places network from the perspective of its form (*Chart 4-42*). Complete centers – dense and intense ones – saw their numbers practically halved, from 172 in 1965 to 97 in 1975, and they lost more than 250'000 jobs to 1'475'000. They still represented more than half of all non-agricultural jobs, but they had lost more than 10 percentage points of job share since 1965, down to 54.5%. The centers which remained complete were larger, denser and more intense than in 1965, pointing to the fact that the units which dropped from the complete category were the smaller ones.

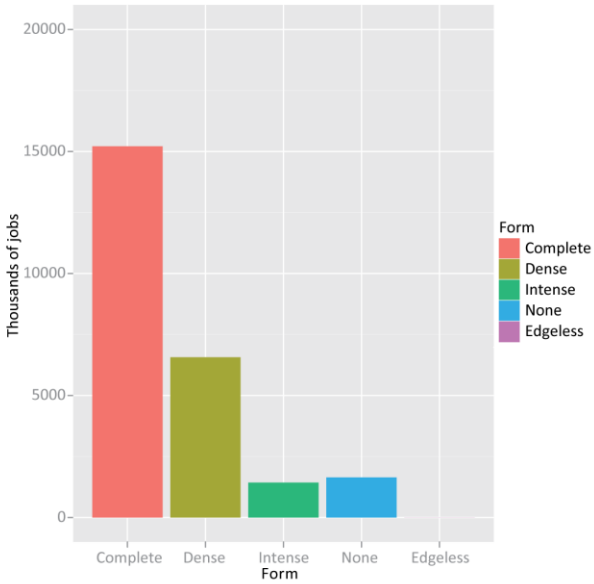


Chart 4-42: Center mean size by form, 1975

An important part of the centers which dropped from the complete category remained dense enough to be included in the dense category. The number of such centers actually grew seven units to 39, while its job share more than doubled to 9.5%, representing 256'000 jobs. Correspondingly, the mean size of those dense units jumped, from 3'560 jobs in 1965 to 6'560 in 1975, which hints at the idea that they were receiving former big complete centers that had lost their intensity during the crisis.

Intense-only centers felt the economical crisis but rather modestly, by losing units. Their job share dipped a bit, but enough to get overcome by dense centers. Structurally there were no big changes between 1965 and 1975 for this category of smaller units, which means that they were not principally constituted by industrial centers; those tended to be small but complete centers.

4.4.1.5. Size: from ashes the rise of major centers

The trend in density between 1965 and 1975 was one of a rather sharp drop, mostly due to the sudden job losses experienced by the industry which left large areas half-empty of their workforce (*Chart 4-43*). This sharp loss was felt in most size classes, as it was in edgeless space. This general retreat was quasi-linear across the board, and the loss being about 2 to 4 jobs per built

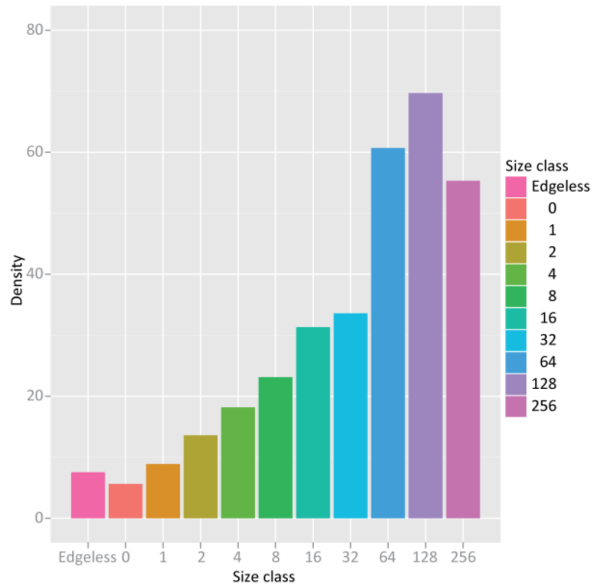


Chart 4-43: Job density by center size class, 1975

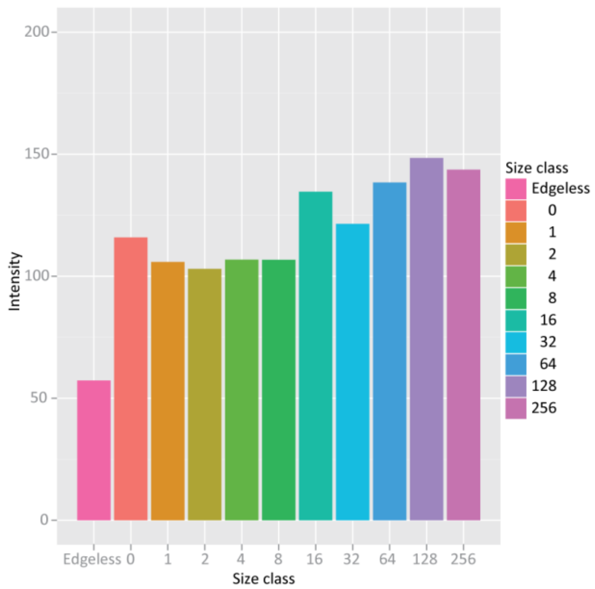


Chart 4-44: Job intensity by center size class, 1975

ha. As job density was very dependent on center size, the effect was far bigger in smaller centers, where this share represented a sizeable chunk of overall density, than in larger ones. Besides, the two largest centers saw their job density actually rise during these times, which points to a further discrimination in the urban network in favoir of those two centers, Zurich and Basle.

While density decreased almost anywhere, intensity showed two different trends according to size (*Chart 4-44*). It dropped in centers smaller than 32'000 jobs, while it climbed in centers larger than that. Correspondingly, the intensity gradient across center sizes, which was decreasing as size grew before 1965, and flat that year, started to assume an increasing form by 1975: at that date, the larger a center, the more intense it tended to be. Furthermore, the crisis had left the smaller centers, those under 16'000 jobs, with rather weak intensities, just above the unit mark, so that altogether the 320 smaller centers job imbalance was just 50'000 more jobs than actives, or a tenth of the reverse imbalance seen in edgeless space. Above 16'000 jobs though, intensities had climbed, and the job imbalance of the 22 biggest centers was close to 320'000 more jobs than actives. Thus a functional imbalance became obvious at the time, with a few larger centers getting most of the commuters originating in edgeless space while the national role of smaller centers grew smaller and smaller and their effects on the network reduced to local ones.

4.4.1.6. Rank-size and job numbers by size classes: the passing of smaller units

As compared to the 1965 distribution of jobs in size classes, the main evolution was that that edgeless space job share significantly grew, and that it did mostly at the expense of the smallest centers, which size classes up to the 4'000 jobs mark all lost job shares (*Chart 4-45*). In 1965 those centers grouped 18.8% of all jobs, in 1975 just 14.4%; furthermore half this share was held in centers above 2'000 jobs. Above the 4'000 jobs mark, though, the distribution seemed to remain relatively in line with Zipf's law, hinting at a resilience of a Christallerian network, although composed only of larger units.

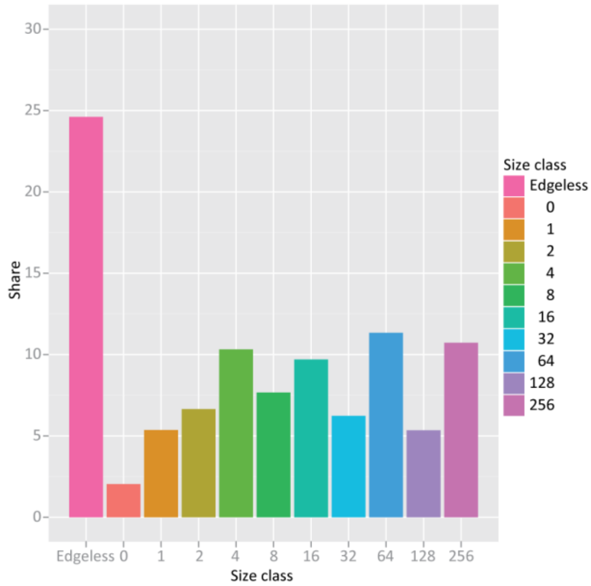


Chart 4-45: Job share by center size class, 1975

When controlling for location and size, trends already noted before, and notably in 1965, remained valid through the crisis period (*Chart 4-46*): bigger centers were in all more resilient to the crisis than smaller units. In urban centers, most of the job losses were supported by the size classes under 4'000 jobs, while size classes above those hardly suffered. In suburban centers, all of the gains were made by units larger than 4'000 jobs. In fact the only category which didn't discriminate along size classes were the exurban centers, where losses were massive regardless of the size class, and where the largest centers suffered the most. Exurban centers were already a realm of small centers; it tended to become a realm of ever smaller, vanishing centers. Their disappearance, though, had a multiplying effect on the dearth of smaller centers in the network at large; since 1975, the lack of small urban centers was compensated for a part by the numerous small exurban centers, but by 1975 those were disappearing even faster than smallish urban centers.

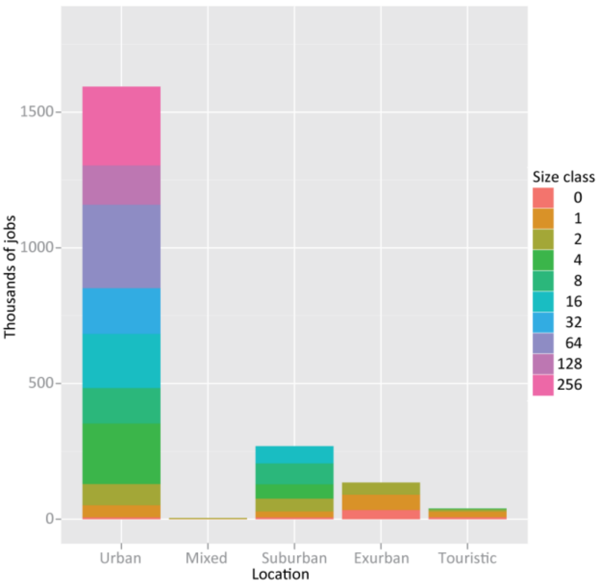


Chart 4-46: Job numbers by location and center size class, 1975

4.4.1.7. Zipf's law, clusters and superclusters: a farewell to Zipf

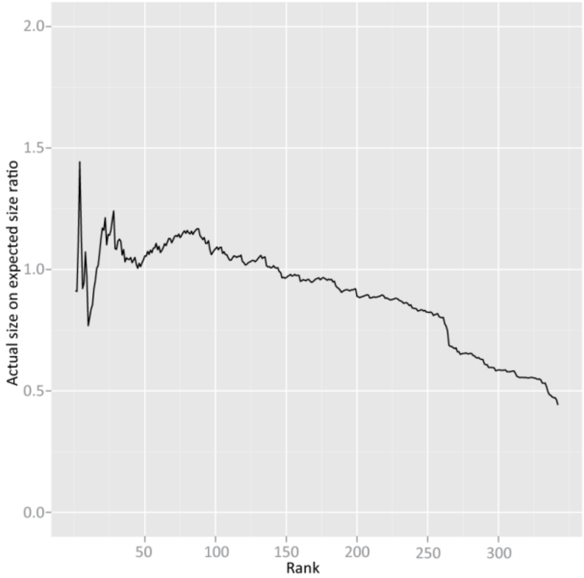


Chart 4-47: Units rank-size distribution compared to Zipf's law, 1975

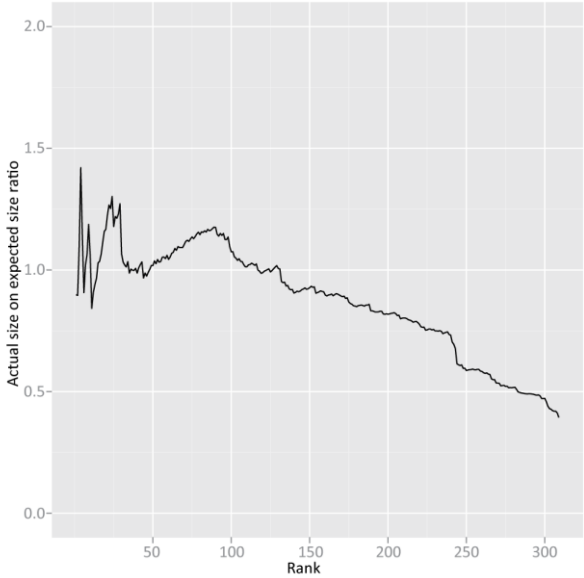


Chart 4-48: Cluster rank-size distribution compared to Zifp's law, 1975

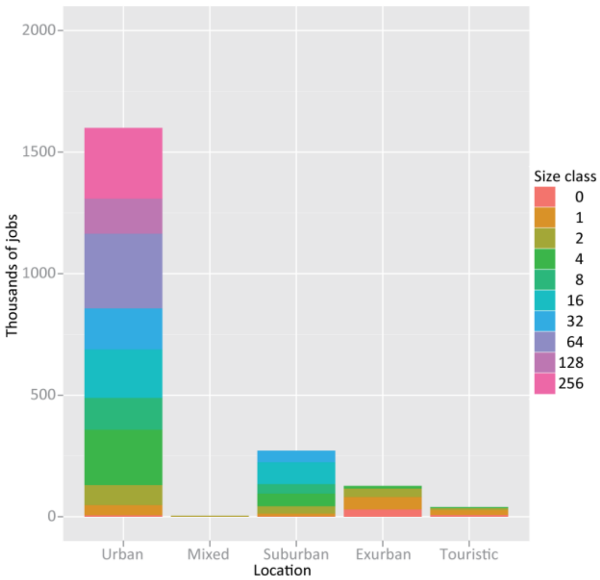


Chart 4-49: Job numbers by location and by cluster size class, 1975

The study of the rank-size curve for 1975 shows above all the losses experienced by smaller centers. The inflexion point noted in 1965 at the 1'200 and 1'600 jobs marks had more or less disappeared, but the actual rank-size curve crossed the Zipf-like one at a far higher point than before, which corresponded to the 2'100 job mark (*Charts 4-47 & 4-48*). Below this limit, centers were now systematically smaller than expected, with a second, more brutal inflection point at the 1'000 jobs limit. Above this limit, a noticeable bump is seen at about the 30th rank, which seemed to correspond to the rise of suburban centers. Basically the same finds were made at the cluster level, with a strong loss of substance at the lower levels of the urban hierarchy and the reinforcement of a bump at the upper mid levels of the hierarchy.

The main interest in looking at the combination between location and size classes is to see how suburban clusters evolve, as clustering involves them above all. In that case it can be shown that the whole growth experienced by suburban clusters during the decade was borne by the larger clusters, those with more than 8'000 jobs (*Chart 4-49*). A new size class had emerged by 1975, the clusters with more than 32'000 jobs, and more than half of the jobs held in suburban centers were grouped in the five biggest clusters. Obviously, if suburban centers were emerging at the time, they were doing so at a very few select places.

At the supercluster level at last, as compared to the 1965 version, changes were relatively subtle (*Chart 4-50*). The 30 largest cities were now all larger than expected, some exhibiting massive overshoots: cities ranked third to fifth were 1.4 times too big. From the 30th rank, though, which corresponded to clusters of about 12'000 jobs, units were systematically smaller than expected, with a gap opening wider and wider as one went down the curve; in 1965, the crossing point was further down the network, at the 7'000 jobs mark. Furthermore, an inflexion point was now situated at the 4'400 jobs mark, corresponding to the 70th rank in the network. All smaller units were now at least 20% smaller than expected, the lowest units of the network being 70% smaller than expected. Thus, massive changes were happening in the structure of the urban network, with three cities – Geneva, Berne and Lausanne – getting far larger than expected and forming a sort of upper pentagon of leading cities, while small centers were eliminated from the network. The Zipf-like structure was clearly on the verge of being abandoned, and by implication, the Christallerian network.

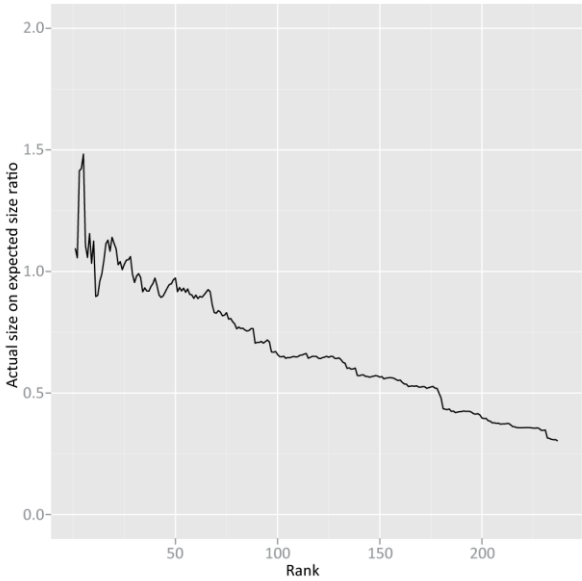


Chart 4-50: Supercluster rank-size distribution compared to Zipf's law, 1975

4.4.1.8. Aspatial conclusions

The years between 1965 and 1975 marked the end of an age of rapid urbanization through industrialization, and signaled a complete overhaul of the urban centers. For the first time since the 1930s a period of urban decline occurred, which was characterized by an intense, brutal restructuration marked by the quasi-disappearance of one formerly important category of centers, the exurban remnants. They were only partially replaced by the emerging suburban centers, the sole category not to retreat during the decade. Further weakening of the Christallerian network was evident through the demise of numerous units formerly members of the lowest classes of the urban network, paralleled by the strengthening of the larger cities. In the upper levels of the hierarchy, Christallerian structures seemed still to dominate clearly the scene, but it was nevertheless undisputedly weakening, and starting to be challenged by new forms of urbanization.

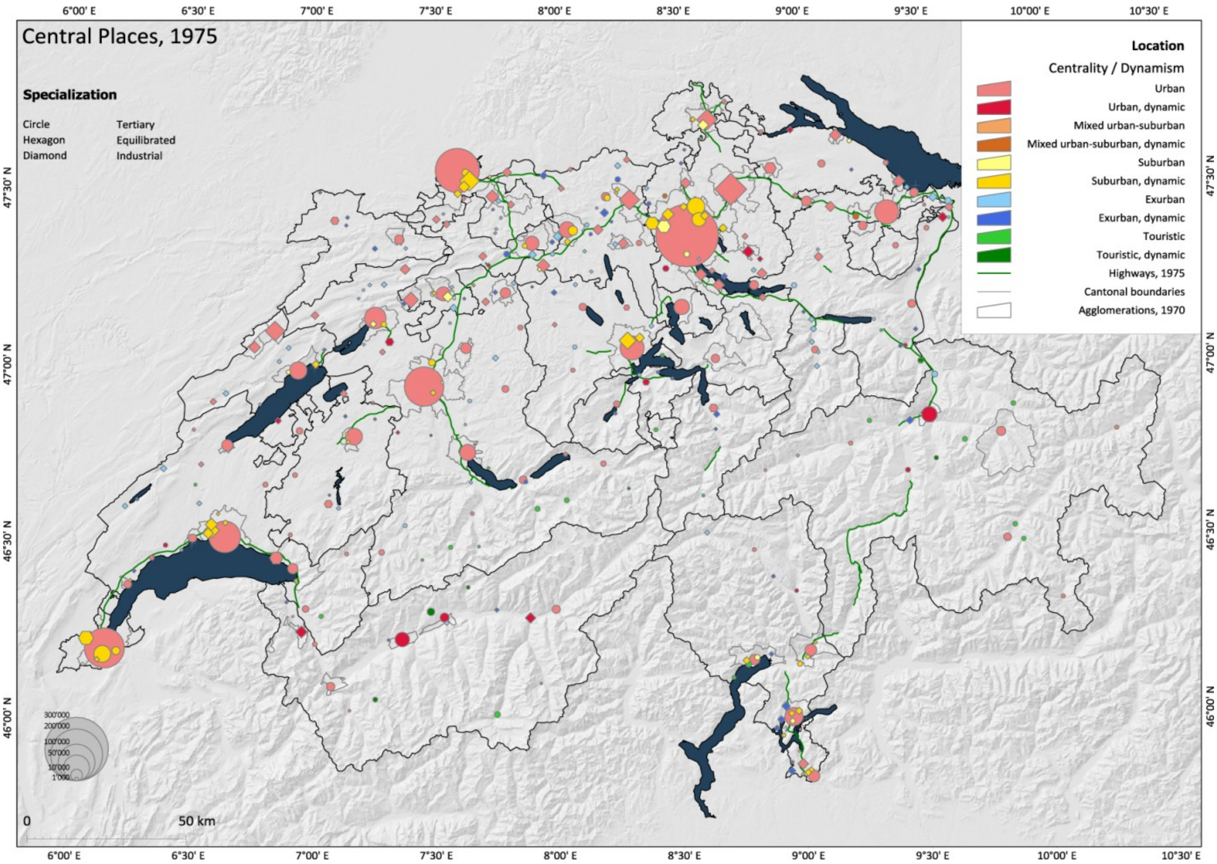
As residential suburbs grew more and more they offered more and more space and opportunities for suburban centers to emerge. A second very important point is that the decade starting in 1965 was the first one to witness substantial development of suburban growth, car ownership and highway development. Therefore, not only the economic conditions were very different in 1975 from what they had been in 1965, the territorial development, and the territorial behavior of the population were also marked by major changes. No wonder, then, that the urban network adaptation had been as extensive as it had proved to be. In that sense, 1975 was truly witnessing an epochal change, which may be resumed from industrial to post-industrial.

4.4.2. Spatial patterns

4.4.2.1. The urban network pattern: a tale of exurban extinction and suburban boom

1975 marked the first time since 1939 at which the network growth stopped. Thus, the 1975 map is characterized by pause and restructuration.

For the most part, job numbers in the larger centers remained stable on the 1965-1975 period (*Map 4-12*). That, in itself, was a novelty as up until then, those numbers had been steadily growing for most of them. In some cases, job numbers even gave in a bit, like in Lausanne, and in most centers of the Jura Mountains and Piedmont, notably in la Chaux-de-Fonds, Biel and Grenchen. Conversely, some centers went on growing during these times, like Berne, Zug or Winterthur. Such patterns were also seen at lower levels of the central hierarchy, and it was difficult to find a



Map 4-12: Central places by size, location and orientation, 1975

legitimate pattern in it. At first sight, the most patent characteristic of the central network of the time was its stability as compared to 1965. It was only by looking at the lowest levels of the hierarchy that changes were becoming apparent, with a number of smaller center disappearances, most notably around Zurich – Uster – and in Eastern Switzerland – Amriswil, Bischofszell, and Diessenhofen all dropping out.

The devastation that the crisis incurred on the urban network befell chiefly on exurban centers, which suffered a mass extinction at the time. As exurban centers were above all concentrated in the industrial heartland of the country, these regions saw the most exurban centers drops, which were particularly spectacular in Eastern Switzerland, around Zurich, and in Aargau, but which were widespread also elsewhere. However, as their territorial distribution was very much skewed towards certain regions only, those regions devoid of them, notably Western and Southern Switzerland, and the Alpine regions, were not as severely affected by this exurban extinction than the rest of the country.

Suburban centers, meanwhile, continued to grow. As before, this growth was particularly sensible around the major cities, which implied that already big suburban centers were getting bigger. In a sense, 1975 marked the real emergence of massive suburban units in the network. This was especially true around Zurich, where Kloten gained 10'000 jobs at now 23'200, Wallisellen jumped from 4'800 to 14'100 jobs, while the two Limmattal units (Schlieren and Dietikon) both crossed the 10'000 jobs mark, with 11'000 jobs each. In Geneva, Carouge, historically the biggest suburban center of Switzerland, reached 20'900 jobs, while Cointrin gained 5'500 jobs to 14'200. In Basle, Schweizerhalle now hosted 19'000 jobs, Renens had 11'200 jobs in Lausanne, and Emmen 14'200 in Lucerne. The suburban units we just mentioned got most of the growth which affected the category as a whole, and for the rest of the suburban centers network, the evolution was similar to that of the urban centers: great stability.

In all, the center network departed from a Christallerian one in two directions: around larger cities by getting bigger and bigger subcenters, and at the bottom end of the network by dropping a large numbers of urban and above all exurban centers. The upper and middle levels of the network appeared relatively untouched by those developments and at those scales the Christallerian network still seemed to apply.

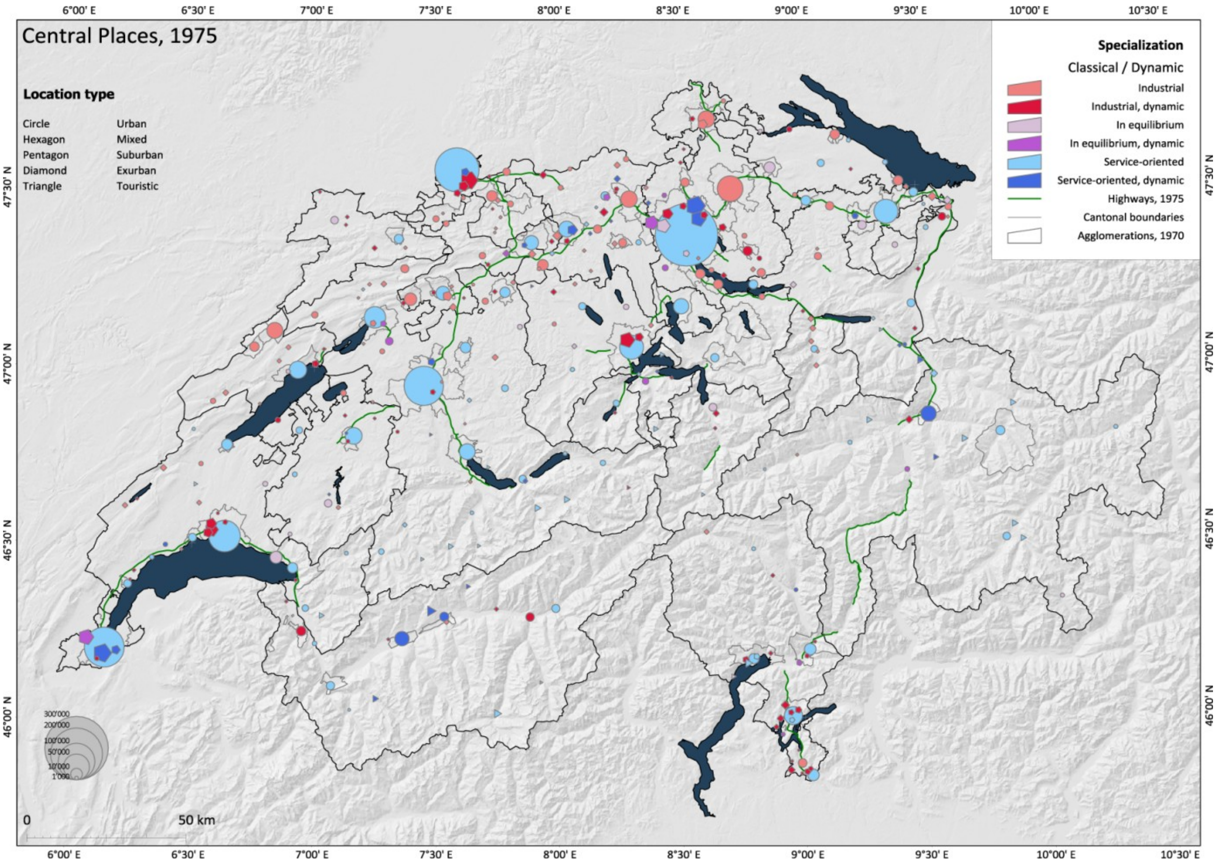
4.4.2.2. Center-periphery patterns at the national scale: the suffering of central regions

In all, the economic downturn of 1973-1974 corresponded to important changes in the center-periphery pattern of the network. Urban centers ceased to grow regardless of their size, but at the bottom end of the network some centers disappeared. It seemed that this phenomenon was especially present in central regions of the country, which is also where the great majority of exurban centers disappearances occurred. Peripheral regions were not all affected the same way by those phenomena. In industry-dominated ones, like the Jura Mountains, the loss of centers was rather severe and compounded by the fact that existing centers diminished in size. In Western, Southern and Alpine Switzerland though, those effects were far more muted, and in a way, by not being subject to extensive changes like central and industrial regions, those peripheries actually gained through the crisis.

4.4.2.3. Differences according to agglomeration size: midsized cities turn towards services

Like in 1965, only the biggest centers, and then not all of them, did see the massive development of suburban centers at their fringes (*Map 4-13*). At a time when urban centers themselves had stopped to grow internally, this signaled a renewed period of differential growth for some of the biggest agglomerations of the country, and above all for Zurich and Geneva.

The real change, though, was happening elsewhere: the crisis marked a very strong industrial backlash which had a lasting effect on cities: a great many of them saw their economy turning from industrial to service-oriented. The largest centers of the country, which were service-oriented from 1939 on, were now joined by the upper-middle level of the hierarchy. Former equilibrated cities like Neuchâtel, Fribourg, Solothurn, Olten, Wil or Chur had now turned service-oriented, while some industrial centers migrated towards the equilibrated category, like Frauenfeld. Moreover, other cities experienced a direct transition from industrial to services.



Map 4-13: Central places by size, orientation and location, 1975

Those included Biel, Aarau, Zug, Yverdon or Rorschach. The phenomenon was country-wide and showed no marked regional bias – rather, the turning towards services was clearly related to center size: the larger a center, the likelier the probability that it had turned service-oriented.

Center's location also played a role into this massive change, as it affected above all urban centers. Suburban centers were less concerned, and differentially. Most suburban centers remained strongly industrial at the time their parent center was turning service-oriented. In a sense 1975 marked the inception of a spatial division of labour, with services locating preferentioally in urban centers while industry remained dominant in suburban centers. However, most larger suburban centers were located around larger cities, which were already service-oriented since 1939; several of those larger suburban centers had themselves also turned service-oriented, like Kloten, Wallisellen and Carouge, or equilibrated, like both Limmattal units or Cointrin. In most other cases though, suburban centers remained firmly industrial, like in Western Lausanne, or around Basle. Still, about half of the largest suburban centers were turning away from industrial dominance as early as 1975, and even if some of those departures can be explained – notably the fact that transportation and logistics are counted as services – this was a significant if not dominant move.

4.4.2.4. Regional patterns: a severe blow to industrial regions

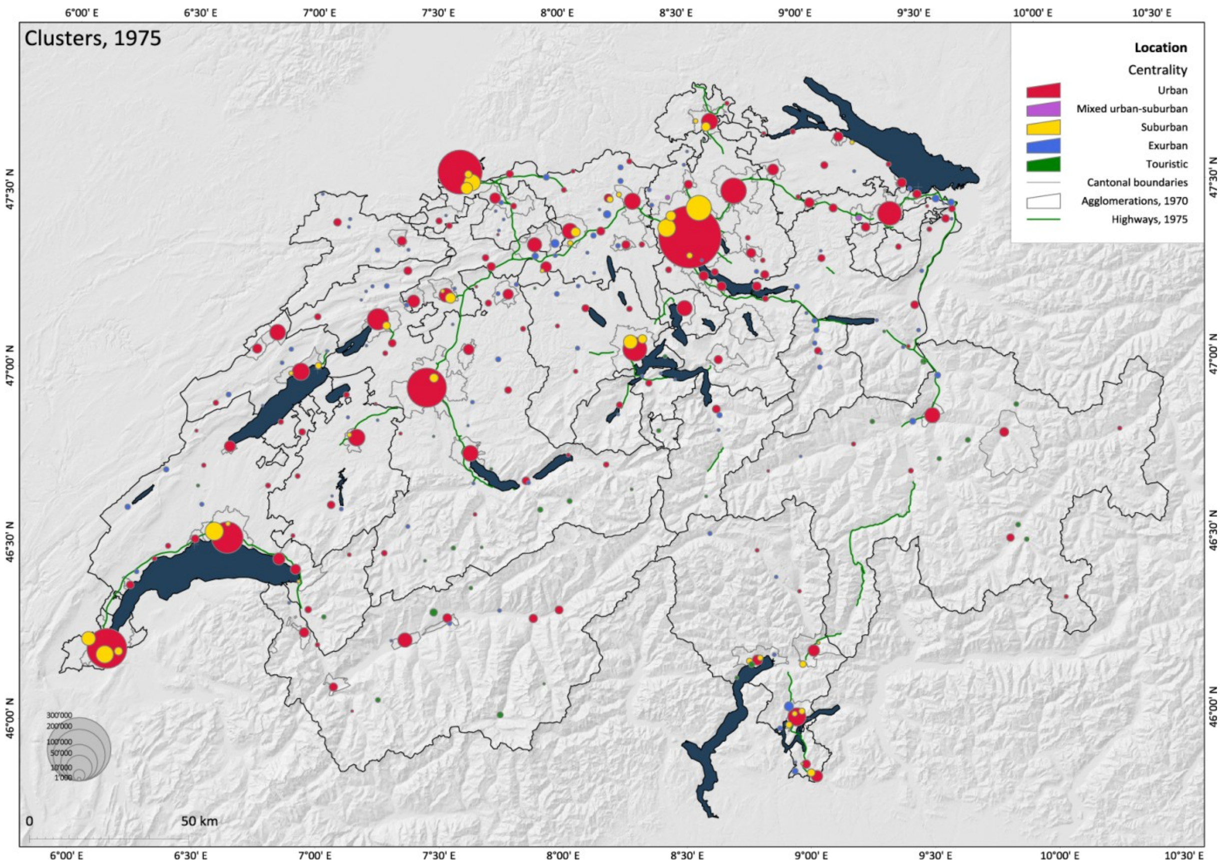
As we have already surmised, the economic crisis had ample regional effect. The fact that it was affecting above all the industry meant that industrial centers were hit harder than equilibrated or service-oriented ones. As industrial centers were not located evenly on the whole territory meant that some regions bore the brunt of the crisis. Industrial regions suffered disproportionately. Eastern Switzerland saw a majority of its lower-level centers disappear between 1965 and 1975, and the same effects were seen, at a lesser scale, in Aargau and the Jura Mountains.

Conversely, areas where the industry had never been dominant, like Ticino, the Alps, and to a lesser the western half of the plains were far less affected. In the middle of this, the position of the greater metropolises, Zurich and Basle, was mixed; their industrial component suffered but they could compensate with their service activities. It remains to be seen, though, if in all the biggest cities could maintain their status when taking into account their clusters, and at the supercluster level.

4.4.2.5. Mapping clusters and superclusters: change amidst continuity

The geography of suburban clusters of 1975 showed a differential progression of those clusters: they grew strongly around service-oriented centers – Geneva, Lausanne, to a point Zurich – while they stagnated around more industrial cities – Basle, Schaffhausen and Lucerne for instance (*Map 4-14*).

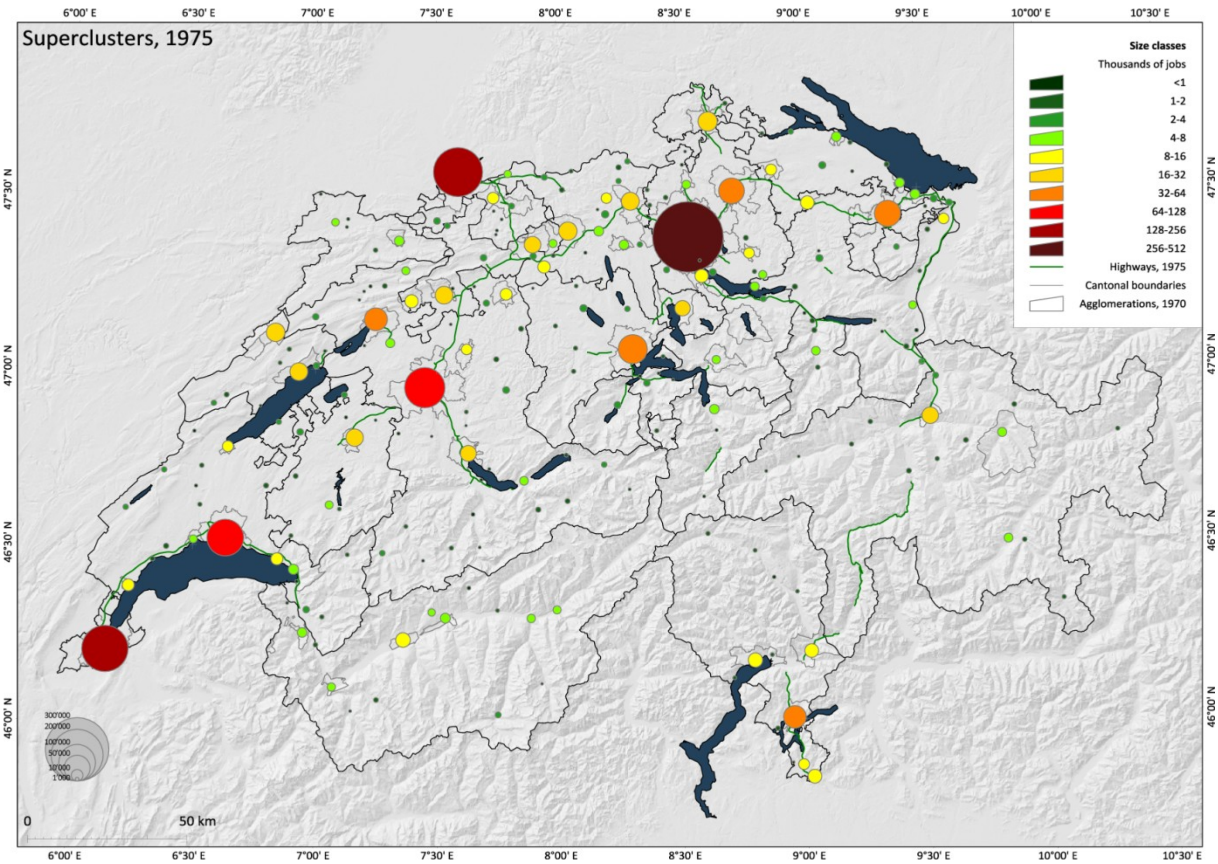
The biggest rise, by far, concerned the Glattal cluster, which doubled its size to reach 47'100 jobs, by far the biggest job number for a suburban cluster and in itself a score which made it the equal of St. Gallen, Winterthur, Lucerne or Biel. The three other clusters of the city were less impressive; the Limmattal cluster also grew, 6'100 jobs to 23'800, the two other (Furttal and Linkes Ufer) remaining small. In Geneva, the two major suburban clusters also grew, Carouge-Praille to 22'300 jobs, and Cointrin to 14'200; in Lausanne, the Western cluster grew to 24'800



Map 4-14: Clusters by size and location, 1975

jobs. Around Basle, Schweizerhalle grew a little to 19'300 jobs, alongside Birstal which crossed the 10'000 jobs threshold. The only other large suburban clusters were the Emmen one north of Lucerne, with 14'100 jobs, and the Unteremmental one along Solothurn at about 8'000 jobs. In other words, the bigger suburban clusters were the same than in 1965, and the structural allure of the suburban cluster network had not been modified as profoundly as the urban centers one. Two facts stood out: first, at a time of retreat suburban clusters still progressed, or held their own, thus extending their job share. Secondly, the biggest suburban cluster of 1965 experienced ten years of explosive growth and was now competing with cities immediately behind the big five.

At the supercluster level 1975 marked a brutal halt to the relentless growth that had presided over the two preceding periods (*Map 4-15*). While several clusters had moved up one class with each new period, practically no center did such a move between 1965 and 1975, and certainly not in the upper levels of the hierarchy. Conversely, many centers did in fact drop one class during the 1965-1975 period, while others disappeared altogether from the scene. Such drops and disappearances were most prominent in Eastern Switzerland, with most of the smallest centers disappearing and the mid-level centers dropping a size class in their majority. Aargau and the Zurich area saw less prominent but similar moves, while Lucerne was the biggest supercluster to drop a size class during these times. Conversely, the area at least saw some superclusters growing, like Brugg or Hinwil, things unseen eastwards. Still less prominent were moves westwards from Aargau, in the Basle area and the Jura Mountains and the western Mittelland area; here changes affected above all the lowest tier of the center network, small centers which had emerged in fact during the 1950s and the 1960s economic boom.



Map 4-15: Superclusters by size, 1975

Between 1965 and 1975, the network evolved by subtraction rather than by addition, but the result, paradoxically, was the same: the dominance of larger centers still grew, while mid-sized centers stagnated and lesser-tier superclusters dropped from the network, and in all the network looked less and less Christallerian. A last feature of this evolution is that the crisis somewhat freezed the network in place and the decennial changes were far less spectacular than before.

4.4.2.6. Territorial conclusions: inching from central places towards metropolises

The first census held after the oil shock and the 1973-1974 economic crisis, 1975 marked a strong retreat of the urban network and indeed of the entire economy, the especially strong downturn of the industrial base of the Swiss economy, and geographically the end of the Christallerian network and its replacement with something new.

The urban network, dynamical cities included, lost many units between 1965 and 1975, in particular small units. Losses were widespread in the country, affecting industrial areas as well as rural ones. Eastern Switzerland was particularly affected, which accredited the idea that industrial regions bore the brunt of the loss, as does the severe decline of the Jura arc urban network. Conversely, losses were limited in the hyper-central regions of the industrial heartland. The same is true of the Lake Geneva region and the Alpine cantons. Thus, regional effects, or even metropolitan ones maybe, played a definite role in the resilience of some parts of the urban network to the crisis.

Meanwhile, the cities which survived the crisis more or less maintained their job numbers intact. Thus, the map looked like it had been wiped clean of a very large number of small units, without touching at the upper levels of the hierarchy, those remaining very stable on the period. Among the urban centers which lost jobs prior to 1975, Lausanne and Lucerne were the biggest, and were accompanied by most of the heavily industrialized cities in the Jura arc, the heartland and in Eastern Switzerland. Thus, an industrial link to urban losses seemed a credible explanation.

Exurban centers went through a sharp decline during this period. Geographically, losses were extensive in industrialized areas, however the decline was basically the same everywhere. What made it an essentially industrial heartland affair is that the network of classical exurban centers was heavily tilted towards industrial areas. It was therefore to be expected that such a loss across the board would affect primarily its preferred zone of implantation. At the same time, several dynamical units appeared and others developed, essentially between Basle and Zurich and squarely in the industrial heartland. Conversely, nothing of the sort happened in Eastern Switzerland or in other, more peripheral areas of the country. Thus, while industrial areas were the most heavily impacted by the urban and exurban crisis of the moment, seeds were planted which showed which regions would thrive afterwards.

Among those thriving regions were suburban areas, especially around big centers. For the first time in 1975 edge cities stood clearly out. Their territorial distribution is insightful as they concentrated in three regions: first and foremost in Switzerland's industrial heartland, around and between Zurich and Basle, with major extensions in the lower Aare valley. This region was also seeing the advent of dynamical exurban centers further afield, as we have already discussed. Secondly, edge cities abounded around Lake Geneva, above all between Lausanne and Geneva, and third in the Sottoceneri region of Ticino. It is striking to see that in 1975, edge cities delimited territories that would be called metropolitan twenty years later. In that sense, edge cities seemed already to be true markers of metropolitan processes that had begun to affect Switzerland.

In brief, 1975 was a time of great upheaval. Christallerian network logics were by and large challenged by other territorial patterns. The most obvious was the advent of massive employment complexes in and around the greater centers of the country, and in that sense we can speak of the advent of the domination of big agglomerations on the territorial economic organization of the country, which essentially wiped out local centers from the scene. However not all big agglomerations did get meaningful edge cities, while seemingly smaller units did get some. The territorial distribution shows that there were areas favorable to edge city emergence. Those were first and foremost the Zurich-Basle-Aargau triangle, also known as the industrial heartland, followed by the Lake Geneva area in western Switzerland and the Lugano-Chiasso complex in Ticino. Incidentally, those were also the only areas of Switzerland which saw the emergence of dynamical exurban centers. Last but not least, by 1975 those three areas were already benefiting from extensive highway development. On the other hand, Eastern Switzerland, the Jura Mountains, Western Mittelland were all practically devoid of such phenomena, as were to a lesser extent the alpine regions in general. Thus, there was a territorial discrimination effect in the location suburban and exurban centers, which pointed out at metropolitan processes that would be talked over in the literature in the following decades.

Those processes had heavy regional effects, whether they were the result of truly regional processes or of metropolitan processes. The future metropolitan areas reinforced themselves during these times while industrial regions declined. For big centers, the orientation towards the tertiary sector more than compensated for industrial losses, while in the industrial heartland, the dredge-up of metropolitan processes compensated more or less the pull-down of the industrial crisis. For those industrial areas that could not be encompassed in those processes, though, the decade was one of prolonged decline, mainly in Eastern Switzerland and the Jura Mountains. In lesser industrialized areas outside emerging metropolitan regions, the effect of the crisis was akin to those in industrial regions, showing a rather steep decline. Regionally, Switzerland appeared as a patchwork of several greater regions, each following its path. Last, in was to be noted that the alpine regions seemed to have escaped the worst of the crisis effects and that, especially in Valais, it continued to develop a stronger and stronger network of small dynamical cities.

4.5. 1985: towards metropolises

4.5.1. Aspatial results

4.5.1.1. Location and centrality: the rise of suburban centers

1985 closed ten years unlike any period that had been experienced since WWII. Up to 1965 the context was one of sheer growth, while the 1965-1975 period was marked above all by a severe downturn (*Chart 4-51*). The 1975-1985 period was one of stagnation instead, alternating lesser but still potent periods of recession – 1979 and the second oil shock, and the recession of 1981-1982 – and period of timid recovery – up to 1979 and since 1983. In all, recovery primed on recession and the global context was one of slow growth.

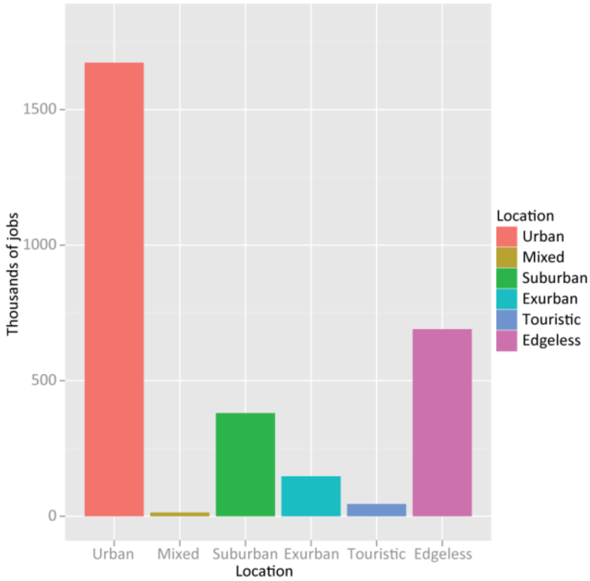


Chart 4-51: Job numbers by location, 1985

In that context, the center network showed signs of stabilization, even recovery, after the 1973 crisis. The network regained 42 units at 384, a figure rather close to the 1965 optimum – 393. More importantly, the network gained 218'000 jobs in ten years to reach 2'260'000, well short of the half million figures of the two decades following WWII, but equally better than the loss experienced by the decade preceding the one under review. In parallel, edgeless locations gained only a small amount of jobs – 24'000 – during the same time, so that the centers job share rose again, up 1.2 point at 76.6% of the total, while edgeless locations retreated to 23.4% of the jobs, despite a small absolute rise, to 690'000 jobs.

In absolute terms, all urban locations gained jobs during this period (*Chart 4-52*). Urban centers recovered well from the shocks of the 1973 crisis, gaining 2 units and 78'000 jobs, to 1'673'000, but this recovery wasn't enough to see them avoid a further retreat in terms of job share, which lost 2.2 points at 56.7%, a loss comparable to the one experienced the preceding decade. In all urban centers experienced a modest rise in mean size, up 390 jobs to 11'780 per urban center. In structural terms, urban centers continued to lose some of their density – a continuation of a long-term trend, although the loss was slight, down 1 point to 30 jobs per built ha. Job intensity, however, jumped massively, gaining 16 points at 146 jobs per 100 active residents. This was

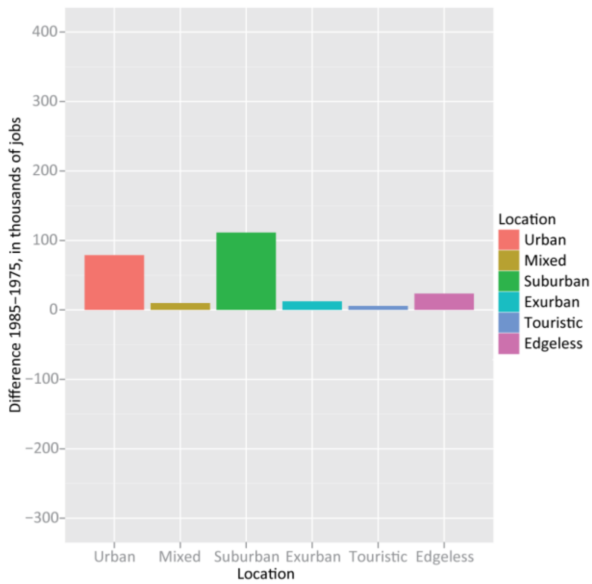


Chart 4-52: Job numbers difference by location, 1985-1975

due to the fact that urban depopulation had now started in full, and while cities had gained 78'000 jobs, at the same time, as a group they had lost 83'000 active residents: clearly, the decade was one of sheer job center specialization for urban centers. As a consequence, urban centers experienced a huge rise in jobs/actives imbalance, which grew 162'000 units to a record 525'000 more jobs than active residents.

Suburban centers numbers continued to grow, up 33 units to 94, as were the number of jobs they held, up 111'000 units at 380'000, or 12.9% of the total, a rise of 3 points, very similar to the one they had experienced during the preceding decade. Between 1975 and 1985 there were more jobs gained in suburban centers than anywhere else, and this rise represented approximately the sum of all other gains across the country. Clearly, suburban centers were benefiting greatly during the decade leading to 1985. Significantly, their mean size wend down 360 units to 4050 jobs per unit, which means that the suburban class encompassed more small units than before, a probable sign of their dissemination in other places than the biggest six to eight centers where they were concentrated till then. Suburban centers were still paying for this relentless growth by relatively weak structural qualities. Their density was now down 1 point at a very low 14 jobs per built ha, while their job intensity climbed back to just above unity. In essence, suburban centers were getting more numerous and getting larger, but not strengthening.

Exurban centers gained 6 units to 115 and 12'000 jobs to 147'000, those figures representing stability more than growth, though. Their job share remained at 5%, a relatively low figure, way lower than the 8.3% they represented in 1965. As a class they remained very small at 1'300 jobs per unit, while structurally they underwent further changes, losing ever more job density – down 1 point at now 8 jobs per built ha – but gaining in job intensity – up 9 points at 121 jobs per 100 active residents. This showed that whatever remained of exurban centers were specializing more and more on land-hungry activities, and that they were also specializing as job centers, drawing their workforce more and more from beyond their communal boundaries.

Edgeless space retreated during the decade under review, gaining some jobs but losing job share, a development that contradicts the general evolution of the economy and confirms that edgeless space thrives in economic recessions, while the organized forms of the urban network as a whole benefits from economical recoveries and booms. During the decade under review edgeless space seemed to reach a stabilization point both in terms of job density and intensity, both of which didn't evolve much since 1975. Job density remained fairly stable at a bit more than 7 jobs per built ha, while intensity climbed back one point at 58 jobs for 100 active residents, the whole while losing units to the urban network. In effect, edgeless space strengthened a bit during this decade.

4.5.1.2. Dynamics: dynamical suburban and exurban units taking the lead

The decade following 1975 saw dynamical centers take more place in the center network (*Chart 4-53*). There were now 162 dynamic centers against 128 in 1975, and they represented about two thirds of the job growth registered by the center network during the decade. That being said, dynamical centers were still relatively small as compared to the classical network, which was still hosting more than three times its job numbers.

Dynamical urban centers were still in the classical urban centers shadow; they were way less numerous, smaller, less dense and less intense than their classical counterparts, representing just one urban job out of twelve. At the same time they were responsible for more than a third of the job gains registered by urban centers during the decade following 1975. Conversely, by 1985 dynamical suburban centers completely dominated classical suburban centers, both in numbers and in quality – in effect, new suburban centers had completely replaced the remnants of a bygone era. Similarly, dynamical exurban centers accounted for close to half of all exurban jobs by 1985, and were more advanced in terms of structure: both less dense and more intense than their classical counterparts, showing that what had already happened on the suburban stage was also happening in exurban locations.

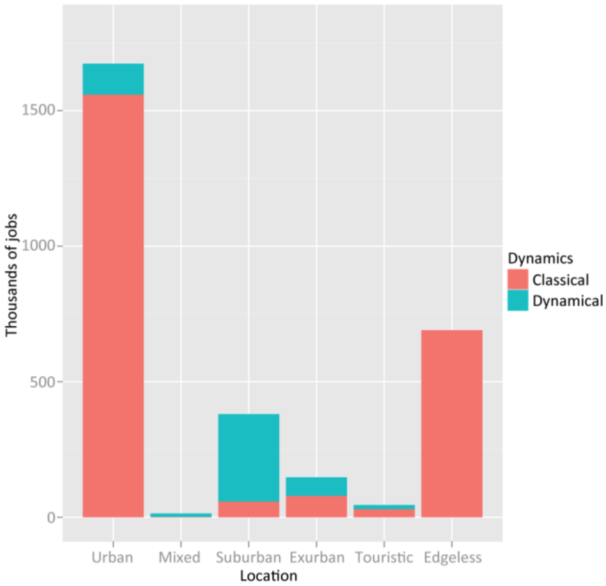


Chart 4-53: Jobs by location and dynamics, 1985

4.5.1.3. Orientation: the passing of industry

The decade following 1975 was marked by a further retreat of the industrial domain at large, and this was seen in subtle manner when looking at the centers by their orientation (*Charts 4-54 & 4-55*). Industrial center numbers actually grew, from 181 units in 1975 to 200 in 1985, but the number of jobs they hosted went down 20%, or 85'000 units, to reach 448'500 jobs. Industrial centers lost a quarter of their job share, which tumbled to 15.2%, and a similar part of their mean size; their density similarly sank down 4 points to just over 11 jobs per built ha, and even if their intensity climbed a bit to 116 jobs per 100 active residents, industrial centers underwent a massive retreat during the 1975-1985 period, a long agony.

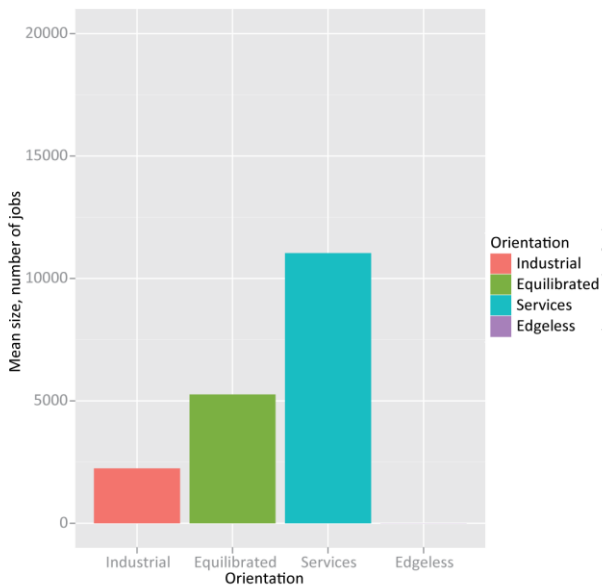


Chart 4-54: Mean center size by orientation, 1985

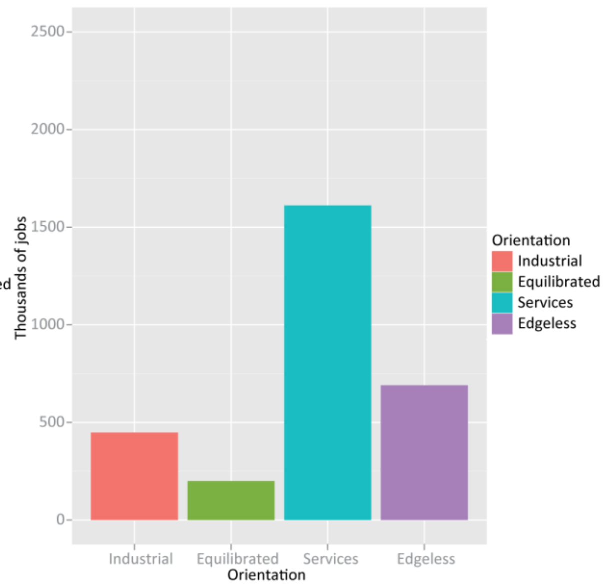


Chart 4-55: Number of jobs by orientation, 1985

While industrial centers were going away, equilibrated and above all service-oriented centers grew. Equilibrated centers gained in quality as well as in quantity, hinting at the fact that they were now hosting former industrial centers that were transiting towards a service-oriented future. The fact is that most of the growth experienced during the decade preceding 1985 befell on service-oriented centers, which gained 17 units and 226'000 jobs to reach 1'611'000 jobs, more than three times more jobs than in industrial centers. Likewise, service-oriented centers were larger, denser and more intense than their industrial counterparts, and largely so. In that sense, 1985 marked the moment when the service-oriented economy asserted its dominance on the center network. From now on, most of what would happen would be directed by what would be happening in the tertiary sector. The industry had become, well, secondary.

4.5.1.4. Form: a return to form

After the massive changes experienced by the center network in terms of form in 1975, the following period was one of return to former structures (*Charts 4-56 & 4-57*). Dense centers, which had experienced a massive surge in 1975 by recovering all centers that had lost their intensity due to the job losses consecutive to the crisis saw their numbers fall back to a level more like the ones reached before 1975, as centers regained their intensity and with it their complete status; the job share of complete centers climbed back about 2 points to 56%.

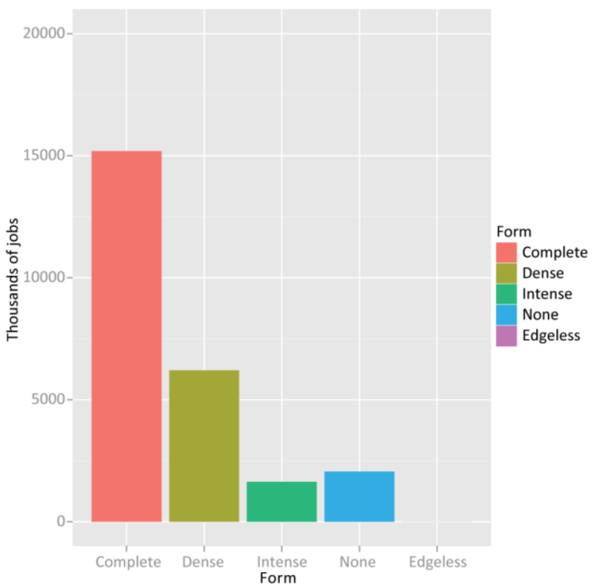


Chart 4-56: Center mean size by form, 1985

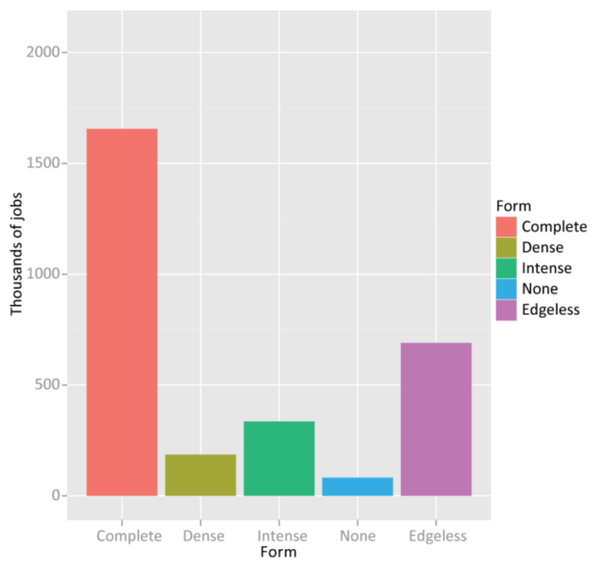


Chart 4-57: Number of jobs by form, 1985

If we neglect the 1975 hiatus and compare directly to 1965, we find that in all complete centers had not recovered all they had lost prior to 1975 and that by and large, both dense-only and intense-only centers had gained ground on the 20-year period. Intense-only centers represented now more than 11% of all jobs, 6.5% more being held in dense-only centers. This seemed to show that classical forms of job centers were giving way somewhat to new central forms, and in particular those without density but with intensity, the land-hungry places – in all, not a very surprising find since the activities needing place, like industry, logistics and transportation, were creating new poles since long, and that the development of the highway network had favored their dissemination. More surprising in fact is the rise seen in dense-only places, which shows that a certain amount of job dissemination was also taking place in dense residential environments.

4.5.1.5. Size: density discrimination and intensity rise

In terms of job density by size, the 1975-1985 period was marked by two opposite moves (*Chart 4-58*). For most centers and size classes, as for edgeless space, job density continued to decrease, albeit at a far smaller speed than between 1965 and 1975. Worthy of note was also the fact that density was lower in the lowermost class, that of centers with less than 1'000 jobs, than in edgeless space at large, and that the job density of the next class, of centers with less than 2'000 jobs, density was now very close to that of edgeless space. Job density of centers between 2'000 and 4'000 jobs likewise was low, under the nominal threshold of 15 jobs per built ha. Conversely, though, in the two topmost classes, which grouped the three biggest centers of the country, Zurich, Basle and Geneva, job density increased. In all, the density gradient was thus reinforced, and the dichotomy between the largest centers and the rest of the network grew. We could interpret this dichotomy by the fact that the number of jobs steadily climbed by replacing residents in the largest centers of the country, while elsewhere the tendency was to sprawl jobs. In all, a double move, of concentration at the top and of sprawling at all other levels of the hierarchy seemed to be the rule. The fact is that very few centers, here only three, were concentrating, a possible mark of a metropolitan process; a Christallerian structure would have required far more centers.

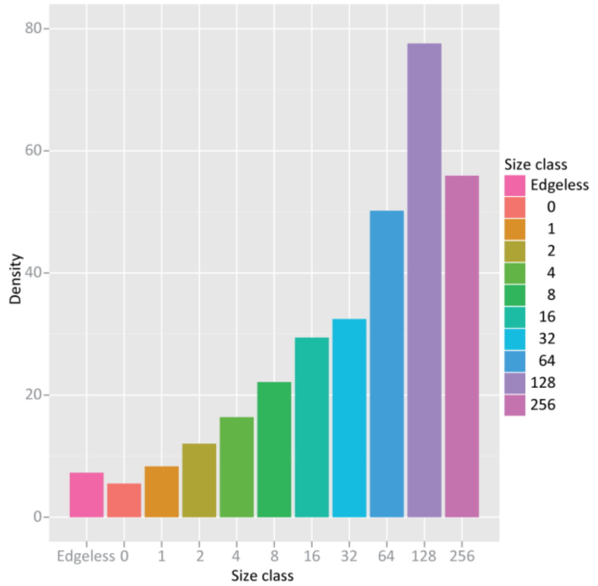


Chart 4-58: Job density by center size class, 1985

While density showed a dual structure for the period under review, intensity climbed everywhere, regardless of the size class, thus distinguishing very clearly between central places where it climbed, and edgeless space where it remained stable and very low (*Chart 4-59*). For the first time, in all size classes, intensity was now clearly above unity. In smaller size classes, those grouping centers with less than 8'000 jobs, intensity was fairly stable at about 115 jobs per 100 active residents, regardless of the size of centers. Above 8'000 jobs though, intensity was climbing according to size, with maximum figures now reaching more than 160 jobs for 100 active residents in the 5 centers hosting more than 64'000 jobs. The absolute result of this general rise in intensity is that job/active imbalances were now

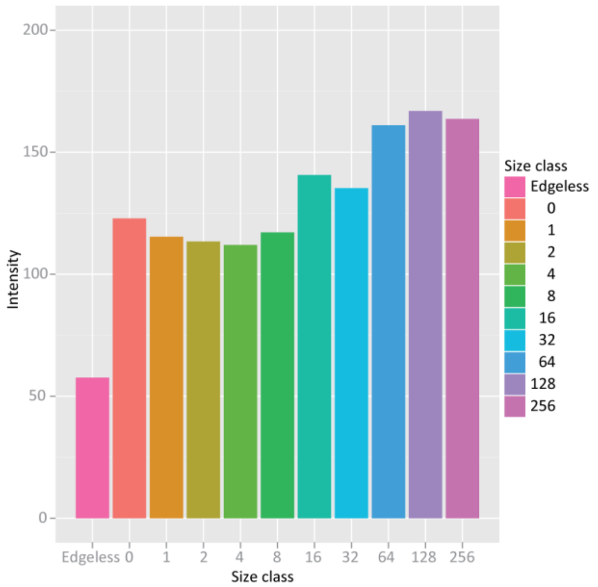


Chart 4-59: Job intensity by center size class, 1985

present at all size classes, commuter movements were now not restricted anymore to the biggest centers, but were starting to have an impact even around the smaller centers which till then had been predominantly served by their own workforce. This signaled a change of perspective for the territory at large: more and more, either a place was job-oriented, or it was residential – and apart in the Alps, it was becoming difficult to be both.

4.5.1.6. Rank-size and job numbers by size classes: towards a two-tier distribution?

By 1985, for long now the job distribution by size class had been unequal and leading away from a Zipf-like distribution (*Chart 4-60*). The most interesting feature of the 1985 job distribution by size class is that it showed a clear double structure. In the lower classes, there was now a clear progression from the smallest centers with less than 1'000 jobs to those with 16'000 to 32'000 jobs, forming a sort of first stage of the Swiss center network, with a strong overrepresentation of those 16'000 to 32'000 jobs centers. Above that limit the pattern was repeated, with a dearth of 32'000 to 64'000 jobs centers, and progressively better numbers above that limit. This pointed to the fact that there was now a two-tier urban network, one formed by a layer of very few, very large centers, and another formed by a number of midsized centers of a very specific size, and a lack of centers sized either between those two categories or beneath them. It may be that this distribution was indicative of a great and rising population of midsized edge cities.

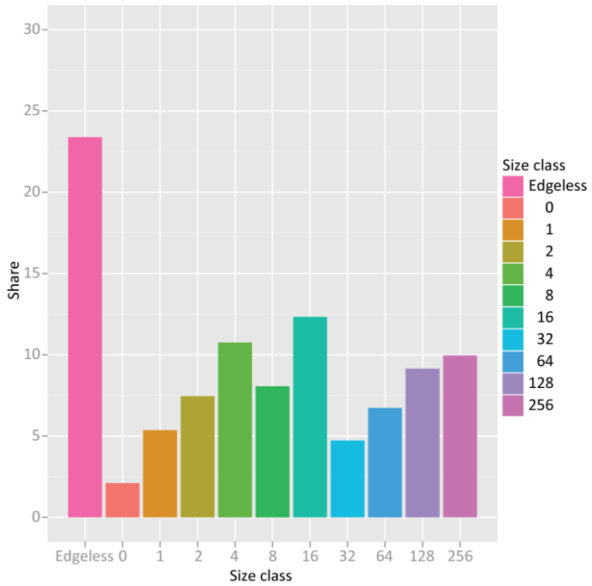


Chart 4-60: Job share by center size class, 1985

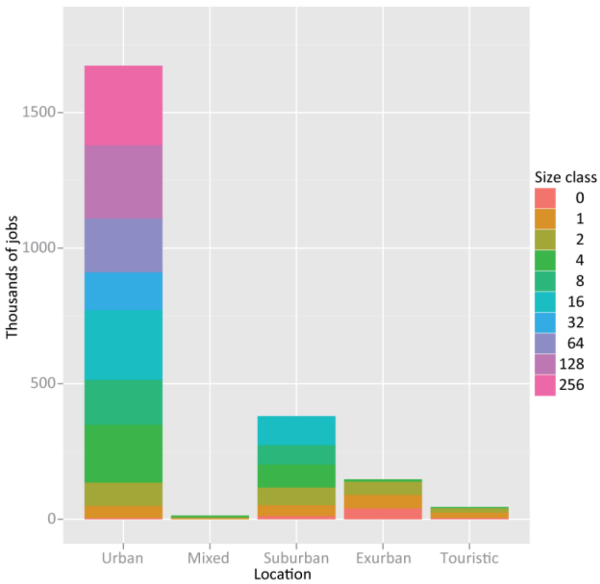


Chart 4-61: Job numbers by location and center size class, 1985

When controlling for location and size, the main result of 1985 was that suburban centers of all sizes had grown, a departure from the preceding periods, when growth was above all due to several big suburban centers (*Chart 4-61*). This better apportioned growth signaled also the dissemination of many new units across the territory, and their good health. In that sense, 1985 was the age of the generalization of edge city emergence.

4.5.1.7. Zipf's law, clusters and superclusters: trend continuation

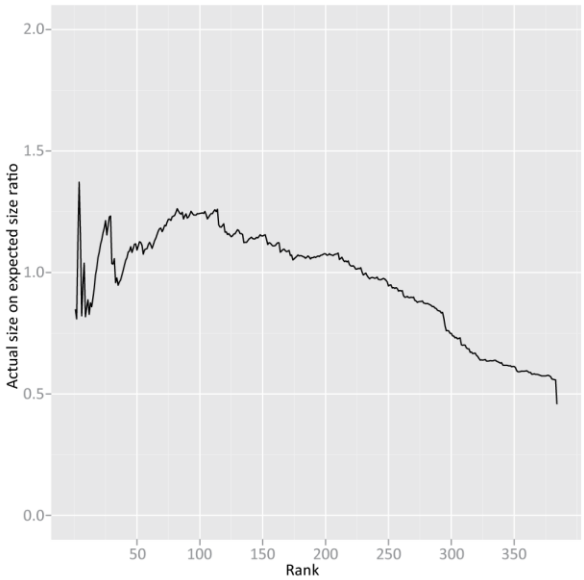


Chart 4-62: Units rank-size distribution compared to Zipf's law, 1985

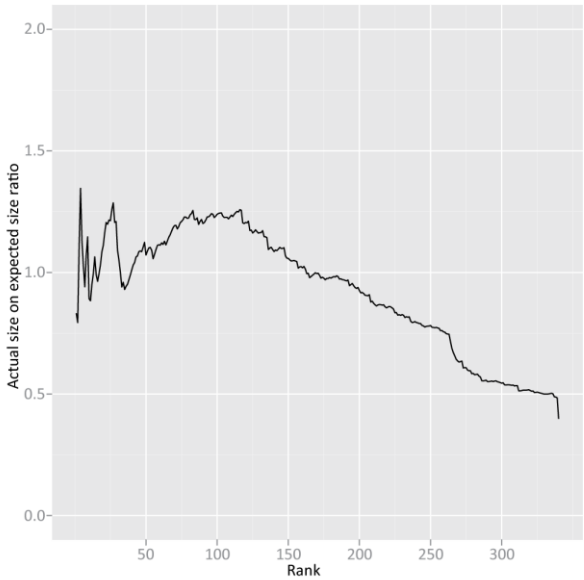


Chart 4-63: Cluster rank-size distribution compared to Zifp's law, 1985

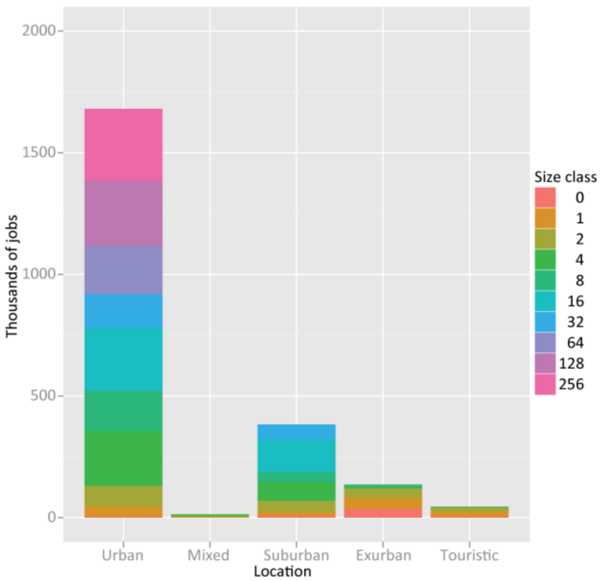


Chart 4-64: Job numbers by location and by cluster size class, 1985

The study of the rank-size curve for 1985 shows first that the two biggest centers had greatly retreated as compared to a Zipf optimum (*Charts 4-62 & 4-63*): in terms of job size, they hadn't moved much since 1975, while the rest of the network had. In a more general way, the 1985 rank-size curve looked more jagged, more irregular than the 1975 one, with deeper over and undershoots, which meant a rank-size relationship farther from a Zipf-like distribution than before. In particular, there was a strong, 25% overshoot around the 100th rank, which corresponded to about 4'300 jobs. This overshoot meant that the crossing point beneath which the size of job centers were systematically too low had gone down, to the 1'400 job mark, and the inflection point back to the 1'600 job mark. However, those findings should not be overemphasized; in all, the most important find was that, more and more, the rank-size distribution moved away from Zipf's law. For the most part, moving at the cluster level did not change anything to those finds.

The cluster location by size for 1985 showed above all that the two-tier distribution we already found by looking at the overall distribution of jobs by size classes was found both in urban centers and in suburban ones (*Chart 4-64*). In both categories, there was a two-stage structure, with big and small units but with relatively few mid-sized clusters in between. This distribution is above all interesting for suburban centers as they are the ones that get clustered. Fort those too, a two-stage distribution was seen which separated between big suburban clusters and small ones, with few interlopers in-between. Of course, big suburban clusters adorned big urban centers, small suburban clusters grouping above all around small centers; the two-tier distribution was taking hold.

That big suburban clusters tended to congregate chiefly around big cities, and that both categories showed the same two-tier distribution resulted in a massive hump at the top of the rank-size distribution of the superclusters, with Geneva, Berne, Lausanne and Lucerne massively bigger than expected (*Chart 4-65*). Conversely, all centers below the 60th rank were now systematically smaller than expected if the Christallerian distribution was still holding. This tended to show that by 1985, only the top part of the center network looked like it had a Christallerian distribution, and only if considering that at the top of this network of thirty cities, four cities were massively oversized. Below the 60th rank, which corresponded to about 5'000 jobs, the centers were systematically missing; at the end of the distribution, centers had only a quarter of the size a Zipf-like distribution would postulate. The dearth of centers with less than 5'000 jobs was now patent.

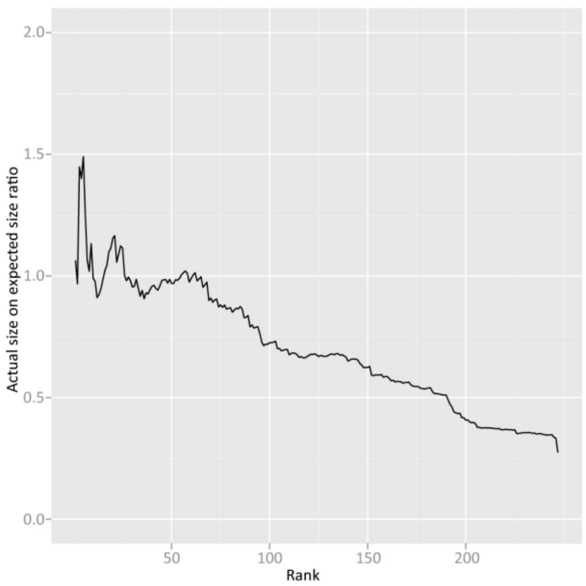


Chart 4-65: Supercluster rank-size distribution compared to Zipf's law, 1985

4.5.1.8. Aspatial conclusions

The decade following 1975 is rather difficult to qualify in terms of economic conjuncture. It wasn't clearly as marked as the economic crisis as 1973 to 1975 were, nor was it a return to pre-1970 growth conditions. Instead, the period was characterized by an alternating pattern of short economical crises (in the late 1970s and again in the early 1980s) and of economic recovery (in the mid 1970s, and from 1983 on). In all, economic recovery prevailed at the decade level with an annual job growth rate of about 1.7% per year. Quite accordingly, the urban network showed no definite evolution during those slightly chaotic years, and seemed to evolve in two different directions. First, it halted the evident slide it was in during the recession years of 1973-1975. Secondly, it seemed to strengthen the trends first seen there, less in terms of decline than in terms of restructuration.

In total, the urban network regained a bit of the ground lost during the preceding period. Accordingly, its overall job share recovered partly. Even if the edgeless job share did regress a little, it remained at a higher level than in 1965, while still gaining jobs at an absolute level, albeit at a far reduced rate than before.

Even if the whole urban network gained a little weight during the 1975-1985 period, such is not the case of the classical urban centers, which job share continued to drop. But the real change the classical centers experienced happened elsewhere. Firstly, their job density dropped significantly, whereas it had remained essentially stable since WWII. Secondly and above all, classical urban centers experienced a massive rise of their job intensity, which highlighted a major change in the urban structure: the late 1970s and the early 1980s were the times when classical cities specialized massively into job centers. At the same time the classical cities gained jobs, they continued to lose active residents, to the effect that the classical cities now counted 500'000 more jobs than active residents, against 350'000 ten years earlier.

Edgeless space remained rather unchanged during the 1980s; its job intensity stabilized while its job density continued to drop. In essence, edgeless space was becoming more edgeless but slowlier than before, as if edgeless space was starting to find an equilibrium point.

As a whole, suburban centers continued to grow. Again, this rise was mainly attributable to the intrinsic growth of suburban centers, which also underwent a definite rise in job intensity. While less impressive than the sudden intensity rise experienced by the classical centers, this concomitant rise confirms that territorial specialization was engulfing the whole of the territory and could not be reduced to a center-periphery dichotomy: inside suburbs, specialized job centers were slowly developing and taking hold besides their parent cities. The fact is that for the first time they seemed to mature as well as to grow; the fact is also that by 1985, suburban center progression was sensible in well-established suburban centers; growth was attained both by adding new units that were not quite central yet, and by furthering the development of established centers. Between 1975 and 1985, some suburban centers started to look like they were going to last, and to compete with cities.

Compared to the suburban centers, the other classes of dynamic centers seemed small. However, at least two of them were also showing signs of growth. Firstly, the dynamical cities continued to gently progress. Their density remained fairly stable, while, like all other urban centers, their job intensity jumped again. As such, dynamical cities remained a sort of transitive form between bona fide cities, with which they shared notably their job intensity, and suburban centers with which they shared growth, mean size and job density.

Another class of transitional objects made their entry in the urban network in 1985: the mixed, urban-suburban centers, former cities that had lost their urban characteristics by being engulfed in urban agglomerations bigger than them and centered elsewhere, and which reinvented themselves as secondary centers of their new parent agglomerations. As defined they should share their characteristics more with suburban centers than with classical cities. In any case, four of them emerged during the twenty years leading to 1985, grouping very few jobs and having the qualities of just emerging places: not very dense, and a very low job intensity. Clearly, those places were just then reemerging from a phase of purely residential development that had swamped their urban qualities.

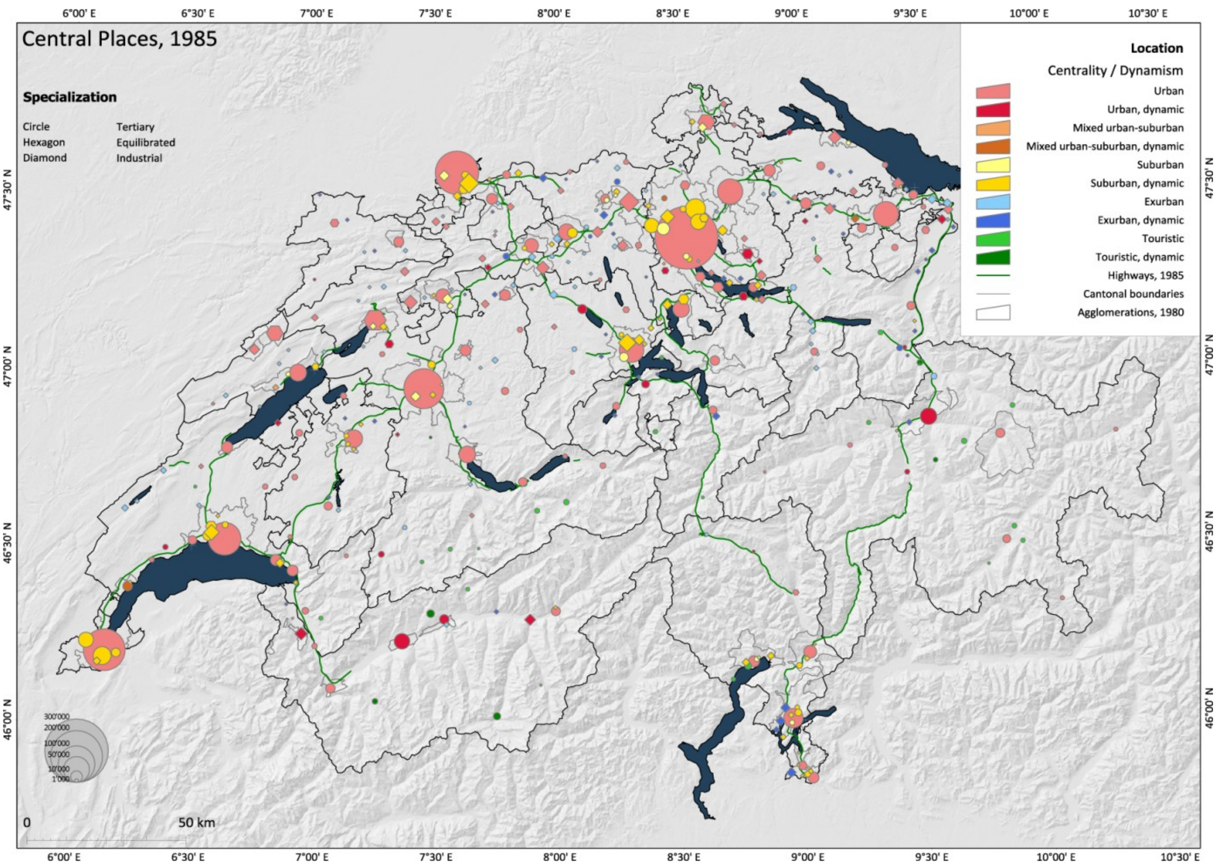
Likewise, dynamical exurban centers continued their slow, subdued growth. Such exurban places were above all remarkable for their low densities and high intensities, which indicated a specialization towards land-hungry activities removed from residential zones.

In all, 1985 marked a period which, in terms of structures, showed a strengthening of the phenomena already noted between 1965 and 1975, with a Christallerian network of cities still dominating, but slowly losing ground both at the bottom of its own network and to new urban forms, above all that of dynamical suburban centers. In terms of functionality though, the period 1975-1985 marked a major change, a second revolution after the disappearance of urban remnants and challenge of the almighty Christallerian network by the suburban centers: that of the relentless functional segregation which occurred between residential zones and job places, showed here by the sudden and violent rise of the job intensities of all major job center categories: classical cities, dynamical ones and suburban centers. That second phenomenon is undoubtedly the major find of this study about this period.

4.5.2. Spatial patterns

4.5.2.1. The urban network pattern: the rise of metropolis

When looking at the 1985 map, the first impression is one of stability (*Map 4-16*). There was clearly no big growth as was the case between 1939 and 1965, and no sudden disappearances like between 1965 and 1975. Most of the biggest urban centers were fairly stable between 1975 and 1985, which gave an impression of great stability. However, this impression was somewhat false as the network evolved, but in a subtle manner.



Map 4-16: Central places by size, location and orientation, 1985

The first major change concerned the suburban centers. First of all, they grew. Growth was clear above all around Zurich and Geneva, but was noticeable also around Lausanne and Berne. Secondly, a wave of suburban centers emerged during this time, which was very clearly metropolitan. The biggest such emergence concerned the Lucerne-Zug-Zurich corridor, where several new suburban centers emerged simultaneously, both shores of Lake Zurich, where urban, suburban and exurban centers emerged or reemerged. In Aargau, a resurgence of mostly exurban centers was also noted. In short, there was a massive and diversified rise of the urban network in what was becoming the Zurich metropolitan area. Conversely, nothing of the sort happened around the other main centers of the country, where growth was limited to suburban centers. Thus, the greater Zurich area distinguished itself from the rest of the country at this time.

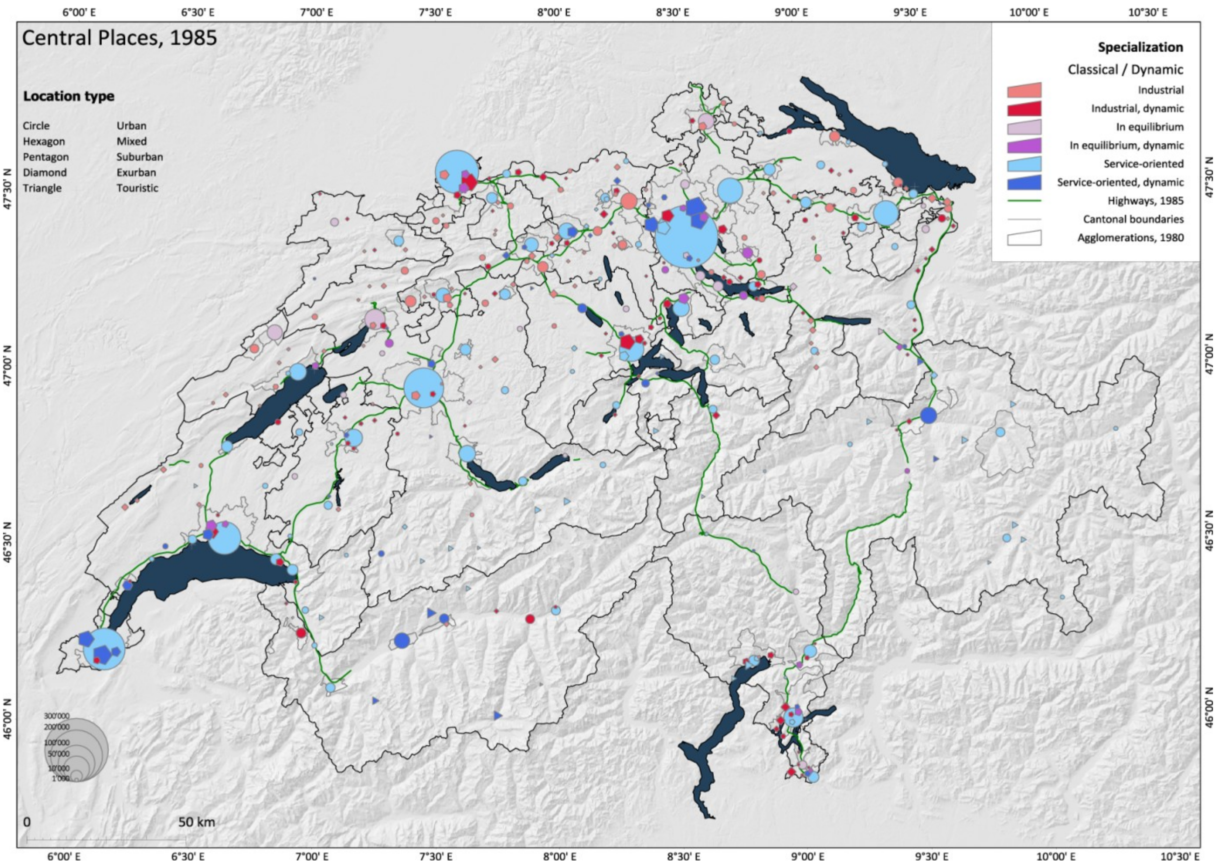
Eastern Switzerland saw a strong recovery of its urban network, which had been decimated in 1975. This recovery took above all the form of a resurgence of many small exurban centers. One could link this resurgence to the industrial status of Eastern Switzerland; however, other industrial areas of the country, especially those far away from Zurich, did not experience growth. On the contrary, for the Jura Mountains the 1975-1985 period was not frankly better than the preceding one, and from Ste-Croix to Delémont crises succeeded to crises. Elsewhere, the main impression was one of stability.

4.5.2.2. Center-periphery patterns at the national scale: A stronger centrality gradient

As we have seen, the larger Zurich area saw changes which were unique to it: around Zurich, suburban centers boomed, but they also boomed further away, in the greater area, notably around Zug and Lucerne, while new urban, mixed or exurban centers emerged or turned dynamic at the time. The area where those phenomena were happening covered the whole cantons of Zug and Zurich, the Lucerne area, Aargau's eastern half, the Zurcher Obersee, and to a point Eastern Switzerland. No other center was able to generate such effects on its neighborhood. Around other major centers, the phenomenon was limited to one of suburban and close exurban center growth, such as around Geneva, Lausanne, Berne, Basle and Lugano. In still smaller areas stability dominated, while many smallest centers disappeared from view, especially in peripheral industrial areas, like the Jura Mountains.

Thus, there was a very strong centrality gradient which built up during the decade leading to 1985, with a true metropolitan area which emerged in and around Zurich, the other big centers still reinforcing their position while in-between areas outside the metropolitan area and peripheries were gradually fading away.

4.5.2.3. Differences according to agglomeration size: industry leaving centers



Map 4-17: Central places by size, orientation and location, 1985

As we have already seen, there were great differences according to distance from the center in 1985 (*Map 4-17*). This was also the time when most medium-sized cities that had not already turned towards services did so. This was – again – particularly clear in the greater Zurich area, with industrial powerhouses like Winterthur and Schaffhausen turning away from industrial domination, as did many of the lesser centers in the immediate vicinity of Zurich, or some of its major suburban centers. This way, 1985 was an age of accelerated deindustrialization for the greater Zurich area. This was less the case in its outer metropolitan areas – the suburban centers of the Lucerne-Zug axis remained firmly industrial, as did most of the Aargau centers that had not already turned towards services.

Around other major centers the period was above all remarked by the fact that suburban centers started to turn less industrial. In Basle and Lausanne in particular, some of them turned equilibrated. Around Geneva and Zurich, suburban centers had by now finished their transition towards services. Around lesser centers, though, suburban centers remained industrial in their majority, as did exurban centers and local centers at large.

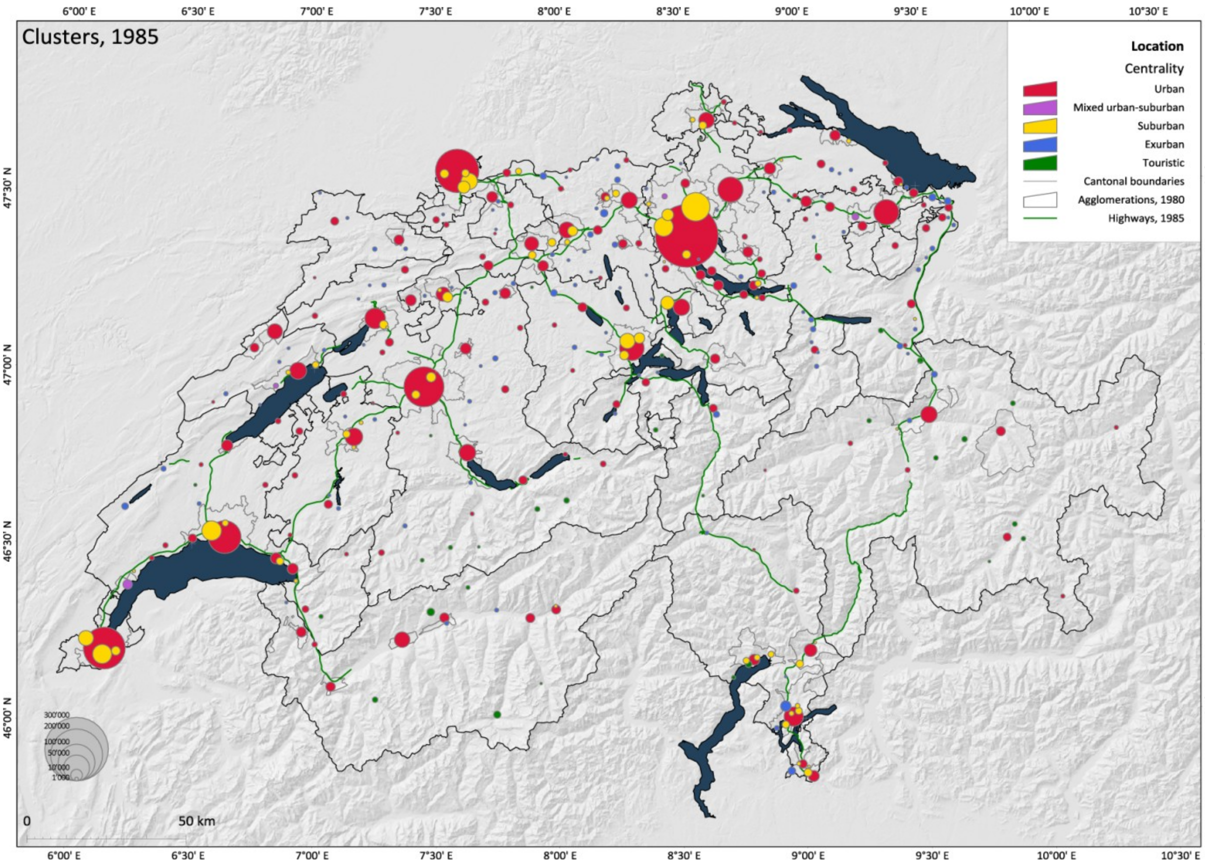
4.5.2.4. Regional patterns: eastern domination and Jura's demise

If most of the developments between 1975 and 1985 could be described in terms of center-periphery theory, it remained that there were clear regional effects involved. The most important is that, as a whole, the 1975-1985 period was one of growth and recovery in the eastern half of the country; the rising metropolis was situated there and its chief industrial regions seemed to recover from the 1975 crisis. Such signs were not seen in the western half of the country.

There, major centers did not spawn a general rise of mixed, suburban and exurban centers like around Zurich – they saw only the closest suburban centers grow. Furthermore, its main industrial region took a battering like the one already registered in the 1970s. For the Jura Mountains, 1985 marked the end of a twenty year crisis. In and south of the Alps, there was great stability.

4.5.2.5. Mapping clusters and superclusters: a farewell to Christaller

Several facts were noted when looking at the 1985 cluster map, first of which the growth of the major clusters (*Map 4-18*). Around Zurich, the Glattal complex gained 13'100 jobs at 60'300, by

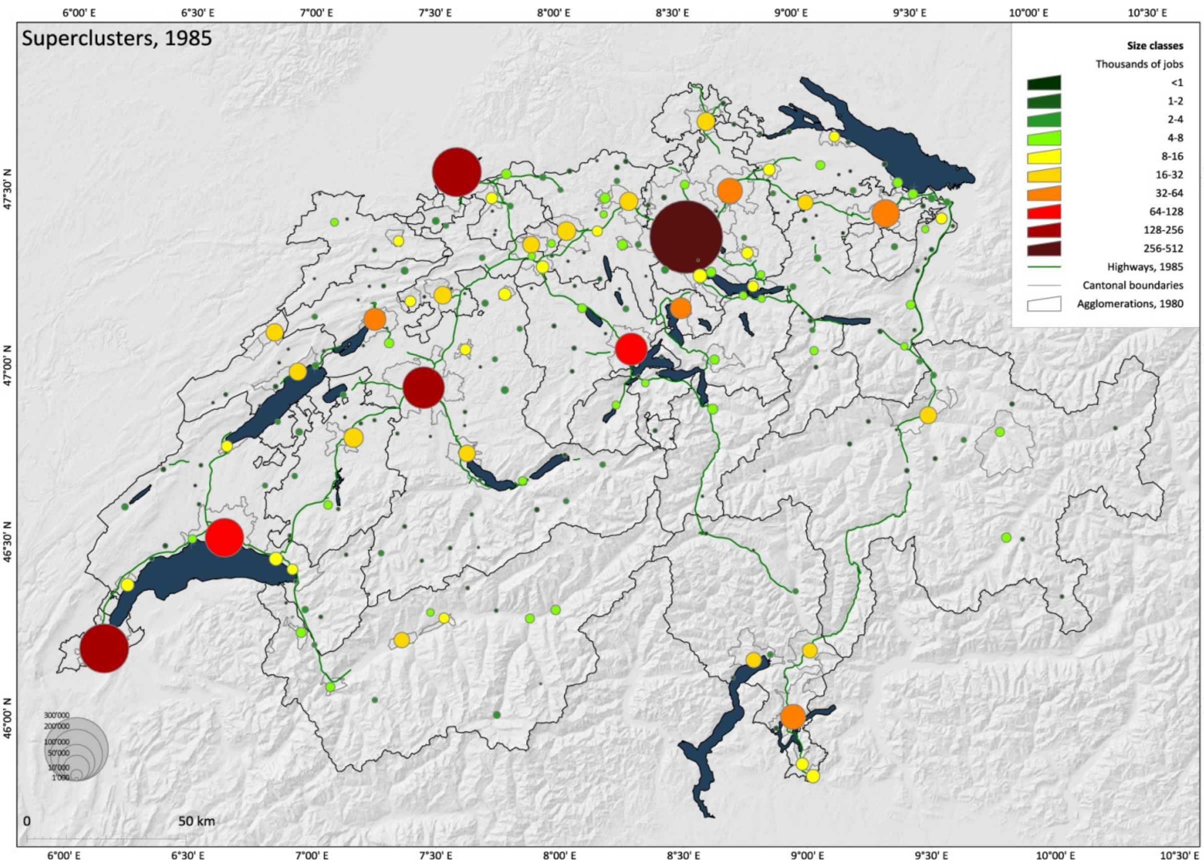


Map 4-18: Clusters by size and location, 1985

very far the biggest edge city of the country. The Limmattal complex gained 3'400 jobs at 26'800. Geneva also saw its two major clusters grow, Cointrin by 2'600 jobs to 16'800 and Carouge-Praille 4'700 at 27'000, the third largest of the country. The Western Lausanne complex gained 3'500 at 28'300 jobs, making it the second largest of Switzerland, although not being half as big as the first. Other clusters above 10'000 jobs included: around Basle, Schweizerhalle, stable at 19'600 jobs, and Birstal, up 700 jobs at 11'000, the Reusstal complex north of Lucerne, up 2'900 jobs at 17'100, and last but not least the new Zugersee complex which appeared at once powerful with 12'800 jobs in 1985, against none in 1975. Just under 10'000 jobs, new units were gaining momentum, like Rotsee, in the Lucerne-Zug corridor, up 2'800 jobs to 8'300, and Vedeggio, west of Lugano, which gathered 2'100 more jobs at 8'100.

Three facts stood out when looking at the spatial development of clusters. The first was that, as before, big units grew quicker than the others, and as they were exclusively grouped around major centers, they reinforced the central role of those centers. However, for the first time there was a general wave of edge cities cropping up around lesser centers. The most revealing example was certainly the Zugersee case, but sizeable clusters were now to be found around Lugano, Aarau and Olten. Thirdly, clusters were progressing more easily around tertiary centers like Zug, Lugano, Olten, than around industrial ones, like Solothurn or Biel, even if themselves were being industrial.

At the supercluster level 1985 marked, subtly, the true departure of the Christallerian network (*Map 4-19*). For the first time a series of distinct phenomena happened, which all, each in their own manner, picked at the Christallerian order. First, and as before, the growth of clusters al-



Map 4-19: Superclusters by size, 1985

lowed the major cities to grow. This was particularly true of the three cities with large and expanding clusters of edge cities: Zurich, Geneva and Lausanne. But more importantly, urban growth was now clearly apportioned along regional and economic lines. In three distinct areas, superclusters grew strongly. The first one was the Zurich-Lucerne-Obersee triangle, with the spectacular growth of several superclusters, Zurich and Lucerne, but also and above all Zug, Rapperswil, Freienbach, Lachen. Here, a whole urban region, a true metropolis, grew as a whole. The second area to experience such regional growth was the Lake Geneva area, in particular in Geneva and Lausanne, but with notable growth recorded also in Nyon and Vevey-Montreux. Thirdly, the Ticino also grew as a whole, with particular mentions to Lugnao and Mendrisio.

If Eastern Switzerland saw its urban network experiencing a rebound after the 1975 catastrophe, such wasn't the case in Aargau, the industrial heart of the country or in the Jura Mountains, and very selectively only in the Western Mittelland. Clearly, there was a strong link between the economic orientation of the region, and the growth of the urban structure. Industrial areas stagnated, or declined. Service-oriented areas progressed. In former rural areas, the urban strcucture also progressed.

Thus, three major facts emerged: first, three major metropolitan areas emerged, around Zurich, in the Lake Geneva area, and in Ticino. Secondly, classical industrial areas continued to stagnate – Aargau, the most industrial parts of Eastern Switzerland – or declined – the Jura arc. New, formerly rural and alpine areas emerged as service-oriented urban networks and as such experienced strong growth. Thus, a new spatial order was put into place on the back of a major economic mutation, being the inception of the service economic domination. And in the process, Switzerland had abandoned the Christallerian layout of the territory.

4.5.2.6. Territorial conclusions: inching from central places towards metropolises

While major structural changes were at play in the decade following 1975, notably the very strong functional segregation tendencies between centers and suburbs, the geographical response to those changes appeared to be relatively muted. After the heavy losses endured in the previous decade, the urban network rebounded somewhat. In terms of size, the middle categories seemed to gain the most. This was confirmed by the fact that most of the job gains were made in larger centers, and especially in mid-sized cities; smaller cities scarcely progressed between 1975 and 1985 in terms of job numbers.

Thus, the Christallerian network was far from rebuilding itself. Upper and above all mid-level cities continued to grow, possibly at the expense of their smaller siblings. That being said, of the cities which appeared between 1975 and 1985, most, but not all, were cities that had disappeared in 1975. Some parts of the Christallerian network seemed to make a comeback on the map, and indeed those reappearances concerned above all some traditional regions, relatively far away from bigger centers. Thurgau saw for instance most of its 1975 casualties return in the network. However, not all peripheral regions reacted the same way. More generally, most casualties of the 1970s remained out of the urban network.

In terms of city growth, the period showed quite differing patterns across the country. In the Lake Geneva region, both Geneva and Lausanne saw their job numbers grow healthily, a phenomenon also general in the Alps and widespread in Ticino. At the same time, city growth in the industrial heartland appeared to be quite muted, with growth limited to the area centered on Lucerne and straddling the A2 and A14 corridors, then to the A1 axis between Frauenfeld and St-Gall. This was compensated by continuing losses in many industrial cities, essentially in and along the Jura mountains in the larger sense, extending to Schaffhausen. The territorial picture is thus quite marked by stark differences between regions, with northern regions losing out to southern ones, and with core regions losing out to outlying ones.

Around major centers, the dynamics were seemingly different. In those areas, restructuring appeared more extensive, with disappearances of relatively big classical centers and concomitant emergence of mixed centers, those former cities back from residential oblivion. It seemed that major centers were hampering the emergence of classical cities, especially smaller units, in their vicinity, while starting to stimulate other urban forms to emerge.

Exurban centers remained rather inconspicuous during this decade. Their numbers progressed, but not by much, and as ever they proved elusive and volatile, many of them disappearing to be replaced by many other which would flourish for one season and then fade away. Out of this statistical noise relatively few units emerged to stay. All those units remained very small in size compared both to classical cities and bona fide suburban centers.

Amid general atonement of the urban evolution in geographical terms, suburban centers stood out. Except around Basle, all major units grew strongly during the period under study. For its part, Berne was still curiously devoid of any meaningful edge city. Such discrepancies were widely seen in lower levels of the urban hierarchy. In general, new service centers fared much better than ancient industrial ones, while eastern Switzerland remained essentially devoid of any form of edge city.

As we have already surmised, 1985 was a relatively subdued time for the urban network evolution, at least with respect to its geographical dimensions. Not much seemed to appear on the map, but in this context, what happened was that suburban centers carried on progressing, being the sole urban category which sustained comparison with urban centers in terms of dynamics. Secondly, strong regional differences arose. In burgeoning metropolitan cores, such as Zurich, Geneva and Lausanne, and Lugano, both urban centers and edge cities showed strong progressions, while in industrial heartland areas, both center categories failed to progress, and retreated in some cases. In industrial outlying areas, cities made a modest comeback but hampered suburban center emergences – those were virtually absent from the Jura Mountains and from Eastern Switzerland. On the contrary, for the first time the southern, mostly catholic, traditional upper parts of the Swiss Mittelland showed strong urban and suburban dynamics, joining the Alpine regions where this phenomenon was essentially carried by regional and local centers.

Thus, this period showed that there were important and growing regional differences which affected the urban network dynamics in the aftermath of the 1975 crisis, with lesser industrialized, service-oriented regions – Upper Mittelland, Alpine regions, Ticino gaining on industrialized ones – Aare and Rhine valleys. On top of these regional imbalances, the largest cities, especially Zurich and Geneva, progressed both as centers and as embryonic metropolitan cores, complete with multiple fledging edge cities.

The 1975-1985 decade was the first where the Swiss Confederation actively pursued a regional policy, aimed at equilibrium between central, urbanized parts of the country and peripheral outlying ones. It could be said that for a part the policy looked a success, with the strong progress made by formerly backward areas such as the Alps in general and many subalpine, piedmont catholic areas of the Mittelland, compared to the more subdued growth of Switzerland's keystone cantons of the Aare valley downriver from Solothurn. However, regional policy also found its limitations and couldn't help counter the relentless success of the most central regions of all – Zurich and Geneva, alleviate the general economic atonement of the Jura Mountains or even overcome to a point the lack of dynamism of Eastern Switzerland.

4.6. 1991: the triumph of edge cities

4.6.1. Aspatial results

4.6.1.1. Location and centrality: the coming of age of suburban centers

1991 marked the end of a very dynamical economical period, unlike any lived since 1965, one of sheer growth (*Chart 4-66*). During this time and in terms of jobs, the economy grew 1.8% annually, a rate which was similar to the one in the post-war period, and double the one of 1975-1985. The period is thus interesting as it shows a pattern of strong economical growth, the first in close to a generation.

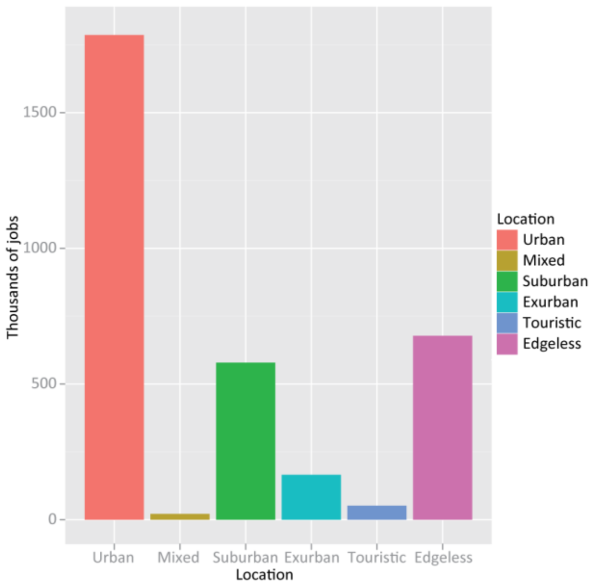


Chart 4-66: Job numbers by location, 1991

The center network indeed showed renewed dynamics. The total number of centers reclaimed 65 units to reach a new record-setting 449. More impressive was the job growth, a total of 344'000 jobs gained in just 6 years, for a new total of 2'604'000 jobs, equivalent to 57'000 jobs gained per year, its best figure ever. This growth was even more impressive when compared to the actual loss that edgeless space registered during the same period, admittedly a tiny loss, just 12'000 jobs, but a loss nonetheless. Thus, all the growth registered during the late 1980s economical boom was going to centers. Correspondingly, their job share jumped 2.7% to 79.3% of all jobs, edgeless space taking the rest.

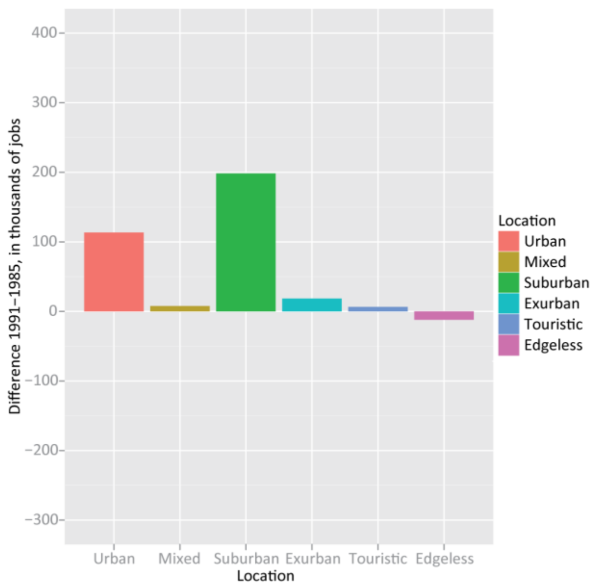


Chart 4-67: Job numbers difference by location, 1991-1985

In absolute terms, all locations types except edgeless space gained jobs, but at vastly different scales, as only two location types were responsible for most of the growth (*Chart 4-67*). First, urban centers gained 6 units and 113'000 jobs at 1'786'000 during the 1985-1991 interval. This gain wasn't enough, though, to guarantee a constant job share and urban centers lost 2.3 points at now 54.4% of all jobs; in fact, the share loss was accelerating, since urban centers had lost in six years what they had previously lost in ten. Structurally, though, they tended to strengthen. They didn't lose any density during those six years, remaining at a very high 30 jobs per built ha, while their intensity continued to grow, at an impressive 150 jobs per 100 active residents. This last fact furthered their job-actives imbalance, which grew about 67'000 units to 592'000 more jobs than actives in urban centers. Likewise, their mean size grew a little to 12'070 jobs per urban center, showing that the growth was attained above all by growth of existing centers rather than by adding new ones into the network, which should unbalance it further from a Christallerian point of view.

The major winners of the period were the suburban centers – again. They gained an impressive 37 units to a new total of 131, grouping 579'000 jobs, 198'000 more than in 1985, and more than half of all job growth of the period. If a job had been created between 1985 and 1991, there were more chances than not that it was being created in a suburban center – and if not it was most certainly created in an urban center. Of course, suburban centers job share progressed greatly, 4.7 points to 17.6% of all jobs, in just six years. During the same time, their mean size grew up 350 jobs par centers to 4'420, which meant that suburban centers grew both by growing existing centers and by adding new ones. Structurally, suburban centers started to strengthen, something they had never done before, trading quality for growth. This gain in quality made them open a sizeable gap in job imbalance. The intensity that suburban centers, as a group, reached in 1991, 108 jobs for 100 active residents, meant that there were now 42'700 more jobs than active residents in suburban centers.

Exurban centers, meanwhile, remained fairly stable during the period under review, participating, but weakly, to the general growth of the time. Exurban centers gained 16 units to 131. However, they gained less than 19'000 jobs. Correspondingly, they remained very small. Structurally, they remained as they already were. Their job density continued to decrease, to less than 8 jobs per built ha, while their job intensity remained stable. Their job share retreated a bit and established itself at 5% of all jobs, far less, now, than the suburban centers job share. Mixed centers, meanwhile, were still very few, as they were only five of them. Structurally, they looked very much like suburban centers.

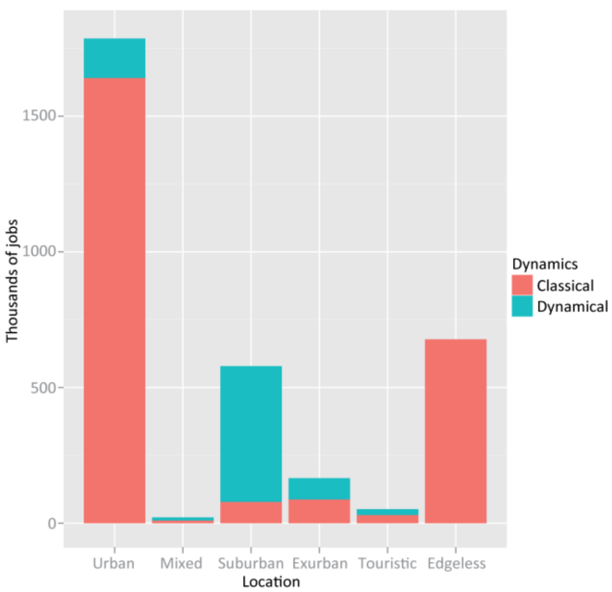


Chart 4-68: Jobs by location and dynamics, 1991

Edgeless space was the only location category which lost jobs during the 1985-1991 period, by losing 12'000 jobs to a new total of 678'000 jobs. It was still the second category in terms of sheer numbers, with a job share of 20.7%, down from 23.4% six years earlier. Structurally, it is interesting to note that edgeless space was now stable. Its job density even crept up a bit, to close to 8 jobs per built ha, the same figure than exurban centers.

4.6.1.2. Dynamics: a furthering of trends

Dynamical centers continued to take more and more importance in the center network (*Chart 4-68*). Their numbers grew strongly during the period, up 63 units to 215, against just 12 more for classical centers, which numbered now 234 units. In terms of job numbers, most of the growth was registered by dynamical centers: they gained 224'000 jobs at now 756'000, which corresponded to about three quarters of the total growth, and a job share of 23.0%, up 5 points in six years. In the central network, about a third of all jobs were now held in dynamical centers, against a quarter in 1985.

In terms of structure, while dynamical centers were still a far cry from classical ones, they tended to have significantly strengthened during the 1985-1991 period. Their density gained one point at about 14 jobs per built ha, against 25 in classical centers, while their job intensity climbed 7 points to 119 jobs per 100 active residents, against 143 in classical centers. As a whole, dynamical centers were still relatively small places that were counting on ample space to develop themselves.

Suburban centers accounted for about two thirds of all dynamical jobs, while most suburban centers were dynamical – 106 such centers against only 25 classical ones. Dynamical exurban centers started to count, too, with about half of all exurban jobs, and structurally the sounder one, located in dynamical units. In absolute terms, at last, dynamical urban centers were also gaining strength, but they still were marginal, as their jobs represented less than a tenth of all urban jobs. As such, the period between 1985 and 1991 furthered the trends already seen since 1975.

4.6.1.3. Orientation: the triumph without return of the services

Service centers continued their relentless progression between 1985 and 1991. Their numbers went from 146 in 1985 to 197 in 1991, a gain of 51 units in just 6 years: service centers were appearing like boomtowns (*Charts 4-69 & 4-70*). Service centers likewise gained 353'000 jobs to 1'963'000, meaning that they were accountable for the whole job growth of the period. Logically, their job share grew, 5.2 points to 59.8% of all jobs. Structurally, they remained unaffected by their growth's increased rhythm, except in terms of mean size, where a decrease was observed. This was the consequence of the diffusion of a service-oriented economy further down the central network: ever smaller centers were now turning towards a service-oriented economy.

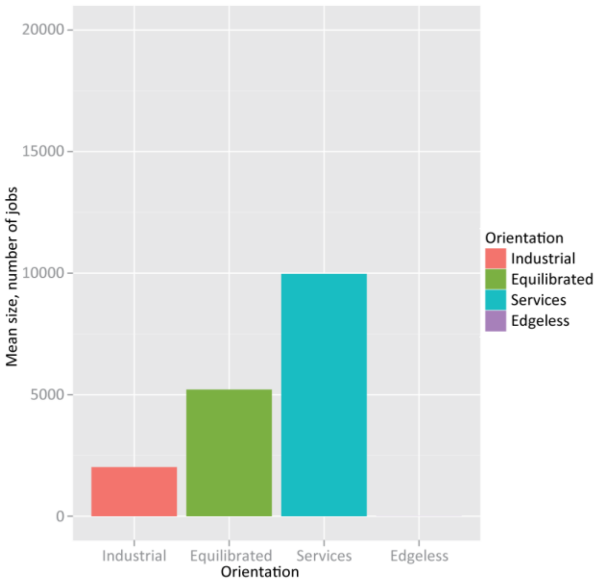


Chart 4-69: Mean center size by orientation, 1991

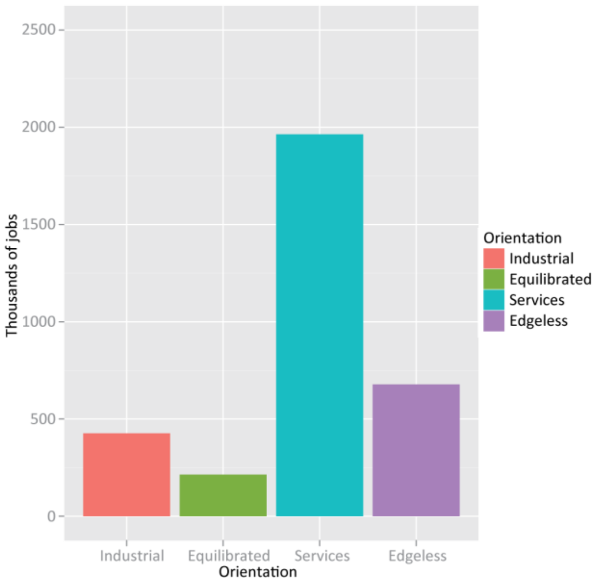


Chart 4-70: Number of jobs by orientation, 1991

In contrast, industrial centers, while gaining 11 units to 211, lost some of their jobs, which went down 22'000 jobs at 426'000. This represented just 13% of all jobs in the country, down 2.2 points. In a generation, Switzerland had effectively deindustrialized: in 1965, industrial centers grouped 35% of all jobs. At the same time, service activities had taken an undisputable and unassailable lead in the economy.

4.6.1.4. Form: a strong structural strengthening

The strong growth registered by the network showed itself by a strong structural strengthening of the center's form (*Charts 4-71 & 4-72*). Most jobs – 281'000 – were gained in centers that were both dense and intense, such as now 59% of all jobs were hosted in such centers. The complete centers also saw their structures hold, while their mean size decrease, for the same reasons than in the preceding paragraph, i.e. because smaller and smaller centers were joining the category. For the first time since 1965, the complete category made gains in absolute and in relative terms. To a point, this was also the case of dense-only centers, which staged significant growth during the period while maintaining by and large their structures: jobs were growing everywhere, including dense residential suburbs where dense-only centers were predominantly located. Their job share managed to grow a bit, 0.8 point to 7.1% of all jobs.

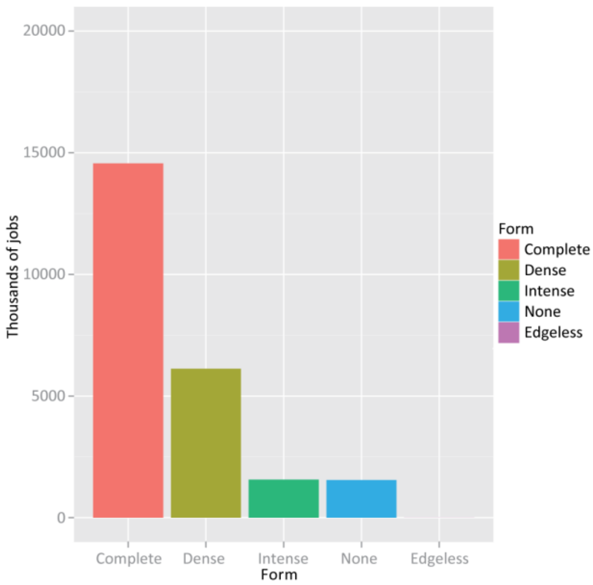


Chart 4-71: Center mean size by form, 1991

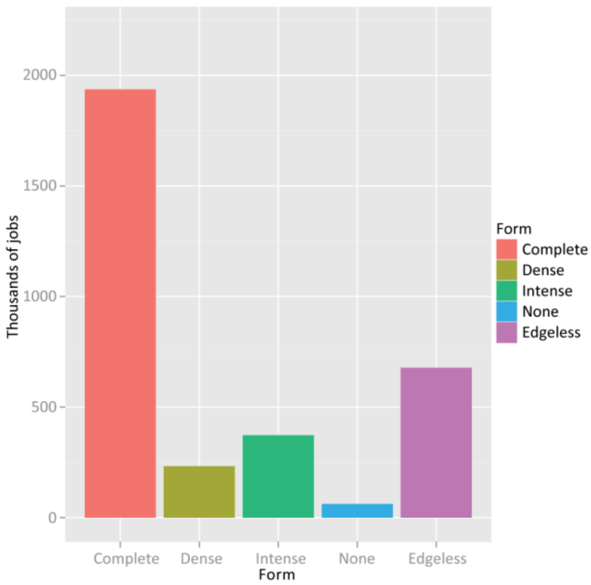


Chart 4-72: Number of jobs by form, 1991

The intense-only category, meanwhile, stagnated, not so much in terms of units – they gained 33 units to 238 – but in terms of structure and job shares, which remained stable. Intense-only centers, while welcoming new units, probably lost a certain number of their best cases which were dredged up by the general context to become complete.

4.6.1.5. Size: a pause, an optimum

While most everything moved fast during the six years leading to 1991, for the first time, job density remained essentially stable when controlling by center size class (*Chart 4-73*). If anything, a small increase in job densities was recorded in the three highest classes of all, those counting centers greater than 64'000 jobs, i.e. the big five. Everywhere else, density remained very stable during the period under review.

Job intensity, for its part, continued to grow across the board, albeit more slowly than before (*Chart 4-74*). Growth was general, but particularly marked in centers greater than 32'000 jobs, with the exception of the three greatest centers of Zurich, Basle and Geneva. There was, then, a catching-up effect which made the two following big cities, Berne and Lausanne, gaining about the same density than the three cities aforementioned.

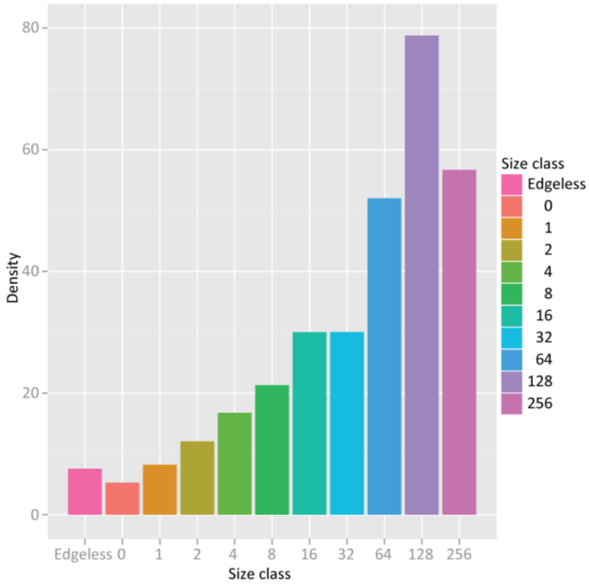


Chart 4-73: Job density by center size class, 1991

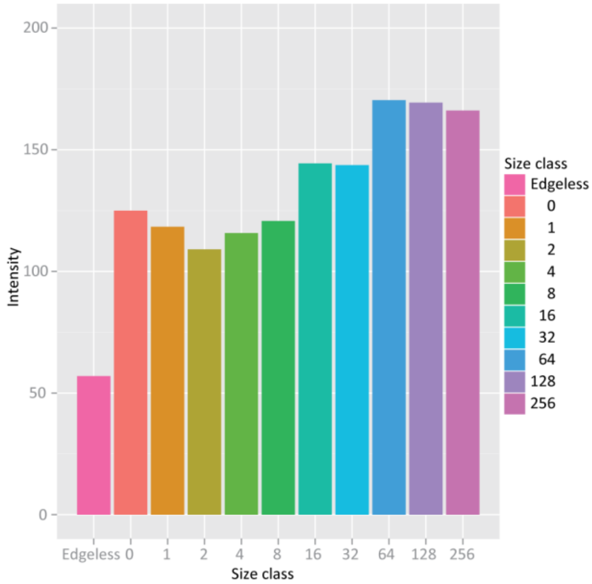


Chart 4-74: Job intensity by center size class, 1991

Therefore, it seemed that at least in terms of job density and intensity with respect with size the situation had stabilized, as if it had attained an optimum. In terms of intensity, the upmost level of the hierarchy was establishing itself as a network of five centers which dominated the others.

4.6.1.6. Rank-size and job numbers by size classes: the return of the mid-sized centers

By 1985 everything seemed to be moving towards a two-tier size distribution of centers, with two sizes grouping many centers while the intermediate levels were rather empty (*Chart 4-75*). In that sense, the strong growth experienced by centers between 1985 and 1991 somewhat contributed to correct this imbalance. By 1991, the rank-size distribution had returned, at least partly, to a more equilibrated state. In particular, the distribution of centers above 32'000 jobs was far more equilibrated than before, while representing the same job share, a bit more than 30%, than in 1985. Some supplemental growth was noted for centers between 4'000 and 32'000 jobs, which together represented now 33%, against 31% in 1985; if there was a size range where overrepresentation was present, it was now in this category. That may be because of an overrepresentation of suburban centers in that bracket, knowing that they didn't conform to a Zipf-like tank-size distribution. Last,

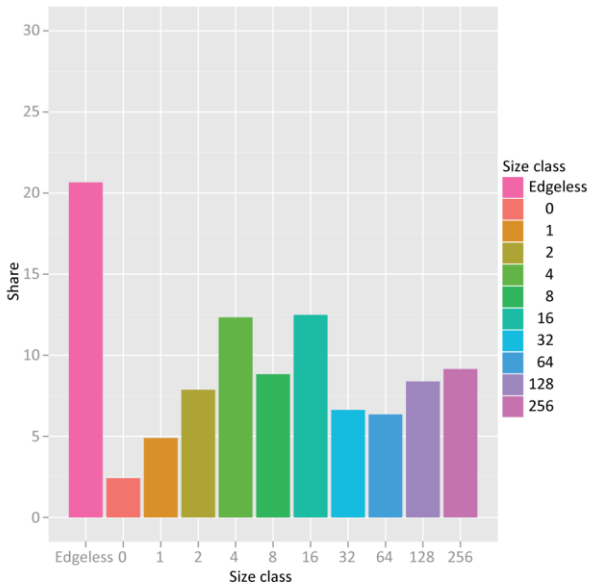


Chart 4-75: Job share by center size class, 1991

while being more equilibrated than before, the center network didn't compensate its strong lack of small-sized centers, which remained as pregnant a feature of the central network as ever. While growth had somewhat redressed the central network, it was only in its upper and middle levels. The lower level stayed depleted. Then again, for the first time in ages, the middle levels of the hierarchy seemed to withstand competition from the top levels; the Swiss central network wasn't that top heavy anymore.

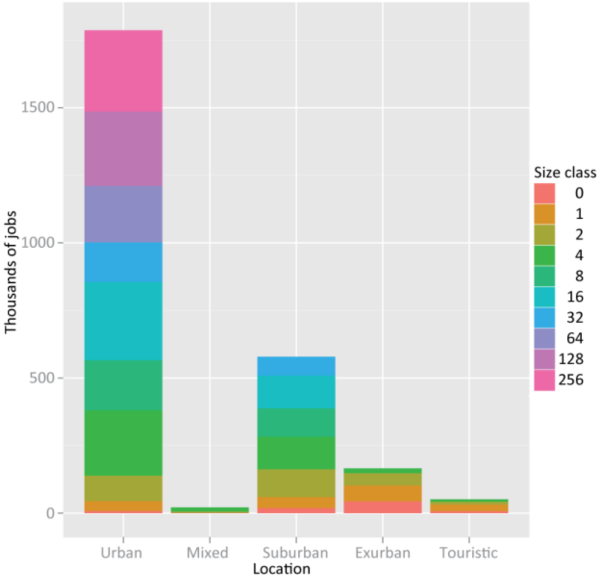


Chart 4-76: Job numbers by location and center size class, 1991

That the central network equilibrated during the 1985-1991 is patent when looking at the size distribution of centers when controlling for location (*Chart 4-76*). First, urban centers grew only from 4'000 jobs up; their growth actually reinforced the dearth of small-sized urban centers. However, small-sized suburban centers saw growth, to a point where they now outnumbered small-sized urban centers. Furthermore, the strong growth registered in suburban centers was especially profitable to all center sizes above 2'000 jobs, including the size classes where urban growth was more muted. Thus, suburban growth contributed greatly to the equilibrium noted in the whole network in 1991.

4.6.1.7. Zipf's law, clusters and superclusters: trend continuation

The study of the rank-size curve for 1991 showed that the trends already noted in 1985 were furthered (*Charts 4-77 & 4-78*). In essence, the biggest centers, which in 1975 were in line with Zipf-like expectations, were falling further under the curve, meaning that from a Zipf's law point of view, compared to the entire network they were getting smaller. This means that growth was

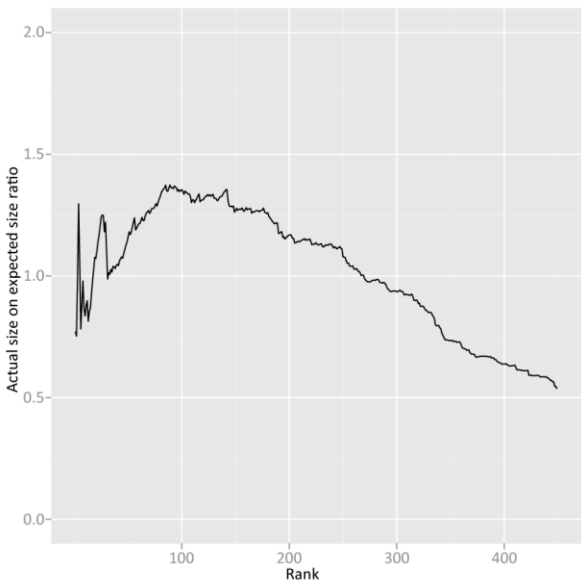


Chart 4-77: Units rank-size distribution compared to Zipf's law, 1991

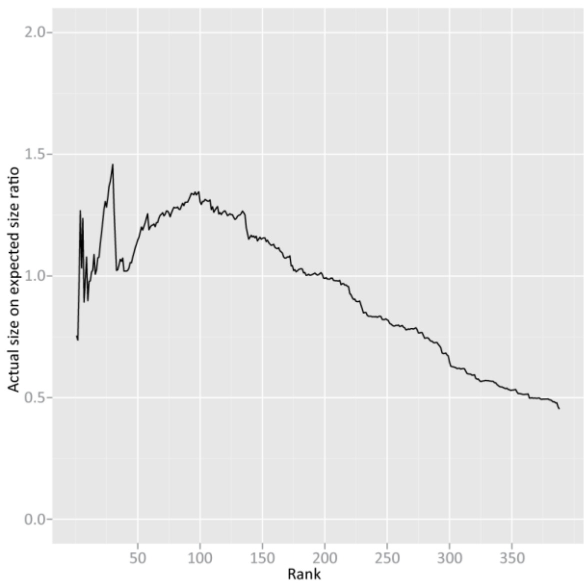


Chart 4-78: Cluster rank-size distribution compared to Zifp's law, 1991

not affecting above all the biggest centers. This was already seen in 1985, buit in 1991, it became more general, with most big and medium-sized centers getting closer to the ideal Zipf's line. On the contrary, the bulge already noted in 1985 for medium-small centers developed between 1985 and 1991: all centers counting between 1'400 and 12'000 jobs were larger than the Zipf expectation, some by a wide margin: centers around 6'000 jobs were 40% larger than expected given their rank in the network. The effect was that the very strong dearth of smallest centers was somewhat reduced.

As we could expect this new bulge development to be essentially due to the inflorescence of edge cities, the rank-size distribution made at the cluster level should be revealing. In essence, the same conclusions are made than at the unit level: a relative weakness of the biggest centers, a fall into line of bigger and medium-big ones, and a bulge at the medium-lower levels of the hierarchy, and a dearth of smallest units. However, there was no reinforcing of the bulge effect by clustering suburban units together, rather the opposite. However, a relative dearth of medium-big centers was corrected at the cluster level, suggesting that suburban units which were strongly present in the bulge were grouped in relatively large clusters, which contributed strongly to correct the two-tier distribution seen in 1985.

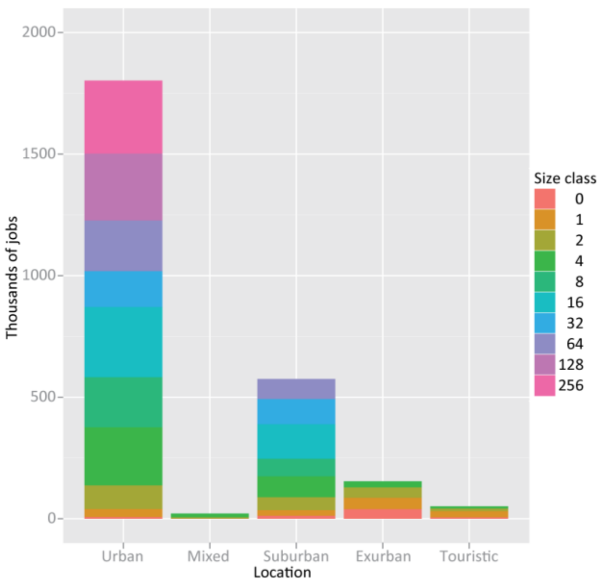


Chart 4-79: Job numbers by location and by cluster size class, 1991

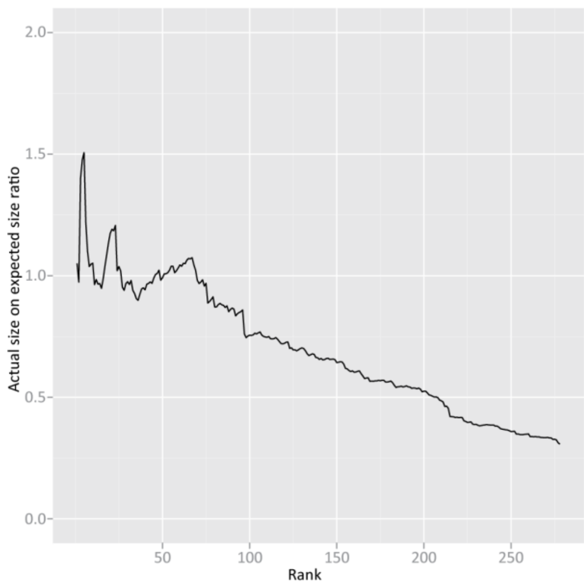


Chart 4-80: Supercluster rank-size distribution compared to Zipf's law, 1991

Looking at the cluster size class distribution when controlling for locations for 1991 showed that suburban clusters had grown first in the size class from 8'000 to 16'000 jobs, and then in the class of objects above 32'000 jobs, thus padding the preriously very much overrepresented class of the 16'000 to 32'000 jobs clusters (*Chart 4-79*). Thus, this imbalance was somewhat corrected on both ends, some of its objects having grown over the 32'000 jobs limit, while a new class of smaller clusters flourished. The two-tier distribution which was seen in 1985 was thus smoothed.

Surprisingly, while at the unit and cluster levels the rank-size distribution evolved, at the supercluster level it remained fairly stable for the period between 1985 and 1991 (*Chart 4-80*). This means that all changes that we noted earlier were affecting above all the internal structure of superclusters, without touching at their general layout or their mutual relationships. In that sense, the 1985 to 1991 changes were clearly affecting the internal structure of agglomerations, notably by promoting a powerful emergence of suburban centers, but the changes remained bound by agglomerations limits. Thus, the metropolitan processes which were at play weren't redrawing the map of Swiss centers completely yet.

4.6.1.8. Aspatial conclusions

The short period between 1985 and 1991 was the most favorable economic period of the time span under study: during this period, the job growth established itself at an annual rate above 3% and the urban network had to absorb this relentless growth. It reacted by relentlessly growing. Thus, 1991 marked another urban optimum, after the one registered in 1965, and marked also an exacerbation of the trends visible since 1965.

The first important find is that as a whole the urban network progressed again on all counts. It did in terms of unit numbers, 449 in 1991, the highest number registered since 1939 and very probably the highest ever. It also grew both in terms of job share than in terms of absolute job numbers.

While job numbers grew in the centers, they remained stable in edgeless locations – the urban network absorbed the entire growth of the job market. However, this period of central growth remained, by and large, very different from the one following WWII. First of all, while the whole urban network grew, the classical centers only took a fraction of this growth. Hence, their job share declined. Their structure remained fairly stable, and by and large, classical centers in 1991 quite resembled the ones already in place six years before. As main component of the urban system they showed stability and continuity. Clearly, most of the growth was happening elsewhere.

As we mentioned already, growth didn't befall on edgeless realms, which remained fairly stable entities. Basically, one could probably say that if something was happening in some edgeless location, it would very quickly be promoted to central status, which would explain the behavior of edgeless space during these times. In terms of growth then, the big winners of the late 1980s were of course the subcenters. All categories of subcenters managed to gain job shares during these times, in all situations: mixed urban-suburban, suburban and exurban locations, whether dynamical or remnants, but of course not all with the same significance. The bulk of the growth occurred in dynamical suburban centers, where the clear majority of all jobs gained happened, way more too than what the classical centers gained. Dynamical suburban centers hosted an explosive growth, marked above all by the emergence of a crowd of new units rather than by sheer growth of the existing ones – although that did also happen. Moreover, this growth marked also a strengthening of the urban form suburban centers represented – it is worth to remember that fifteen years earlier those areas were qualitatively very weak. While the 1975 to 1985 era was one of specialization of classical centers as job places, and one of emergence of suburban centers as potentially very significant urban forms, 1985 to 1991 marked the massive irruption of so-called edge cities onto the Swiss urban scene. What had been visible till the mid-1960s as a potential did finally happen in full.

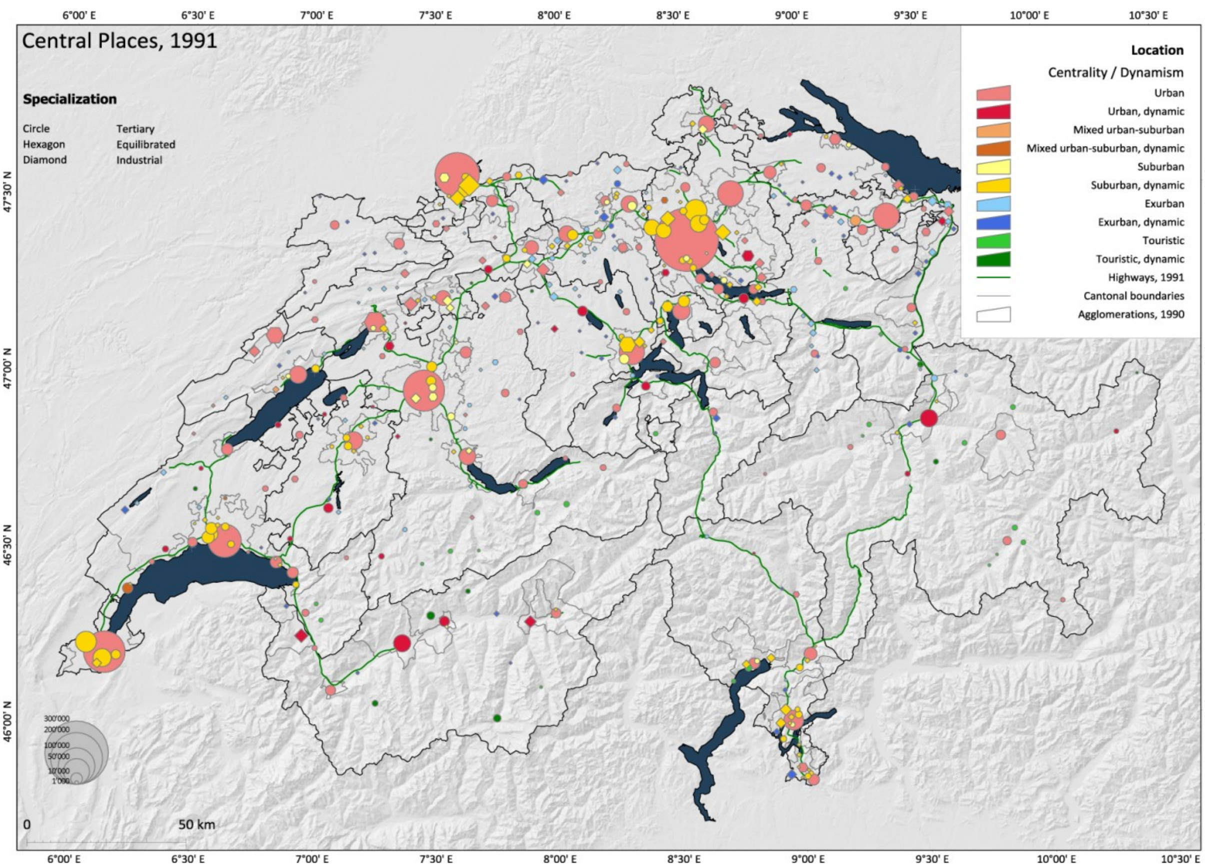
Also significant was the rise of dynamical exurban centers. In 1991, they matched at last the number of jobs held in exurban remnants. While they resembled the exurban remnants by their size and their density, they showed strong job intensity, at 142 jobs per 100 active residents, which separated them quite neatly from their antiquated counterparts. Lastly, dynamical mixed centers did not show a definite trend during those years, and did not progress as much as their suburban counterparts. The 1985-1991 years were not conducing to reoccupy former cities that had turned into residential suburbs yet: edge cities were being built out of scratch. To those who think that there is no urban space outside of classical centers, then, this period was a period of dilution or destruction of urbanity.

The period leading to 1991 was above all marked by a relentless growth of the urban network at large, with the suburban component playing a leading role in absorbing this growth, and outclassing classical cities as prime locations to absorb job growth. For this reason alone, for Switzerland as for the US, the late 1980s were clearly the age of emerging edge cities.

4.6.2. Spatial patterns

4.6.2.1. The urban network pattern: a generalization of edge cities

When looking at the 1991 map, the overall picture is one of furthering of the trends already noted for 1985, i.e. a reinforcing of the urban structure of the country (*Map 4-20*). However, there were significant disparities amongst centers as to how this growth happened.



Map 4-20: Central places by size, location and orientation, 1991

By and large, urban centers showed stability and resilience, but for the most part no significant growth. Amongst the largest centers of the country, for instance, Zurich and Geneva saw no significant increases of their job tally, whereas Basle, Lausanne and above all Berne saw such developments. At lower levels, there were strong regional and structural effects in the differential growth of centers, it being decidedly stronger in the southern half of the country: the Alps, and the Upper Mittelland parts, with major growth occurring in the urban centers of Valais, Graubünden and Central Switzerland. In the northern half of the country, stability reigned. In the same vein, it is worthy of note that most of the dynamic centers that had appeared by 1991 were also situated in the southern half of the country, particularly in Valais and Central Switzerland where they formed a big part of the urban network.

Of course, the major change between 1985 and 1991 concerned the suburban centers, which exploded into view even more strikingly than in 1985. Growth was absolutely spectacular around all major centers of the country, while colonizing other areas as well. Berne, which had been shielded up until 1991, saw the concomitant emergence of a string of edge cities, all along its Eastern highway belt. In Geneva, the Cointrin-Meyrin area boomed, as the Birstal south of Basle, and the Upper Glattal area East of Zurich. At lower levels, emergences were also impressive in the Lucerne-Zug corridor, the Lake Zurich shores, around Fribourg and Neuchâtel. At lower levels, several exurban centers being engulfed in expanding suburban belts experienced rebirths as dynamical suburban centers, particularly in the Gäu area west of Olten, and in the Val Vedeggio west of Lugano. Moreover, in the Aargau corridor several smaller units appeared interspersed with urban centers. By 1991, not only major centers, but most regional centers were now adorned with significant edge cities. Exurban centers lost some of their units to suburban belts but by and large maintained their levels, and even reinforced in some areas, above all in Eastern Switzerland and Aargau.

If there was on oly one thing to retain from the center network evolution between 1985 and 1991, it would be the very strong expansion of suburban centers, which took most of the growth of the period upon themselves.

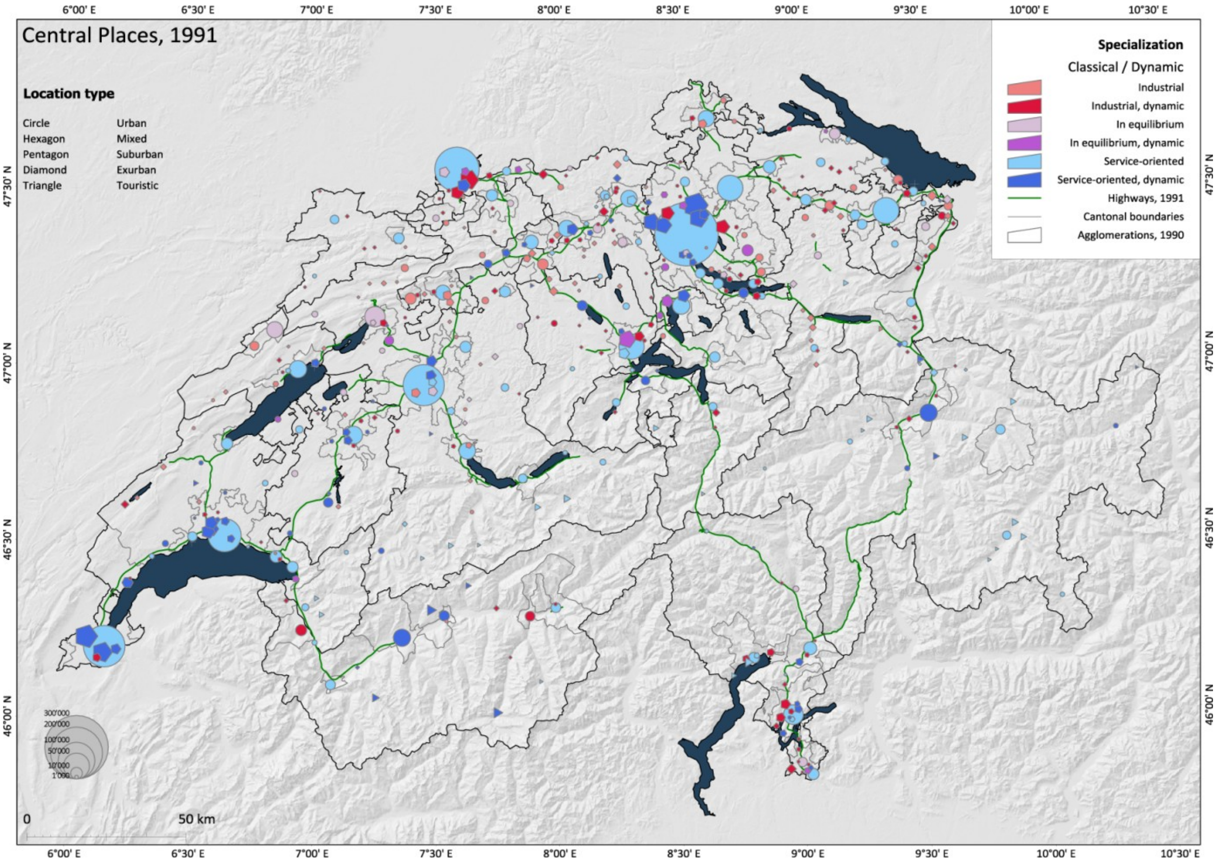
4.6.2.2. Center-periphery patterns at the national scale: equilibrium furthered?

In terms of national center-periphery relations, the 1985-1991 evolution showed a markedly mixed picture. On the face of it, it seemed that peripheries were doing better than central areas, on all accounts. In all, cities were growing quicker in the Alps and in former rural areas than in the industrial heartland of the country. Inside the newly formed metropolitan areas also, peripheries were growing quicker than centers: Lausanne grew more strongly than Geneva, Basle and Lucerne than Zurich, and Berne, the last of the big five not to be included in a bona fide metropolis, grew the strongest. On the surface of it then, it looked like at the national level, the central network equilibrated itself.

However, the pattern of growth was above all concentrated in suburban centers, and those were clearly metropolitan in their location. When taking them into account we would find that metropolitan areas concentrated most of the growth; conversely, the argument could be used in reverse, the areas of edge city emergence and inflorescence being designated as metropolitan. In that sense, Berne and Lugano were becoming clearly metropolitan by 1991. While urban center development seemed to accredit the idea of a return to equilibrium, suburban center development furthered the claim of a metropolitan development of the country. Both were correct, but in terms of number, the metropolitan phenomenon was clearly larger than the equilibrium one.

4.6.2.3. Differences according to agglomeration size: metropolitan processes gathering full steam

The massive growth experienced by edge cities clearly favored the biggest centers of the country, which gathered the bigger suburban centers of all. In that sense the return to equilibrium hinted at in the preceding section was outweighted by the growth of the bigger cities by way of



their suburban centers. Moreover, growth looked like it was occurring preferentially in certain

Map 4-21: Central places by size, orientation and location, 1991

areas of the country (*Map 4-21*). Like in 1985, what we could now call the metropolitan area of Zurich, i.e. the whole Zurich canton, the Lake Zurich shores, the corridor towards Lucerne and to an extent the Aargau corridor were seeing rather strong developments, above all in suburban and exurban centers that were developing in a nappe fashion across the whole space. Around several other centers – Geneva, Basle, Berne, Lausanne and Lugano – suburban and exurban centers seemed to develop strongly, which accredited the metropolitan hypothesis, and even more when centers outside those areas did not show the same developments.

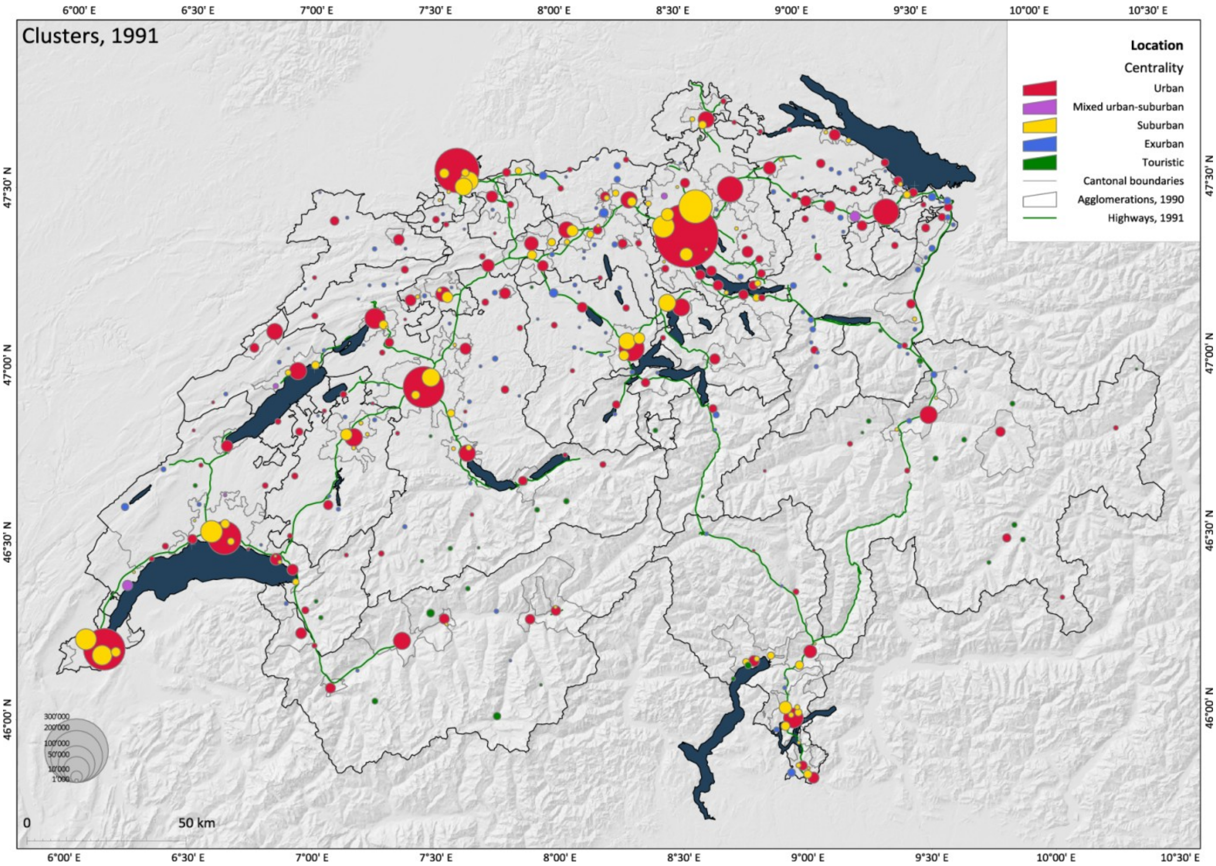
In terms of industry-services distribution, 1991 marked the time when the remaining major industrial edge cities turned towards services. Around Zurich and Geneva that had already happened by 1985; in 19091, Lausanne's and the new Berne's suburban centers were now service-oriented, as was the emerging Birstal one. Around lesser centers, though, suburban centers remained largely industrial, as in fact in larger metropolitan area: thus, for instance, in the Zug-Lucerne corridor, around Lake Zurich, in the greater Zurich metropolitan area.

4.6.2.4. Regional patterns: Again, a mixed image

While regional effects were in full swing in 1985, the pendulum had swung back to a center-periphery pattern by 1991. The very strong regional effects seen in 1985, notably the gains made in Eastern Switzerland and in Ticino, against the atonement of industrial Western Switzerland, were not obvious anymore by 1991. Instead, center-periphery moves were more clearly seen, as we have already seen. The exception to this rule concerned the Alps, where regional centers fared very well. Thus, both metropolitan spaces, by way of their suburban center's growth, and the Alpine arc, by way of its regionsl centers, grew quite strongly. In-between spaces, as soon as they weren't included in metropolitan areas, weren't affected as much by growth as the rest of the country.

4.6.2.5. Mapping clusters and superclusters: edge cities and metropolis

The 1985 to 1991 period was above all marked by the massive rise of several suburban clusters (*Map 4-22*). The biggest cluster of Switzerland, that of the Glattal area north of Zurich, gained more than 21'000 jobs to 82'000, equaling the job tally of Lausanne: at the cluster level, Kloten was now as important as one of the big five cities. Other Zurich clusters also went up significantly, the Limmattal complex up 9'000 jobs to 35'100, or the second largest of the country, the Lake Zurich left Bank up 7'000 jobs to 12'000, and the Furttal complex up 1'000 jobs at 11'200. More



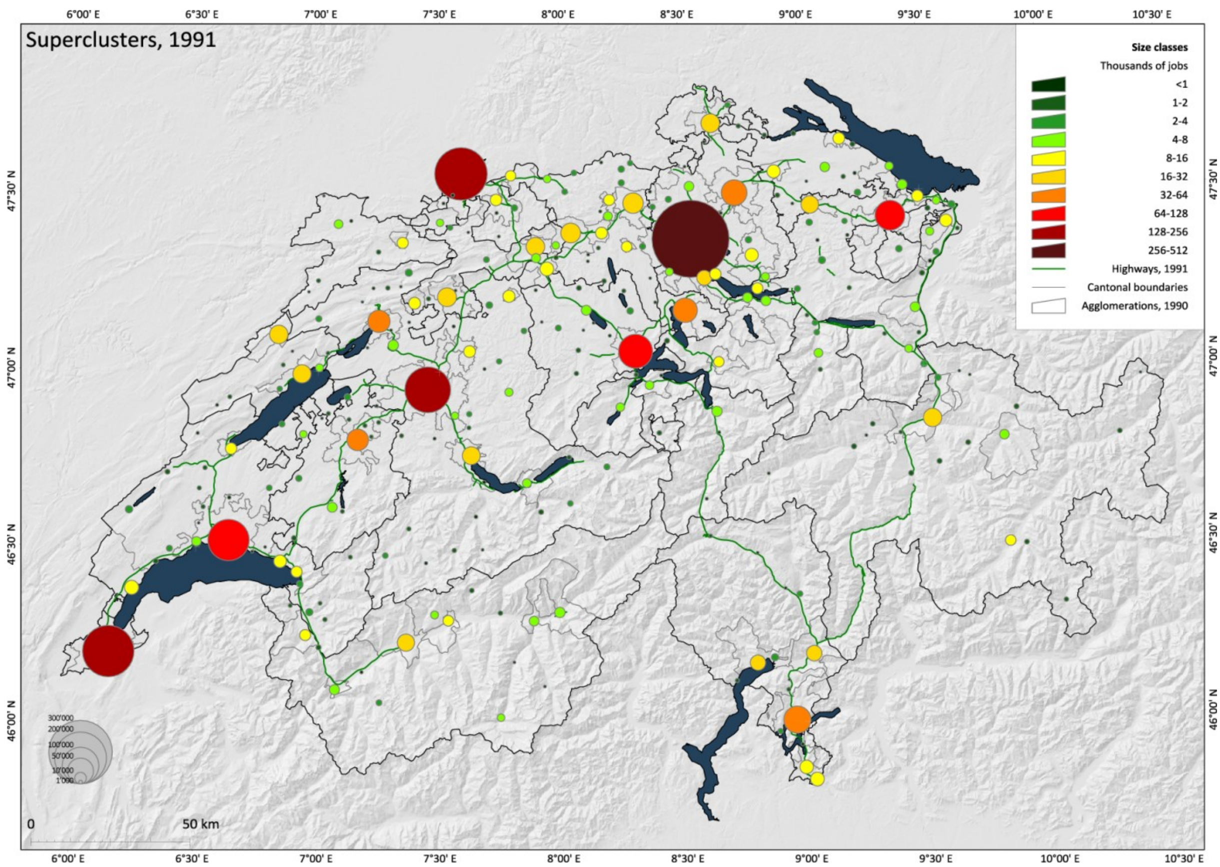
Map 4-22: Clusters by size and location, 1991

significantly, further away in the metropolitan area several edge city complexes also gathered steam. In the Zug-Lucerne corridor, the Zugersee complex which had appeared in 1985 only gained 9'000 jobs to now 21'700, practically as much as its parent city; the Reusstal complex followed with 4'000 more jobs to 20'200; further away, the Gäu complex reached 11'400 jobs or close to 5'000 more than in 1985. The phenomenon wasn't restricted to the Zurich metropolitan area, and in every metropolitan area of the country massive gains were made: in Geneva, Cointrin gained 15'000 jobs to 32'500, while Praille remained fairly stable at 28'900, surrendering its first place to Cointrin and signaling a bascule of the Geneva area towards its airport. In Lausanne, the Western complex gained 7'000 jobs at 35'300, making it the third of the country. In Basle, Schweizerhalle gained more than 5'000 jobs to 25'100 while the Birstal corridor gained more than 11'000 jobs to 22'300. In Berne, the newborn Ostring complex grew explosively, up

17'000 jobs to now a very respectable 24'000. The remaining big clusters were found west of Lugano, with the Vedeggio complex now at 11'800 jobs, up about 4'000 from 1985, and the first unit from Eastern Switzerland, the mixed center Uzwil, getting above 10'000 jobs west of St-Gallen, and the new western complex in Fribourg, which came just short of the 10'000 jobs bar.

At the same time the urban network itself remained remarkably stable, as did the exurban center network: most of the growth was realized in suburban centers, which made the suburban clusters the obvious show of the time. The geography that this massive inflorescence revealed was twofold. First, at the local scale, it showed a massive decentralization process, urban centers losing significant job share towards their suburban belts; however, in all, this resulted in stability for urban centers, and massive growth for edge cities, which bursted into view. The total result, though, was one of sheer growth of the affected areas, which were organized around the major centers of the country: Zurich and its surroundings, the Geneva-Lausanne pair, Basle, Berne and Lugano. In those five areas, metropolitan processes started to take hold.

When taking into account the growth of the suburban belts, most urban areas showed a strong growth (*Map 4-23*); at the regional scale then, this was a time of concentration of substance unto central regions, even if those concentrations largely happened to locate themselves outside classical centers. And in the regional competition, major centers were clear winners: the most spectacular growths, at the supercluster levels, were recorded in the biggest urban areas, the new metropolises: Zurich, Basle, Bern, Lausanne and Geneva. The larger metropolitan areas also fared well, and their urban areas thrived like, in the larger Zurich area, Zug, Baden, Horgen or Wetzikon. At this scale also, there were rather strong regional effects; all metropolitan areas gained, as did the alpine region, especially its two main cities of Sion and Chur, and to an extent



Map 4-23: Superclusters by size, 1991

Eastern Switzerland, with notable progressions along the main highways, like in Wil, Frauenfeld and Kreuzlingen. Conversely, heavy industrial urban areas stagnated, especially north and east of Zurich like Winterthur, St-Gallen and Schaffhausen, but also in the Aargau area with contrasted evolutions, and lastly in the now perennially lagging region of the Jura Mountains, the only one where some urban areas still lost jobs. Thus, apart from metropolitan effects, regional and structural effects still played a significant role in the territorial evolution of Switzerland.

4.6.2.6. Territorial conclusions: metropolitan Switzerland, released

The period running from 1985 to 1991 was unlike any other the country had known since then. It was marked by a relentless growth of the economy and accordingly of the urban network at large. In just 6 years, 330'000 jobs were gained across the urban network; but such growth rates were not unheard of in Switzerland, as the 1945 to 1965 period showed, and on longer periods. However, what made the 1985-1991 period so special is that growth did occur mostly outside urban centers. The fact that growth was massive and that it occurred above all outside classical urban centers made it very spectacular and conspicuous. In that sense, 1991 is a momentous time for the study of edge cities in Switzerland, the time they really took center stage and burst into view – albeit by no means the summit or the end of their evolution.

The 1985-1991 period shows several different phenomena at hand. Globally, this was a period of strong growth, and furthermore this growth was pretty much well spread out regionally. Most of the differentiations of the time happened within urban areas more than between them. Edge city emergence arose as well in the most central metropolitan areas like Zurich and Geneva than in the industrial heartland, the dynamical subalpine regions, or the peripheries. In the only regions where edge cities couldn't develop, the mountainous areas of the Alps, urban centers grew accordingly. Thus, with the glaring exception of the Jura arc, growth did not discriminate much regionally, and in a sense it even contributed to lessen regional disparities across the board. Its main impact, then, was primarily on urban form, by challenging classical urban centers with fast-growing alternate centers. This played at two different scales. Firstly, as we surmised, at the local, intra-regional level, subcenters challenged centers. At a larger scale, growth expressed itself more by the establishment of new suburban and exurban centers than by reinforcement of the underlying remnants of the Christallerian network. Again, growth did not result in the reestablishment of the Christallerian network – indeed, it resulted in further weakening of the Christallerian structure as metropolitan urban forms, most notably suburban and exurban centers, started to dot the territory. Lastly, it is worthy to note that some regions did not see the sudden inflorescence of suburban and exurban centers: As we have said, the Alps and the Jura Mountains concentrated their development on existing classical cities. In the Alps though, those were clearly dynamic, while in Jura they hadn't shown the same growth. It is also notable that this inflorescence was very conspicuous in all future metropolitan areas of the country, and to an extent in Eastern Switzerland, leaving only the most rural areas of western Mittelland out. What is interesting here is that at this time, Eastern Switzerland was concerned by the inception of a metropolitan process, as well as Aargau for example.

4.7. 1998: seven lean years

4.7.1. Aspatial results

4.7.1.1. Location and centrality: a strong attack on urban centers

By most accounts, the seven years separating 1991 to 1998 were marked by the most stringent economical crisis the country had experienced since the times of the great depression in the 1930s (*Chart 4-81*). From the onset of the downturn, which happened several months after the 1991 business census, unemployment, which was virtually nonexistent in Switzerland until then, attained levels compatible with those of its European neighbors. Unlike them, though, after an initial very stringent three-year period during which most of the losses were recorded, the crisis lingered in a protracted way and the recovery didn't happen before the 1998 census had taken place. Initial studies showed that the 1995 and 1998 censuses showed the same patterns, the 1998 edition only a bit more so. Thus, our choice was to neglect the 1995 census here and to jump directly at the 1998 one.

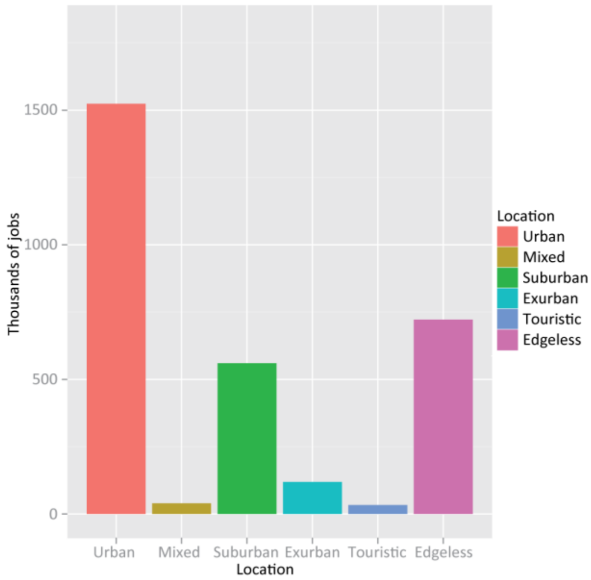


Chart 4-81: Job numbers by location, 1998

For the first time since the 1973 oil shock, the Swiss economy lost jobs during the 1990s crisis, 284'000 in all, or most of the growth that had been recorded between 1985 and 1991. The whole loss, and then some, was supported by the urban network, which lost 329'000 jobs in seven years or about 15% of its 1991 numbers. The job loss wasn't supported so much by unit numbers – of which 44 "only" were lost for a new total of 405. As a whole, central places lost jobs; they shrinked.

Most of the loss was supported by urban centers (*Chart 4-82*). They lost 21 units to 127 and more impressively 263'000 jobs, getting also a beating in terms of structure, intensity reverting back 10 to 140 jobs per 100 active residents, density falling 4 points to just 26 jobs per built ha. Urban center's mean size hardly moved, remaining at 12'000 jobs each. The urban centers lost massively in terms of job share, dropping 3.6 points to remain just over 50% at 50.4% of all jobs.

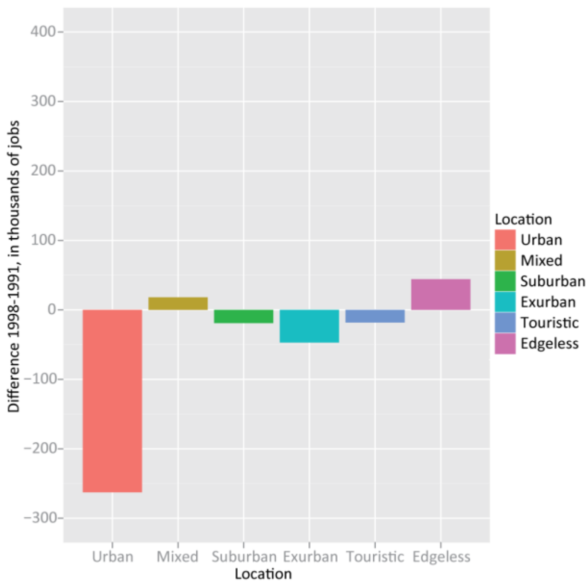


Chart 4-82: Job numbers difference by location, 1998-1991

In contrast, suburban centers held relatively well during the crisis. They gained 5 units at 136 and lost "only" 19'000 jobs for a total of 560'000, which pushed their job share up a bit more than 1 point to 18.7% of all jobs. However, suburban centers, as a class, paid for their resilience in terms of structure, as they went down on all three counts of intensity, down 1 point to 107 jobs per 100 active residents, density, down 1.8 points at 13.6, or not enough to qualify as urban in our definition, and mean size, down 300 jobs at 4'120. Suburban centers resisted better than other categories to the crisis onslaught on the central network, but it was at the cost of their internal strength and quality.

To the contrary of suburban centers, exurban centers were very severely affected by the crisis. They lost 27 units to 104 but more importantly 47'000 jobs to just 119'000 remaining by 1998, and their job share plunged to just 4.0% of all jobs. In terms of structure they also lost some strength, especially in terms of density, which landed at a very low 6.7 jobs per built ha, a density close to the one of edgeless space. But mostly, the remaining exurban centers just shrank, to just over 1'000 jobs each.

As for preceding crises, edgeless space gained jobs during these times, by taking back into its fold former centers which had lost their urban qualities. Edgeless space gained 44'000 jobs to 722'000 in total, or 24.1% of all jobs, up 3.4 points. Very tellingly though, in terms of structure edgeless space suffered as much as the center network, with a big drop in job intensity, from 57 jobs per 100 active residents in 1991 to 52 in 1998, while job density also fell significantly down 0.7 point to 6.9 jobs per built ha.

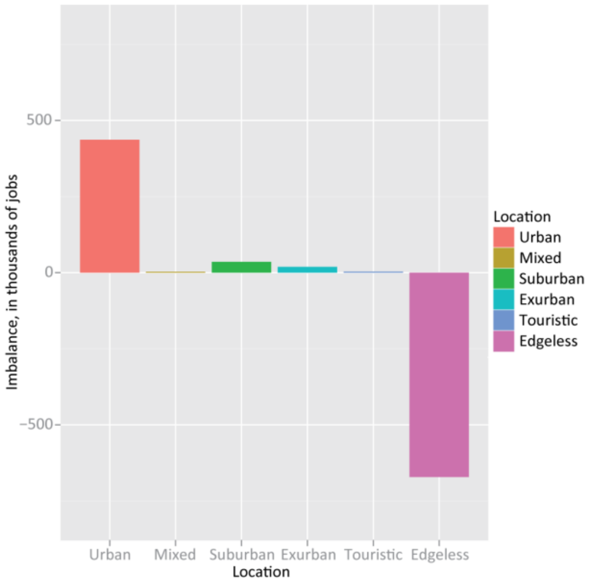


Chart 4-83: Jobs-actives imbalance by location, 1998

As we have seen all classes lost strength during the 1990s (*Chart 4-83*). The net result of those changes materialized itself when looking at job imbalances, where urban centers saw their imbalance drop from 592'000 more jobs than active residents in 1991 to 437'000 in 1998, when the active surplus grew in edgeless space from 512'000 in 1991 to 672'000 in 1998. As a result, at the national level a surplus of jobs amounting to about 165'000 jobs in 1991 vanished and made place for a deficit of about 175'000 jobs in 1998, a move that in itself explained the massive unemployment rise of the times.

4.7.1.2. Dynamics: dynamic centers resisting better than classical ones

The main point about the dichotomy between dynamical and classical centers during the 1990s crisis is that, in all, dynamical centers fared far better than classical ones (*Chart 4-84*). Dynamical centers gained 42 units at 257, while classical centers lost no less than 86 units at just 148: by 1998, there were for the first time, more dynamical centers than classical ones. Moreover, classical centers had lost 375'000 jobs since 1991, while dynamical centers had surprisingly gained more than 45'000 jobs during the period. Accordingly, the classical center job share plunged 7.2 points to 49.1%, while the dynamical centers job share jumped 3.8 points to 23.8%. By 1998, less than half of all non agricultural jobs were held in classical centers, the rest shared almost equally by dynamical centers and edgeless space.

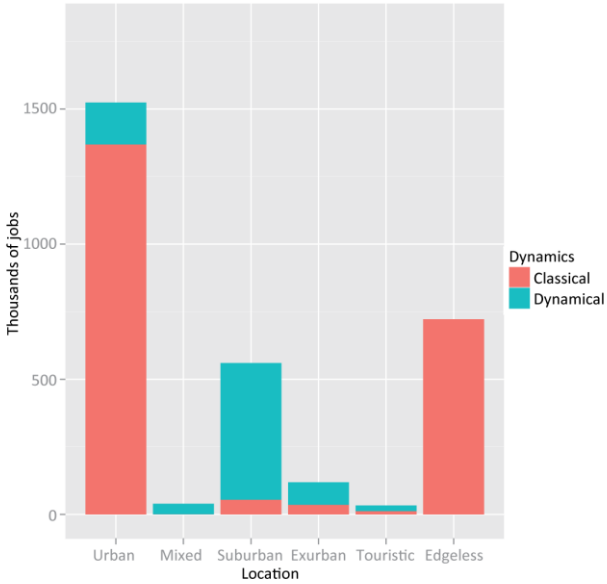


Chart 4-84: Jobs by location and dynamics, 1998

It has to be noted that part of the gains realized by dynamical centers were due to the fact that as the overall growth was largely negative, with an annual rate of -1.3%, it allowed centers with relatively weak growth to transfer from classical to dynamical at this time. Nevertheless, the general effect is that, by and large, the costs of the crisis were above all borne by classical centers. Dynamical centers dodged the crisis pretty well.

Furthermore, the dynamic centers resilience seemed not linked with their location, as dynamic centers resisted equally well in all situations. The end result was that in all situations except urban ones, dynamic centers were clearly dominant, in mixed, exurban and touristic centers as well as in suburban, where this evolution had been notable since the 1980s. By 1998, then, the urban network was constituted by a layer of largely classical urban centers, surrounded by overwhelmingly dynamical groups of mixed, suburban and exurban centers.

4.7.1.3. Orientation: a general decrease, reinforcing the dominance of service centers

That the central network was hit across the board during the 1990s economical crisis is clearly seen where looking at the centers while controlling for their economic orientation (*Charts 4-85 & 4-86*). In the 1990s, service centers were as affected as industrial ones, at least in absolute terms. All three categories lost approximately the same number of jobs, a little more than 100'000 each. However, as each category was hosting a vastly different job tally, the effects on the overall structure of this linear cut were not equivalent: the job loss corresponded to about 6% of all service center jobs, but a third of the total in industrial centers and half of the total in equilibrated ones. This passed on overall job shares, with the industrial centers job share dropping further, 2.7 point to just 10.3%, while the service centers job share actually grew 2 point to 61.8%.

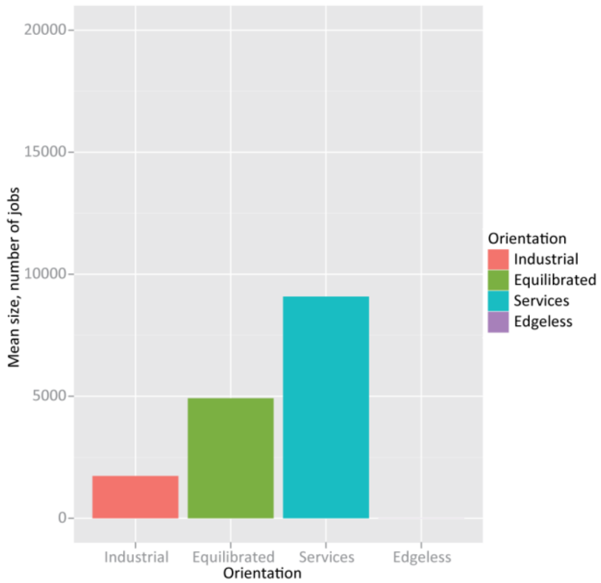


Chart 4-85: Mean center size by orientation, 1998

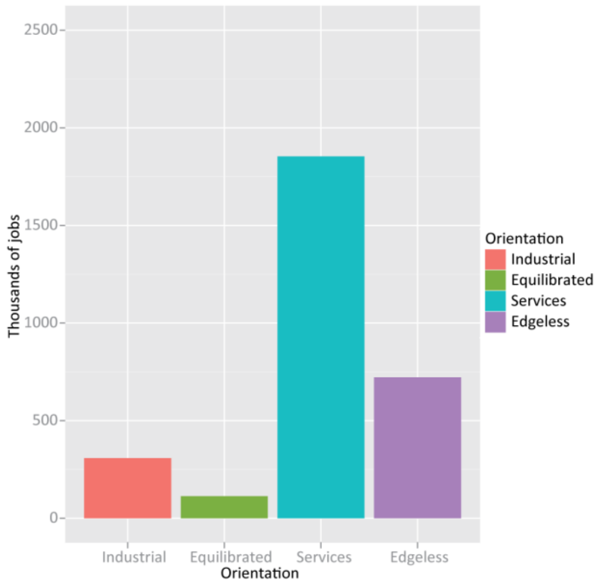


Chart 4-86: Number of jobs by orientation, 1998

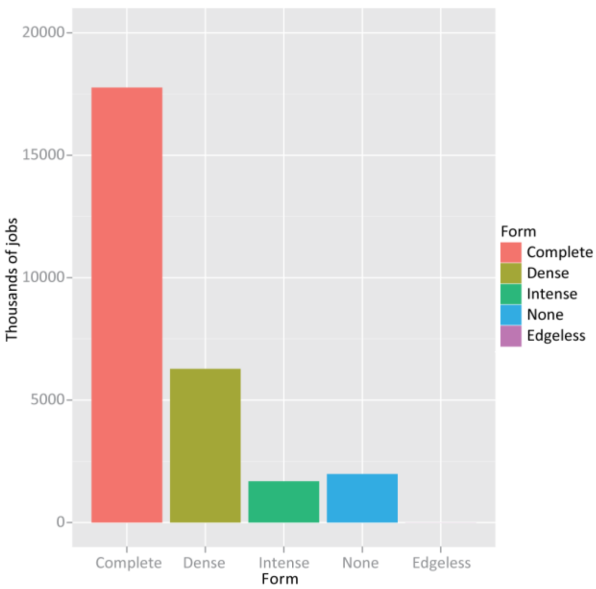


Chart 4-87: Center mean size by form, 1998

In essence, the period furthered the definitive destruction of the industrial network. Even if the crisis hit centers regardless of their orientation, the result was that yet another big part of what was remaining of the industrial domination in the economy of the country went bust. By 1998, only one in seven central jobs was held in an industrial center, even though those were still nearly as numerous as service centers. Switzerland had become overwhelmingly service-oriented.

4.7.1.4. Form: shock across the board

As with other points of view, the examination of the structural quality of the centers revealed that the crisis had affected all kinds of centers (*Charts 4-87 & 4-88*). The number of jobs held in complete centers decreased the most, about 335'000 jobs, while their numbers decreased more than a quarter, to just 90. At the same time, their mean size jumped. Altogether, this meant that complete centers were fewer and larger than before: the category had lost units at its base, units which lost their central qualities either in terms of density or in intensity. However, those also lost jobs, albeit far less than the complete centers. This concerned above all dense centers than intense ones, confirming an impression about the closeness of destiny between dense and complete centers. Dense centers lost 70'000 jobs, about a third of their 1991 tally. Intense centers resisted better but still lost jobs, about 35'000 or a tenth of their tally. While dense centers evolved rather like classical urban ones, intense centers were closer, in terms of dynamics, to the dynamical centers.

That being said, apart edgeless cities, the only category to have grown steadily between 1991 and 1998 was the "none" category, centers which were neither intense nor dense enough to qualify as centers but remained in the category because of their history. This transient category gained 110'000 jobs, and along with edgeless cities were the true winners of the times.

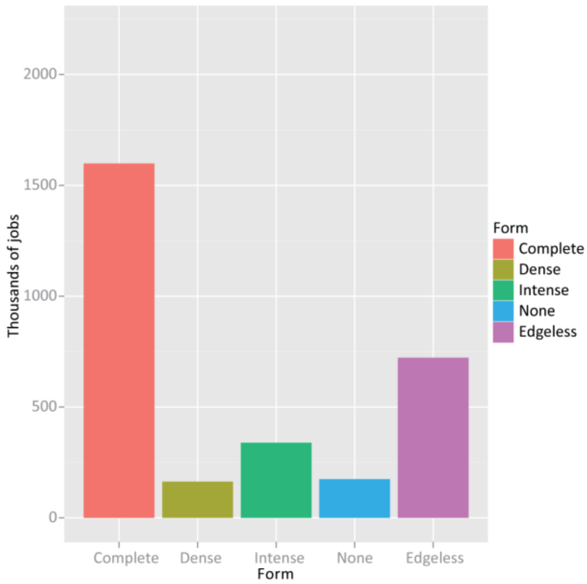


Chart 4-88: Number of jobs by form, 1998

4.7.1.5. Size: signs of structural pain

Density showed a general decrease between 1991 and 1998, an expected result given the general context (*Chart 4-89*). The density loss was relatively linear when controlling for size up until about the 64'000 jobs limit, which isolated the big five from the rest of the network. As a group, centers up to 4'000 jobs showed a density below 15 jobs per built ha. More tellingly, in

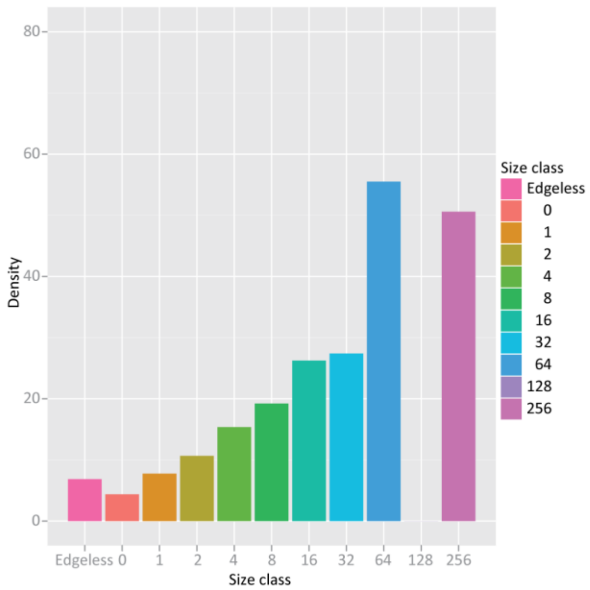


Chart 4-89: Job density by center size class, 1998

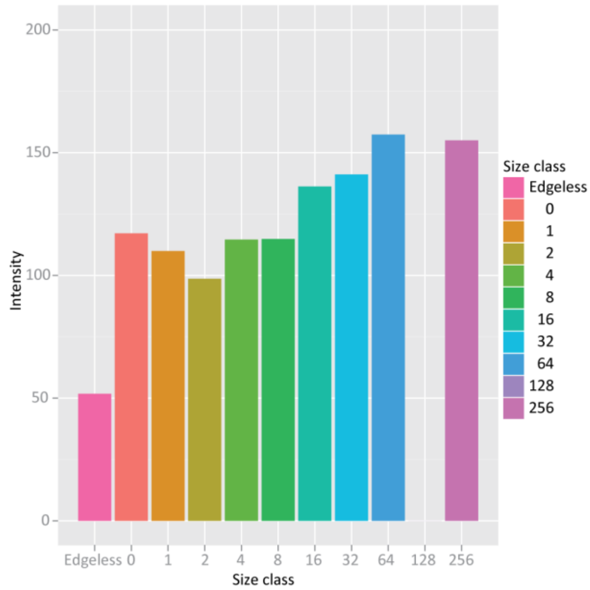


Chart 4-90: Job intensity by center size class, 1998

terms of job density centers under about 2'000 jobs do not distinguish themselves from edgeless space. In all, smaller centers were not centers anymore because they were denser than surrounding space. By 1998, central status was attained by other means than density, at least for the smallest units of the network.

The job density fall was most notable in the largest centers. As a group, the big five had a job density of 61 jobs per built ha in 1991; in 1998, this had gone down to 53 jobs. If the crisis hit hard all center categories, it was notable that the big five were hardest hit by it.

Job intensity experienced a general decrease, regardless of the size of the concerned centers, but the overall allure of the curve remained stable during the 1990s (*Chart 4-90*). Even with the decrease, as groups all center classes kept their job intensity at or above unity. By 1998, intensity alone seemed to define central places, at least for smaller places. As for density, the general pattern across size classes was one of progression, the bigger the center, the higher its intensity. This was certainly valid for centers with 4'000 or more jobs; however under this limit the pattern was still inverted, with smaller centers sporting higher job intensity, while centers with 2'000 to 4'000 jobs exhibited the lowest intensity of all, at exactly unity.

4.7.1.6. Rank-size and job numbers by size classes: equilibrium challenged

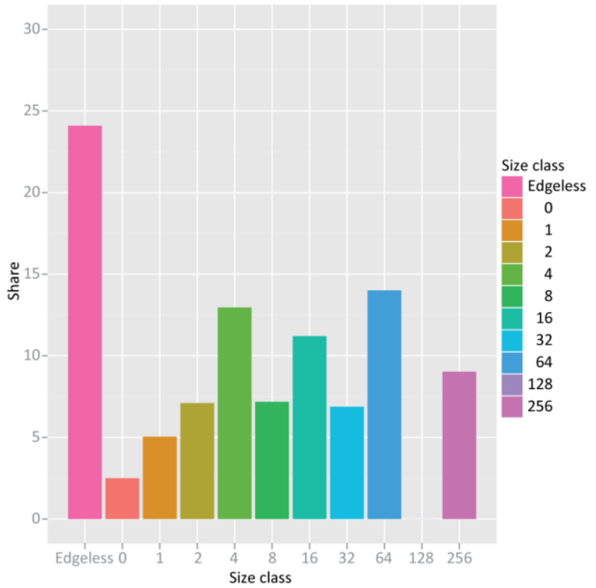


Chart 4-91: Job share by center size class, 1998

1991 saw a return to a rank-size equilibrium for classes above 4'000 jobs as well as a general reinforcement of the mid-sized centers, linked to the emergence of numerous mid-sized edge cities (*Chart 4-91*). On the surface of it, the 1990s economical crisis shattered this new organization, with wide variations between classes, even over the 4'000 jobs mark. Thus, centers with 4'000 to 8'000 jobs, and with 16'000 to 32'000 jobs were largely bigger than their neighboring classes, the 2'000 to 4'000 jobs class and the 8'000 to 16'000 jobs class seeing also a net diminution of their share. That being said, though, when considering classes two by two, things seemed to be relatively equilibrated between sizes, with about 20% of the jobs in each of the three following categories: from 2'000 to 8'000 jobs, from 8'000 to 32'000 jobs, and from 32'000 to 128'000 jobs. Below 2'000 jobs the lack of centers already noted since at least 1965 remained patent with only 7% of all jobs located in centers with less than 2'000 jobs, while the largest centers were in the same situation with only 9% of all jobs in centers above 128'000 jobs – i.e. Zurich. At this large scale, then, equilibrium was still well present.

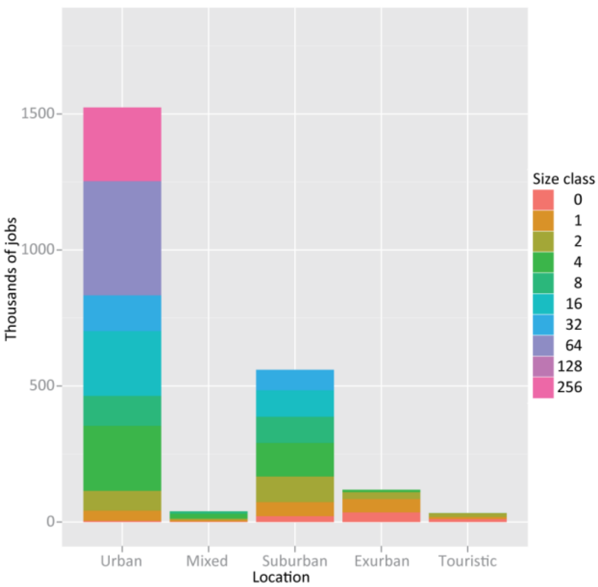


Chart 4-92: Job numbers by location and center size class, 1998

Looking at the size distribution of centers according to their location, one can see first that urban centers suffered about equally, regardless of their size and secondly that the general imbalance seen between size classes were above all theirs (*Chart 4-92*). On the contrary, suburban centers seemed not to suffer too much from the crisis, especially its smaller units. The loss experienced by suburban centers was borne exclusively by suburban centers larger than 16'000 jobs, i.e. by the five to ten major units of the country. This meant that, even if the crisis affected suburban centers as well as urban ones, it didn't impeach the emergence of new units, particularly small ones, the numbers of which soared during the period under review.

4.7.1.7. Zipf's law, clusters and superclusters: stability amidst crisis

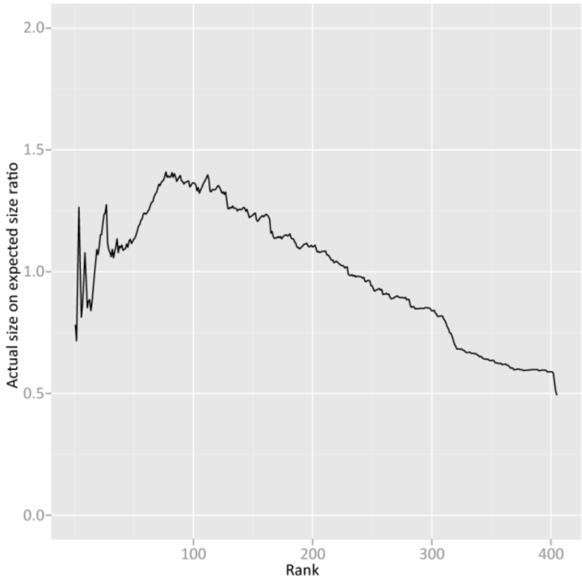


Chart 4-93: Units rank-size distribution compared to Zipf's law, 1998

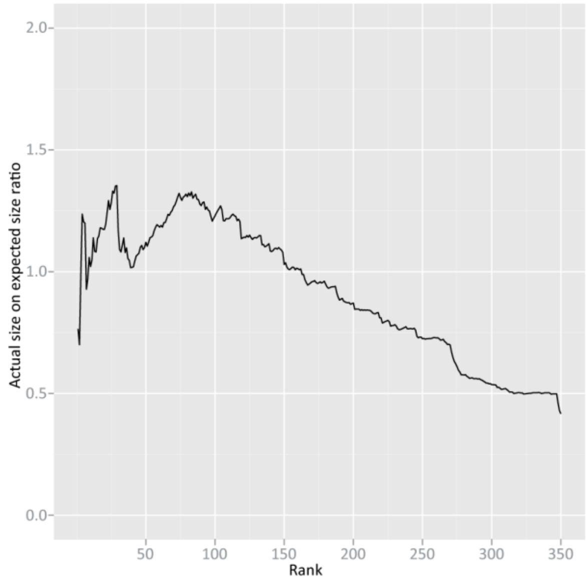


Chart 4-94: Cluster rank-size distribution compared to Zifp's law, 1998

Whether at the unit or at the cluster level, between 1991 and 1998, the stability of the rank-size curve at the unit level was quite remarkable given the fact that the country experienced a severe economic crisis (*Charts 4-93 & 4-94*). As we have already noted before, the crisis hit across the board and through the preceding sections we saw that there was no definite pattern as to how the crisis had a preferential effect on such and such category. The look at the curves for 1998 confirms that they were, in all, remarkably similar to those of 1991: the crisis, at these scales, had a clear freezing effect on urban development.

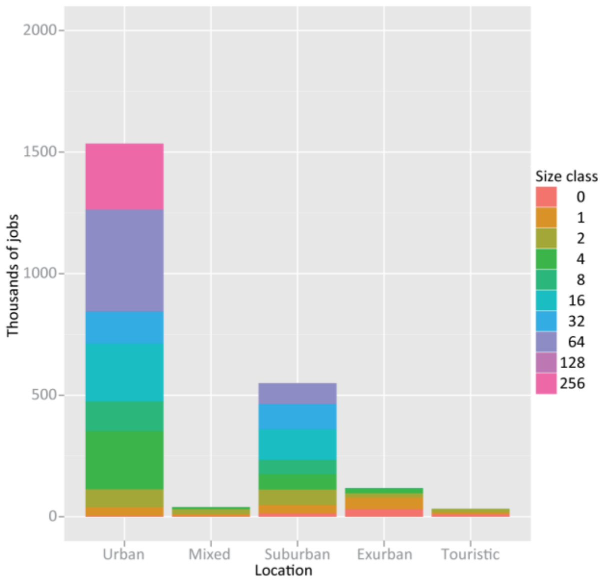


Chart 4-95: Job numbers by location and by cluster size class, 1998

At the cluster level, the suburban center evolution between 1991 and 1998 showed a light departure from the same study made at the unit level (*Chart 4-95*). As for units, smaller clusters tended to appear, which points to the fact that new, smaller edge cities were developing during the 1990s despite the crisis. At the other end of the distribution, the largest clusters went relatively unscathed through the crisis. Most of the losses were borne by mid-sized clusters, those counting between 4'000 and 32'000 jobs, and more particularly the lower half of this range.

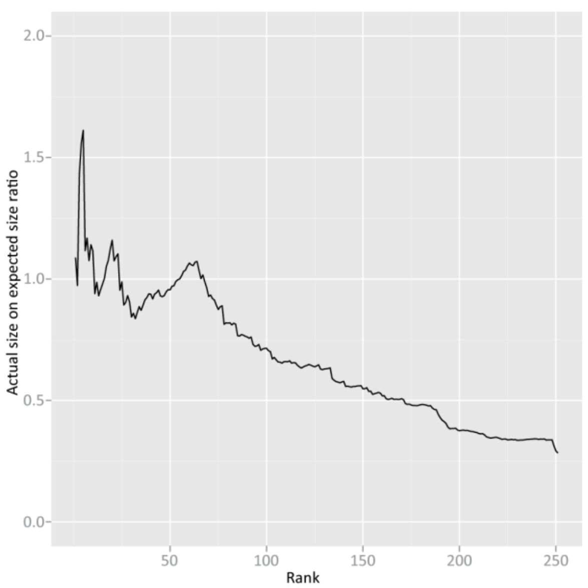


Chart 4-96: Supercluster rank-size distribution compared to Zipf's law, 1998

The rank-size distribution of superclusters for 1998, while very similar than the same curve for 1991, let appear subtle differences (*Chart 4-96*). The uppermost members of the supercluster distribution reinforced somewhat their position, as the rest of it tended to sink. This meant that at the supercluster level, large urban areas were still reinforcing even if their classical centers suffered, while the rest of the urban network, the superclusters ranked after the 12th place or so, superclusters with less than about 35'000 jobs lost terrain against their bigger counterparts. While this effect was indeed subtle, it was also revelatory of the continuing processes of metropolization at work even through an economical crisis. Amidst the general impression of stability through general decrease, even if they slowed down, metropolitan processes were still reshaping the country.

4.7.1.8. Aspatial conclusions: an ice age?

The seven years leading to 1998 were marked by severe phases of economic recession which had hit Switzerland since 1993. Accordingly, the urban network saw a complete reversal of fortune as compared to the preceding period.

As a whole, the urban network lost a lot of jobs, about 15% of the total. This job loss was a bit larger than what the country experienced at large, which meant that the urban network bore the brunt of the crisis, while edgeless locations went on gaining jobs. Classical centers continued their long-term decline. In other words, as the urban network did register the whole of the national job loss, in turn the classical centers assumed most of the urban system job losses. Thus, their job share continued to slide, to under 50% for the first time since probably the industrial revolution. Furthermore, this continued decrease did extend to the quality of the remaining centers, which saw both their job intensities and their job densities slide. Another effect was that the jobs-actives imbalances turned very sharply from a solid job excess in 1991 to a large job shortage in 1998, which translated in an explosive unemployment rise.

Edgeless space gained jobs but far more active residents, and its job imbalance continued to grow relentlessly. Less than two thirds of edgeless space active residents could be taken care of by the job excess in classical centers, whereas in 1991 those two imbalances essentially cancelled themselves out. Thus, the 1990s opened a huge gap between the capacity of cities to provide jobs to workers living in the periphery, and the number of prospective workers that the periphery had to dump on centers. Meanwhile, edgeless space continued to grow ever sparser, with a big loss in job intensity, while keeping an extra low job density. Even if it was gaining jobs in absolute numbers, and gaining job share in the process, edgeless space actually saw its situation worsening steadily, housing ever more actives than it could occupy through its own jobs, and its densities and intensities getting lower and lower. As seen in 1998, there is no doubt that while it was growing, edgeless space could not provide a solution to the weakening of the classical network; edgeless space was more part of the problem than of a potential rebalancing solution.

In the midst of those two spaces, the job share of non central urban forms remained stable and maintained more or less its job numbers. Gains in the dynamical centers were offset by losses in whatever remained of remnants, but stability in a time of losses meant that the suburban centers job share rose a bit. Around them, other forms of dynamical centers held themselves even better. Dynamical urban centers held very well their own, while continuing to lose their "urban touch" in terms of substance. In effect, while for a time dynamical urban centers developed as a hybrid between cities and suburban centers, during the 1990s, as they grew in numbers, they resembled more and more their suburban and exurban counterparts, and ever less the cities they were still formally. Between urban and suburban centers, mixed centers started to be a notable part of the urban network, revealing a new trend, maybe a "return" towards centers that did manifest itself not in major centers but in secondary ones. In all, dynamical non central urban forms had by 1998 an excess of about 100'000 jobs relative to their active residents, to be added to the some 435'000 excess jobs the classical cities had. They had become significant job purveyors at the scale of the country.

While the dynamical non central urban forms maintained themselves quite well during this period, such wasn't the case of remnants. Exurban remnants in particular all but disappeared completely from the urban scene. Suburban remnants resisted a bit better, but were now restricted to several dense job places engulfed in very dense residential settings, most likely in very internal parts of the few agglomerations they still adorned.

The 1991 to 1998 years saw an important economical crisis deploy its effects on the country. A severe decrease in the number of jobs ensued, which affected about equally centers big and small, central and peripheral, urban and exurban. Thus, while numbers changed vastly, and while structures were hard hit, the general layout of the central network structure did not appear to evolve strongly: besides the jobs and quality losses, in terms of network structure the period was one of stability, or more correctly of freeze: an ice age. Not much happened which modified the spatial order already in place, save for the subtle but significant reinforcing of the metropolitan effects at the supercluster scale.

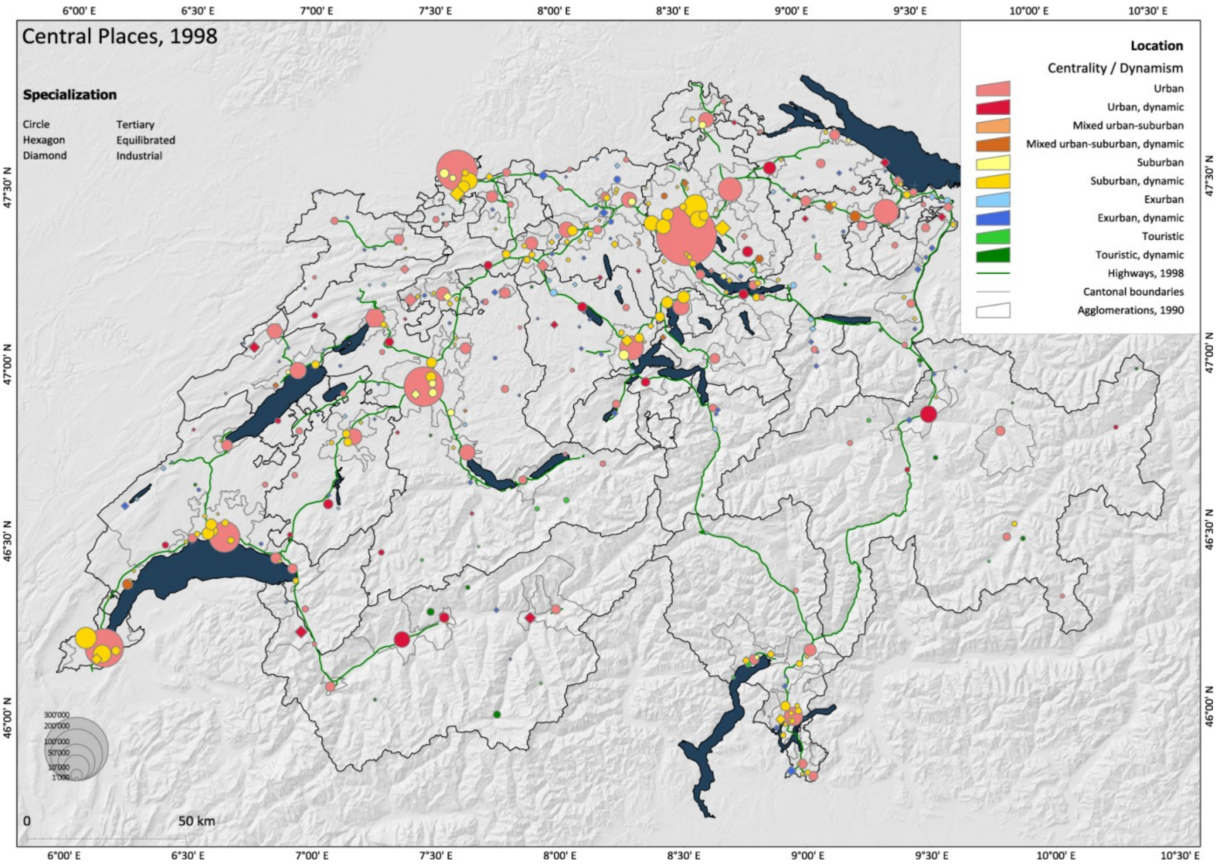
Maybe the most significant development of the time was the growing imbalance in job number between central places and edgeless space such as there were now a big excess of workers in edgeless space that classical centers could not accommodate anymore. For the first time during the 1990s, suburban and exurban centers became relevant as job centers for the whole country, taking up a sizeable part of the job excess centers had to provide to active residents of edgeless space. Thus, the classical center-periphery dichotomy that was put into place since the 1950s became more complex than just a "work in centers, live in periphery" scheme. Up to one in five excess actives in edgeless locations was now to work in non-central places.

4.7.2. Spatial patterns

4.7.2.1. The urban network pattern: suburban centers resisting amidst general retreat

The 1998 central network map shows that urban centers, and among them the biggest ones, suffered greatly during the 1990s crisis (*Map 4-24*). And indeed the big five took hefty losses: 30'000 jobs lost in Zurich, 23'000 in Basle, 19'000 in Geneva, 12'000 in Lausanne and 10'000 in Berne: amongst them, the big five lost close to 100'000 jobs, or a third of all job losses of the country and a good 15% of their tally. However, those losses were mirrored, in proportion, in lower levels of the urban network, where most any city lost about as much in proportion as in the big five. In very rare cases cities managed to hold their own against the general trend, but they were not numerous enough to make it a recognizable trend. In particular, there were no easily recognized regional or structural pattern in the way urban centers behaved during the crisis.

Suburban centers, in their vast majority, managed to hold to the jobs they already had in 1991 and by and large no general retreat of suburban centers was noted at the time – of course, this meant that their share of the job pool increased during the crisis. In several cases suburban centers went down, the most spectacular case of which was the Emmenbrücke unit north of Lucerne, consecutive to a great reduction in its industrial jobs. More or less the same remarks could be made concerning exurban centers, which up until then had been the main casualties of the urban evolution of the country. The classical exurban centers had but disappeared, but the new class of dynamical exurban centers resisted quite well to the crisis, and now clearly dominated the exurban map.



Map 4-24: Central places by size, location and orientation, 1998

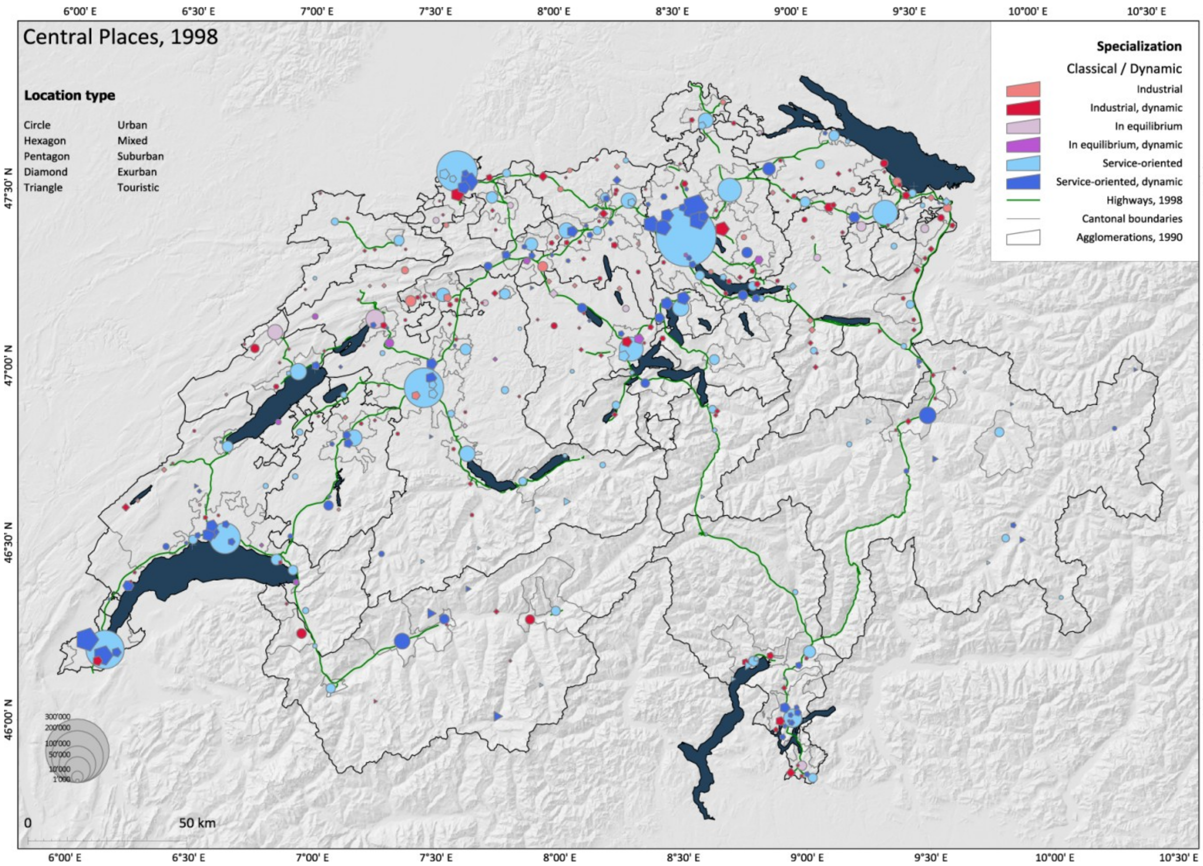
Notably also was the apparition of mixed urban-suburban centers. Those had been recorded for about a quarter of a century by 1998, but their role had always been very small. But by 1998, several new units had appeared, particularly in Eastern Switzerland where Uzwil morphed into such a unit while Gossau emerged as one. Both those units were fairly big and recognizable on the map, with respectively 6'000 and 8'500 jobs, and together with Hinwil – 4'500 jobs – and Nyon – 7'600 jobs, they started to be noticeable additions to the network. Furthermore, they tended to behave far more like suburban centers than like urban ones; in particular, they tended to keep their jobs instead of losing them.

Thus, the first impression was one of general decline of the urban network, not so much by disappearances of centers, though those were common in the lowest levels of the hierarchy, but by a bleeding of jobs from the existing ones. Clearly, urban centers were the main victims of the economical crisis of the 1990s.

4.7.2.2. Center-periphery patterns at the national scale: very equilibrated losses

In terms of national center-periphery relations, there were essentially no changes in the 1990s. There was no notable difference as to whether metropolitan areas, in and around major centers, reacted differently to the crisis from peripheral areas. On the contrary, it may seem remarkable that the territorial consequences of the crisis were so well balanced between central and outlying areas: the large job and center losses seemed to be extremely well spread out on the territory, being registered in metropolitan areas as well as in rural ones, in plains and in mountainous areas.

4.7.2.3. Differences according to agglomeration size: metropolitan processes gathering full steam



Map 4-25: Central places by size, orientation and location, 1998

As the job losses were so well distributed across Switzerland, and as the general rank-size center distribution general pattern had remained largely intact during the crisis, it should come as no surprise that agglomeration size effects were very hard to find on the map (*Map 4-25*). Those size effects were all but undetectable at the time.

However, the economic crisis had a very visible side effect in that it pounded hard on industrial centers. The result was that numerous formerly industrial and equilibrated suburban centers veered to become more and more service-oriented places, attaining this structure by replacing their lost industrial jobs by new service ones, some of which gained on the urban centers. Major examples of this transition were found in Schweizerhalle east of Basle and Furttal northwest of Zurich, but other examples were found in the greater Zurich area, where it concerned also secondary urban and mixed centers, and around Berne, Zug and some others. The crisis, while slowing down urban evolution sometimes to a halt, did not reverse it. Switzerland was getting more and more service-oriented regardless of the economical context.

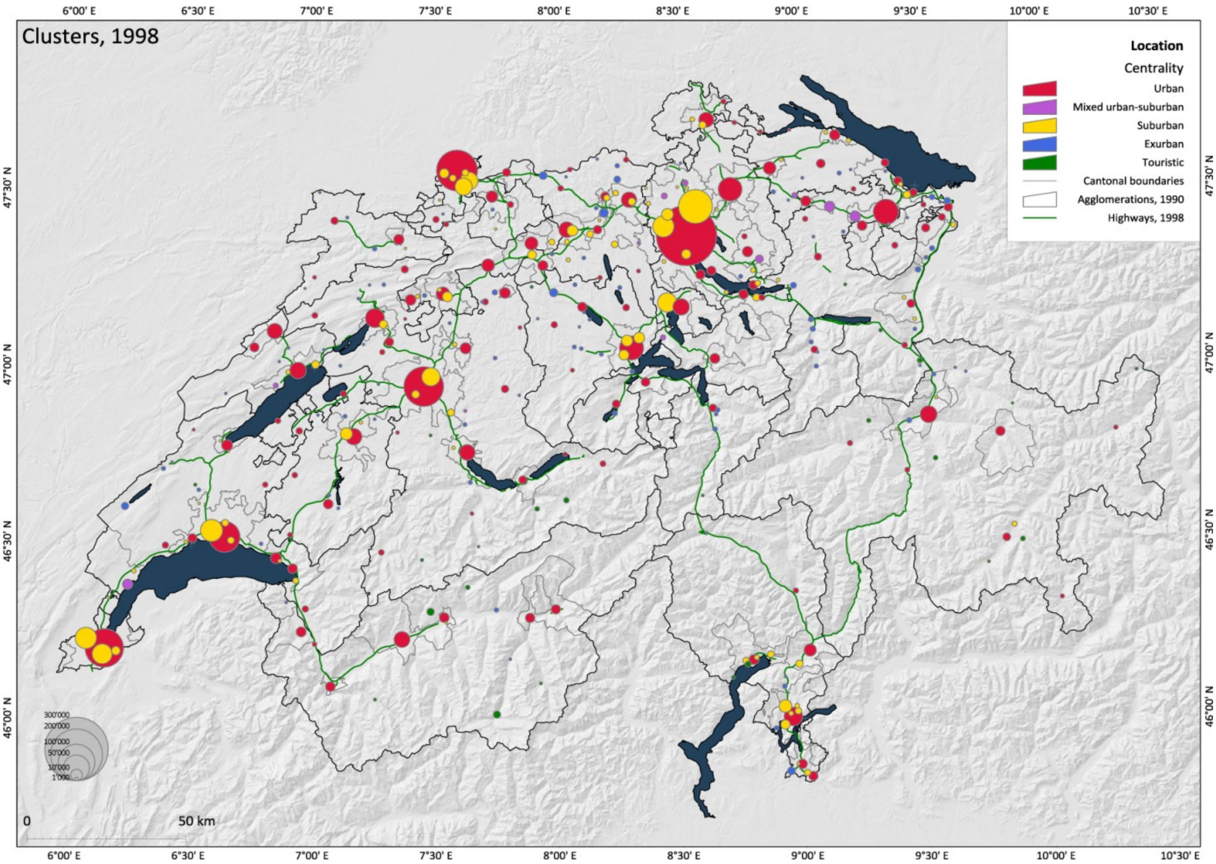
4.7.2.4. Regional patterns: receding Alps

On the basis of the preceding parts one could expect to find scant evidence of regional and structural effects on the Swiss map of 1998. However, subtle but definite effects were legible. The most visible regional effect was that Eastern Switzerland, as a whole, tended to resist a bit more to the crisis than the rest of the country, and thus experienced a recovery after the disaster it had lived in 1973. Furthermore, it realized this feat while maintaining a healthy industrial base, as this was the Swiss region where the transfer of centers from industrial to service-oriented was the less evident of all.

At the other end of the spectrum, the alpine arc paid a heavy price for its past progress. This was by far the area most affected by the disappearance of small centers: while elsewhere those disappearances were not regionally important as close-by greater centers could take the lead, in the Alps their fall signified that entire regions were now practically devoid of any central place, notably in areas like the Vaud Alps, Simmental in the Berner Oberland, Leventina in Ticino, Surselva and Mittelbunden in Graubünden. In those extended regions, the advances of urbanization which had contributed, since the 1970s, to bring them closer to the country's mainland were brutally reverted by the crisis. Territorially, this was probably the most profound effect the crisis had on Switzerland.

4.7.2.5. Mapping clusters and superclusters: the resilience of edge cities

During the 1990s crisis, edge cities resisted far better than any other type of centers and this is graphically spectacular when looking at the territorial distribution of clusters (*Map 4-26*). While urban clusters experienced major job losses, suburban clusters emerged unscathed from the crisis, and their list was as impressive in 1998 as it had been seven years earlier. The Glattal complex had even gained 3'000 more jobs at now 85'200, well above Lausanne in fifth place. Eight other clusters cleared the 20'000 jobs mark, which were Cointrin with 33'700 jobs and Praille with 29'500 in Geneva, the Western Lausanne complex, at 36'100 jobs still the second largest suburban cluster of the country, the Ostring east of Berne with 24'500 jobs, Schweizer-

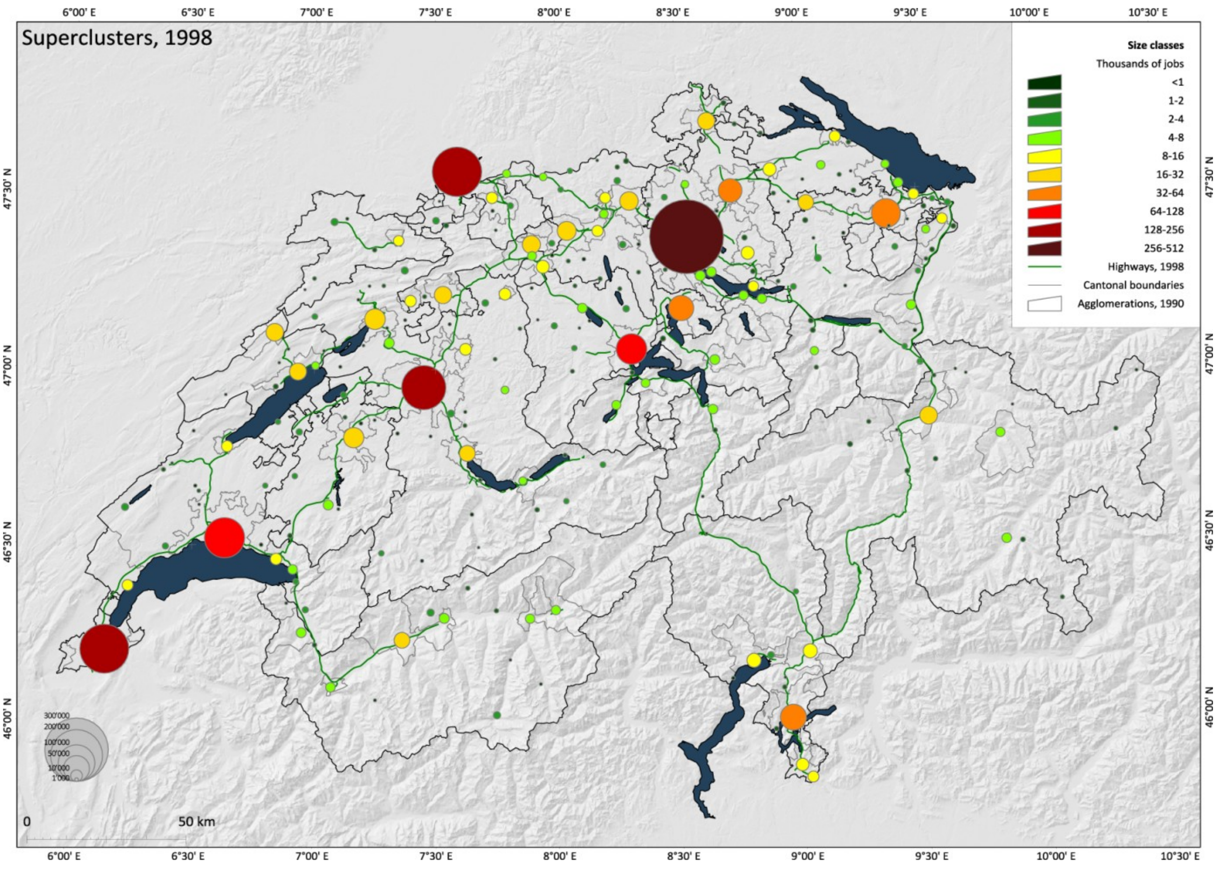


Map 4-26: Clusters by size and location, 1998

halle and Birstal in Basle with resp. 23'100 and 21'800 jobs, the Zugersee Corridor at 27'300 jobs, more than those of its parent city of Zug with 20'000 jobs, and the Limmattal complex with 33'500 jobs. All eight had a size very close to the one they already had in 1991. Four other clusters had managed to cross, or remain above, this threshold, which were the Fribourg western belt with 10'800 jobs, the practically independent Gäu complex, nominally attached to Olten, with 11'900 jobs, the fourth Zurich cluster of Furttal with 10'100 jobs and finally the Vedeggio complex in Ticino, with 11'900 jobs.

The overall picture is one of extreme stability, with one glaring exception all major clusters held their own pretty well during the 1990s. The situation was less bright for smaller units, however, where losses were more widespread and were not compensated by the emergence of new units. Thus, the emerging mid-sized edge cities had more difficulties to maintain their numbers. The biggest casualty of the crisis was the Reusstal cluster north of Lucerne which lost more than half its jobs at just 9'200 in 1998, but other units suffered severely, notably the Left Shore edge city south of Zurich, and the Goldküste one across the Lake. For the first time, major edge cities had suffered setbacks in their growth. All did not escape the crisis.

At last, the supercluster map gives an idea of the magnitude of the changes which battered Switzerland during the 1990s crisis (*Map 4-27*). At the supercluster scale, nearly all centers lost jobs:



Map 4-27: Superclusters by size, 1998

the resilience of edge cities could not make up for urban losses. Big centers were particularly affected – The Zurich, Basle and Geneva superclusters losing 10% or more of their jobs, Berne and Lausanne faring a bit better, as if the crisis helped in a way cities with strong governmental services above those in the financial and industrial sectors. But as impressive as these losses were, the setbacks endured by centers in the lower levels of the central hierarchy of the country were sometimes even more dramatic. The former industrial centers around the Zurich greater area – Lucerne, Winterthur, Schaffhausen, Baden – lost massively; even more spectacular were losses in the immediate vicinity of the city, like along the shores of lower Lake Zurich, or as seen in Bülach or Wohlen. The same effects were also seen around other major superclusters, with for instance the demises of Rheinfelden near Basle, Münsingen near Bern or Morges near Lausanne.

In the middle levels of the hierarchy, the evolution seemed to be regionally controlled. The Alps saw a sharp decrease of their job numbers, with corresponding retreats from their superclusters, especially local ones; up to a point these descriptions fitted also Ticino, where decline was general except in Mendrisio and maybe Lugano. In the industrial heartlands between Biel and St-Gallen, the middle level of the urban hierarchy held its position well with superclusters like Olten, Aarau, Zofingen, Lenzburg in Aargau, or St-Gallen, Frauenfeld and Kreuzlingen in Eastern Switzerland; however in those areas lower-level centers took a beating. In Western Switzerland it has to be notzed that what was remaining of the Jura urban network resisted indeed quite well to the crisis, having restructured all along the 1970s and the 1980s; down in the lowlands of Western Switzerland, though, the retreat was general.

In the midst of all the gloom, several superclusters managed to progress, the most notable of which was Zug, which now competed with centers historically much bigger like Lucerne, Winterthur or St-Gallen. The Zug emergence seemed to be an exceptional case as it was also the only place in Switzerland where edge cities taken together had overtaken the center in job numbers. In all, while the study of most structural angles showed a great stability of those during the crisis, the study of the size and distribution of superclusters serves as a powerful reminder that if the crisis did not alter so much the structures, it is chiefly because it attacked them all equally; the 1991 to 1998 period wasn't one of stability after all: it was one of decline without restructuration.

4.7.2.6. Territorial conclusions: decline without restructuration

The seven years following 1991 were marked by a very severe economical crisis which was at its worse between 1992 and 1994, and which dragged on towards the end of the century. During those seven years, the Swiss urban network shed about 380'000 jobs, about two third of which were lost in urban centers. The crisis mirrored the preceding period in the sense that the preceding growth period was profitable above all to edge cities, whereas the 1990s crisis burden was borne above all by urban centers.

In metropolitan areas it seemed that the takeover of urban functions by greater centers and the parallel demise of former local centers were happening. Elsewhere, i.e. in outlying areas, center demise concerned more classically small peripheral centers. More significantly, the major cities registered massive job losses; but big as they seem, those losses were actually commensurate with their position in the network. Almost no cities above 10'000 jobs did pass the 1990s without substantial losses, and some losses were downright frightening. There was a clear pattern in the most heavily affected cities: they were either industrial strongholds, or they were French- or Italian-speaking. It is not to say that those were sufficient conditions – after all, La Chaux-de-Fonds, did not fare that badly despite being both industrial and French-speaking, but it is to note that no service-oriented, German-speaking center did enter in this category. The 1990s crisis might have had both a regional and a structural component.

Mixed urban centers did especially badly during this period, underlining the difficulties that local centers faced in a crisis context when engulfed in metropolitan processes. A different picture is drawn from the exurban center evolutions. As a category, exurban centers suffered heavy losses during the 1990s crisis. Overall, there was a big discrepancy between the metropolitan areas, where exurban centers did resist quite well, and the rest of the country where they tended to fall easier. This reading would have implied a major metropolitan area growing above all west and south of Zurich, one around Basle, one in Ticino and one between Lausanne and Geneva. Conversely, Eastern Switzerland, Berne and the part of Western Switzerland not included in the Lausanne-Geneva axis would have remained non-metropolitan.

This is indeed what the larger picture seems to show. By considering urban, mixed and exurban centers, all of which appear to be independent units, there is a compelling pattern of differentiation between forming metropolitan areas and the rest of the country. The economic crisis probably accelerated the urban network evolution, by eliminating weak structures. In metropolitan areas, those were above all urban and mixed centers – they indeed disappeared in large numbers in the vicinity of major centers, above all around Lausanne and Zurich, while in outlying areas mostly urban, especially industrial, and exurban centers disappeared. This gave a rather strong dichotomy between metropolitan areas, constituted by urban centers, normally large, and interspersed exurban centers, and peripheral regions from which exurban centers were more or less absent but where the regional urban network had more or less held.

On top of that were the suburban centers. Like all urban categories, edge cities lost units as well as jobs during the crisis, however those losses were relatively minor as compared as those of the network as a whole. Losses were above all borne out by smaller, frailer units in the network. Whatever survived in the edge city list did so without big losses, or in some cases, with actual job gains. Indeed, with the exception of Emmen, all greater edge cities escaped the crisis relatively unscathed. Elsewhere, around smaller centers, the evolution of edge cities was diverse. First, a fair number of the disappearances were from non-dynamical units, often with strong industrial roots, and this is furthered in that the non-dynamical edge cities fared worse than the dynamical ones in general, and edge cities around industrial centers or regions fared worse than edge cities situated around service centers. Secondly, there was a strong size effect on the robustness of edge cities, such as in areas where they were small, they showed a large variability.

In all, the economic crisis of the 1990s, unlike the boom which immediately preceded it, acted as a decelerator for structural changes happening at the time. But subtly, by selectively culling scores of urban units it helped reveal the might of the metropolitan processes that were at play at the time. From a regional point of view, the Alps suffered the heaviest losses of all, as did to a lesser degree the most industrial regions of the country. Furthermore, a clear distinction started to be strongly visible between metropolitan cores, metropolitan polarized outskirts and regional remnants across the country, based on their urban network structure. In metropolitan cores and polarized areas, classical urban centers had to withstand the competition of fledging metropolitan centers like Zurich, Geneva and Lausanne. This eliminated an astonishing number of cities from the network while propping up massive edge cities, and preserving exurban centers in their extended range. On the contrary, in regional redoubts, the urban network survived better, although registering significant job losses at the city level, and losing practically all exurban centers outside them. The picture which emerged from this array of phenomena was one of a Switzerland undergoing metropolitan processes, with two metropolitan cores: Zurich and the Lake Geneva region, to which polarized regions were turned: the Aare Valley and the Zug-Lucerne axis for Zurich, and the Vaud canton, more or less, around Lausanne and Geneva. Two other metropolitan regions of smaller size seem to appear, around Basle, and in southern Ticino, mostly recognizable by the size and relative importance of edge cities. A fifth metropolitan area was maybe emerging between Berne and Fribourg. Outside those areas remained regional strongholds, such as the Jura arc, the Alpine regions, and Eastern Switzerland, which did not show the same characteristics than metropolitan areas. In a sense, the 1990s mark the moment when classical regional oppositions in Switzerland definitely morphed into a new dichotomy between metropolitan and peripheral areas, superseding classical territorial oppositions between city and country, plains and mountains, east and west.

4.8. 2005: in the doldrums

4.8.1. Aspatial results

4.8.1.1. Location and centrality: cautious recovery and metropolitan growth

The seven lean years constituted by the crisis years of 1991-1998 were not really followed by seven years of plenty (*Chart 4-97*). Between 1998 and 2005, the economic outlook varied wildly. First to come was a modest economic recovery which encompassed the internet bubble years and lasted to about 2001. This upturn was followed by a brief but brutal slowdown, epitomized in Switzerland by the demise of the national carrier Swissair, some three weeks after the Sept. 11th 2001 attacks. This period was in turn followed by a second phase of mild recovery which lasted to about the end of the period under review. In all, the Swiss economy gained about 125'000 jobs between 1998 and 2005, which made this period rather similar to the one which had followed the 1973 oil shock: after the crises, the doldrums.

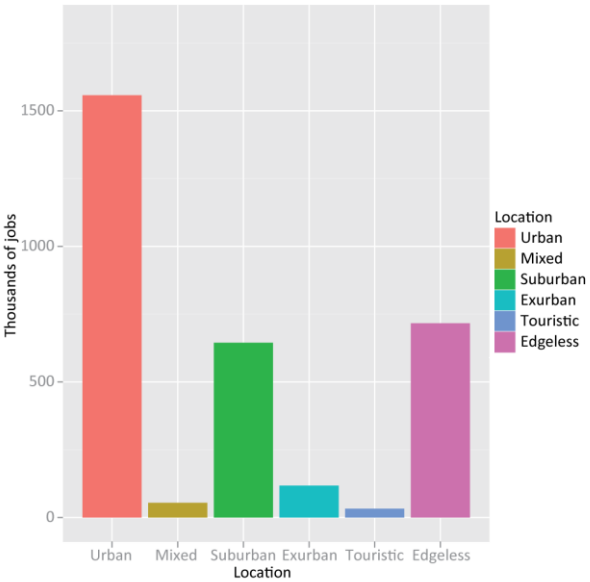


Chart 4-97: Job numbers by location, 2005

All of the jobs gained during this period were absorbed by the urban network, which grew of just three units to 408, and more significantly of 132'000 jobs in a now classic pattern seeing the urban network readjusting more clearly to crises and upturns than the country at large. Accordingly, the central network gained in terms of job share, which grew 1.2 points to 77.1% of all jobs. Conversely, edgeless space lost 7'000 jobs and 1.2 points of its job share.

Within the urban network, most of the growth was absorbed by two categories of centers (*Chart 4-98*). The urban centers gained about 34'000 jobs and just two units during the seven years under review, not enough of a growth to maintain their job share. In 2005, accordingly, the job share of urban centers, at 49.9%, dropped under 50% for the first time since the industrial revolution. By 2005, there were marginally more jobs outside urban centers than inside them. However, while losing job shares, urban centers gained in terms of structure, with both job densities and job intensities rising rather strongly, along with their mean size. The estimated job density for 2005 attained about 27 jobs per built ha, while the job intensity progressed from 140 jobs per 100

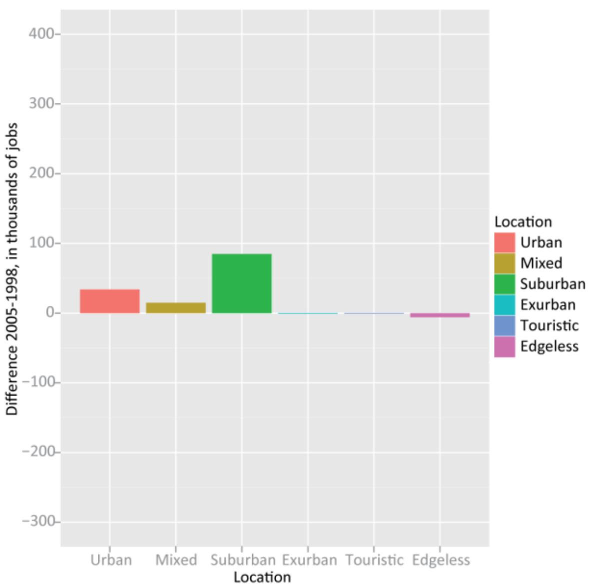


Chart 4-98: Job numbers difference by location, 2005-1998

active residents in 1998 to 146 in 2005. Urban centers were clearly strengthening again, after decades of slow but steady structural losses.

As always since 1965, suburban centers were the main beneficiaries of the job location evolution. They gained 10 units at now 146, and 85'000 jobs or close to two thirds of all that was gained by centers during the seven years leading to 2005. Correspondingly, their job share continued to climb, this time 1.9 points to 20.6%, meaning that by 2005 one in every five jobs were held in suburban centers, and that for five jobs held in urban centers there were now two held in suburban ones: they had definitely become major elements of the job location landscape. Furthermore, like urban centers, their structure also reinforced both in terms of densities and intensities. In particular, the mean job intensity gained 5 units at 112 jobs per 100 active residents, opening a significant gap for the first time in terms of job-active imbalance, as we will see later.

Significantly enough, mixed centers deserved a mention. They gained one unit at 13, and 15'000 jobs. This was significant in proportion to the gains made by bona fide urban centers, showing that while their absolute numbers remained modest, at 13 units, and just 1.7% of all jobs, but by 2005 they were significant as growth locations, which all other types weren't anymore: exurban centers continued their sinking by losing 8 units and some jobs, and less than 4% of all jobs.

Edgeless space, as we have already seen, lost some jobs, while maintaining its structures, as if it had reached an optimal distribution between residual jobs and its overwhelmingly residential function.

As the economy recovered somewhat and as urban and suburban centers both saw their job intensities climb, job imbalances logically grew during the period under review (*Chart 4-99*). Edgeless space active resident excess topped 704'000 persons, up 33'000 only since 1998. The reverse imbalance was up 56'000 persons to 492'000, while suburban centers job excess grew 32'000 units to 68'000, a relatively small number, just about 15% of the urban centers imbalance, but nearly double the preceding figure. For the first time, suburban centers started to play a role in the great equilibriums of the way territorial work-home relationships worked. For the first time, suburban centers could host a sizeable, if small, percentage of the jobs needed by edgeless residents: about one in ten edgeless residents was now working in a suburban center. To note also the visible but slow economic recovery impact on the job market, the nationwide job deficit having been reduced from 174'000 units in 1998 to about 122'000 in 2005.

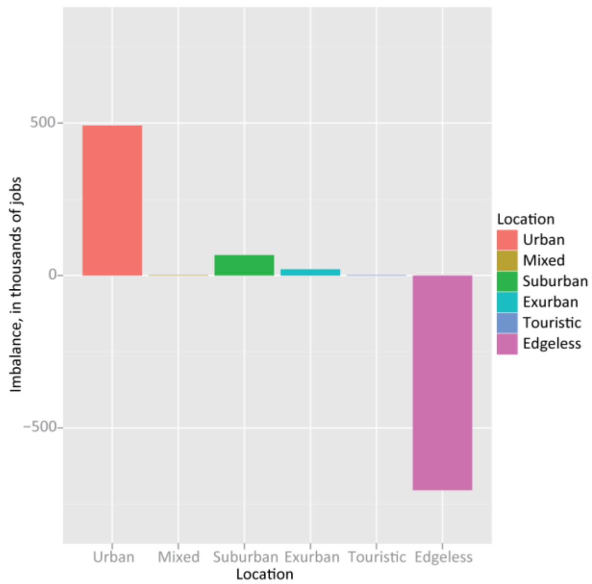


Chart 4-99: Jobs-actives imbalance by location, 2005

4.8.1.2. Dynamics: the power taking of dynamical centers

In doldrums times as in crisis ones, dynamical centers fared better than classical ones (*Chart 4-100*). Dynamical centers gained a further 26 units at 283 – though it has to be noted that the progression was less impressive than during crisis times. In parallel, the number of classical

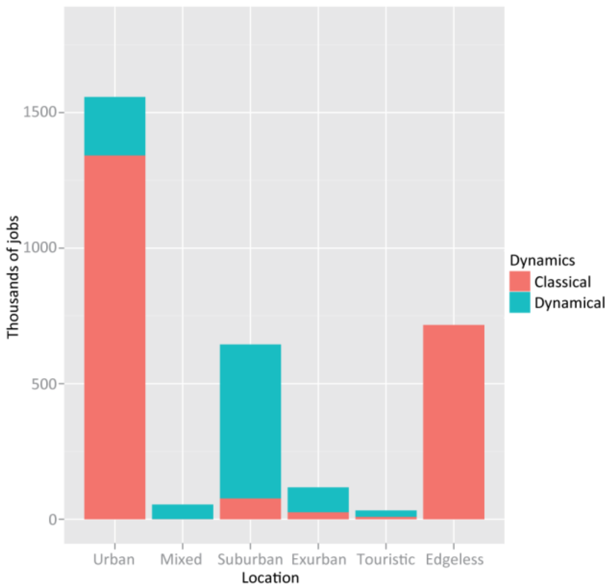


Chart 4-100: Jobs by location and dynamics, 2005

centers declined further, losing 23 units at now just 125. Likewise, all of the growth experienced during the 1998-2005 period took place in dynamical centers, which gained close to 150'000 jobs, either by internal growth and by addition of new dynamical centers, while classical centers lost about 17'000 jobs. As a result, classical centers lost 2.4 points to 46.6% job share, while dynamical centers jumped 3.7 points to 30.5%, meaning that a very significant part of all central jobs were now held in dynamical ones, to be precise two in every five.

Seemingly, classical centers lost above all smaller, weaker units as their structure decidedly improved at the same time: classical centers job density, job intensity and mean size all climbed up significantly, the latter the most spectacular. The same trend was seen for dynamical centers, with an even higher upturn in job intensity than in classical centers, while their mean size remained fairly stable.

When controlling for location, dynamical centers always outperform classical ones. The differences are particularly clear in urban centers, where dynamical units represented in 2005 one in every eight jobs against one in ten in 1998, progressing more than 60'000 jobs when classical units lost 27'000, and in suburban units where dynamical centers were completely dominant with nine out of ten jobs already held in dynamical, recent units. In what remained of exurban centers, dynamical units also continued their progression, as in mixed centers, which were however by definition originally dynamic.

4.8.1.3. Orientation: terminal industrial decline?

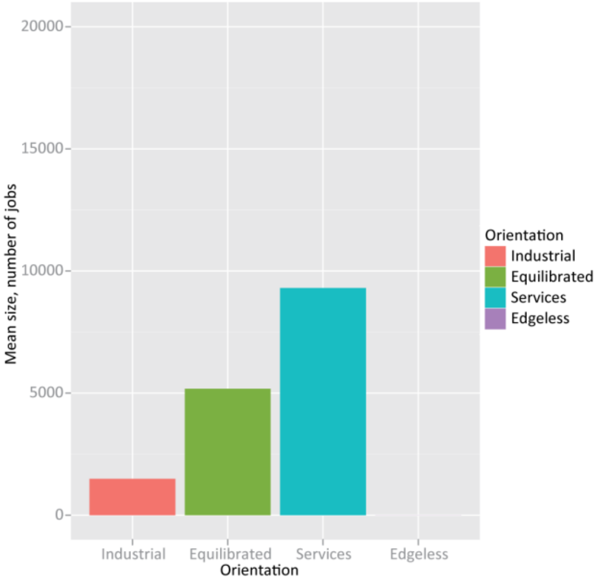


Chart 4-101: Mean center size by orientation, 2005

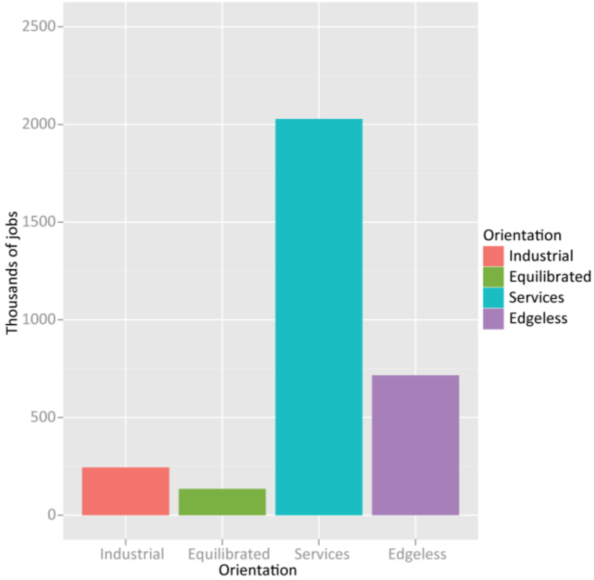


Chart 4-102: Number of jobs by orientation, 2005

The economic recovery following the crisis years profited only to service centers, which gained 14 units at 218 and a significant 175'000 jobs in seven years, while industrial centers continued to lose both units – 14 at 164 – and jobs, with a 64'000 job loss (*Charts 4-101 & 4-102*). Accordingly, the service centers grouped now 64.9% of all non-agricultural jobs of the country, a rise of 3.1 points, while industrial centers grouped now only 7.8% of all jobs, down 2.5 points, a damning assessment of their vanishing significance in the country. Parts 1998, the network of industrial centers was in such a state that it wasn't able to trigger an upturn. In hard times it lost inordinate amounts of units to the crisis; in good times, it lost them to equilibrated industrial centers. At least territorially, there was seemingly no future for industrial centers in 2005's Switzerland.

4.8.1.4. Form: a return to complete forms

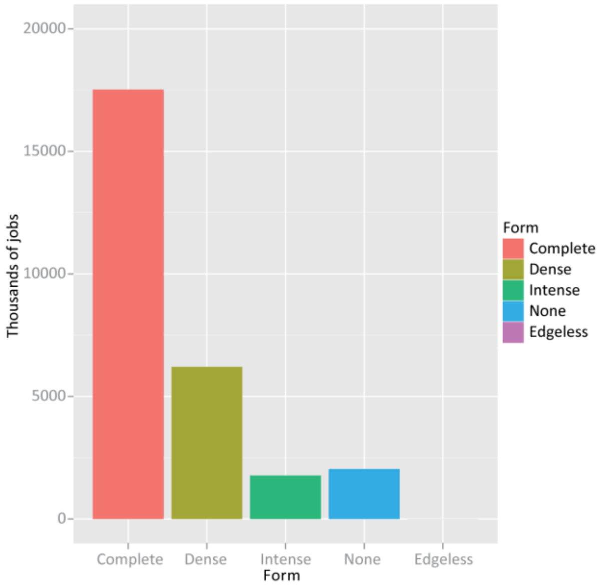


Chart 4-103: Center mean size by form, 2005

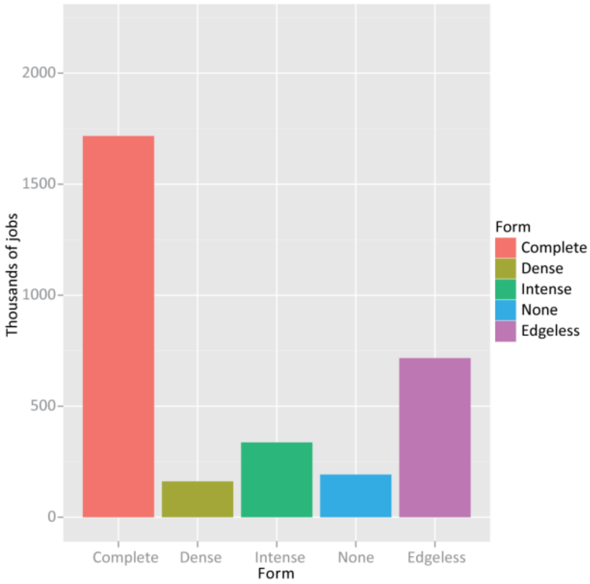


Chart 4-104: Number of jobs by form, 2005

As the recovery favored primarily urban and suburban centers, especially dynamical and service-oriented ones, the recovery profited above all to complete centers, those exhibiting both enough density and intensity to qualify as centers (*Charts 4-103 & 4-104*). This confirmed that across the board, structures were again gaining ground. Accordingly, most of the jobs gained during this period were located in complete centers of which there were 8 more at 98, and which job share correspondingly progressed 1.7 points to 55%. These gains were made, again, in a structural context of reinforcement: complete centers, in particular, gained greatly in job intensity. The fact is that they only maintained their mean size, meaning that their growth had above all been by adding new, smaller units to the group.

Both dense-only and intense-only centers declined as groups. The only other group to progress was the "none" category, those centers with neither density nor intensity to qualify for center status but included if they were dynamical enough and close to getting there. This means that already established but incomplete centers were migrating up to complete status as new units were entering the network from the bottom. As a whole, the central network was experiencing indisputable, if discreet, recovering.

4.8.1.5. Size: structural stability amidst great centers intensification

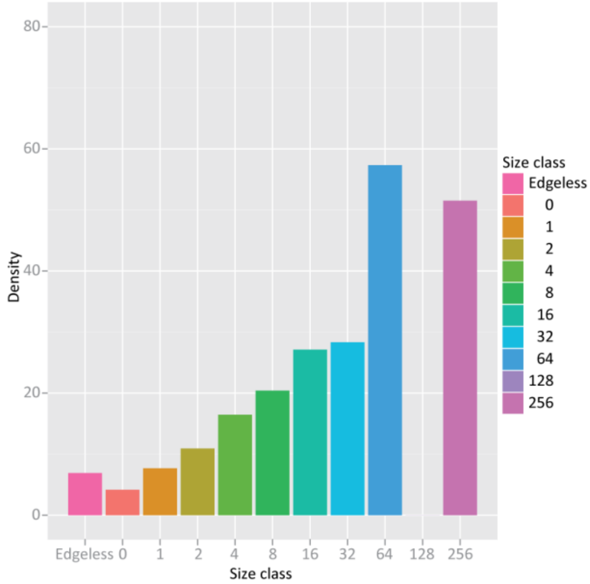


Chart 4-105: Job density by center size class, 2005

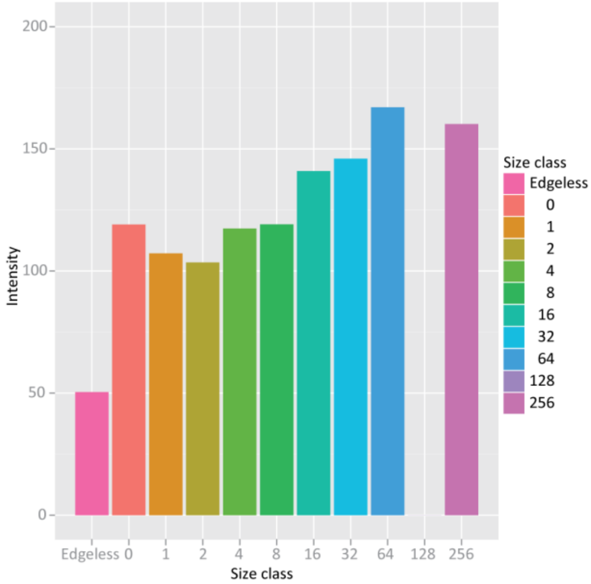


Chart 4-106: Job intensity by center size class, 2005

Density showed remarkable stability when controlled by size class, with a very gentle rise in all classes over 2'000 jobs (*Chart 4-105*). This general rise is very modest, and never exceeds 2 points. In very small centers, the historic tendency towards decentralization remained and those smallest centers lost density, albeit at a very small rate.

While density remained frozen in place, intensity showed distinct signs of strengthening (*Chart 4-106*). Moreover, there was a clear link between size and intensity growth, the biggest centers being also those where job intensity grew most. Thus, the dichotomy between the smaller centers, those with less than 16'000 jobs, and the larger ones also grew: while the smaller centers did not reach intensities above 120 jobs per 100 active residents, while larger ones sported now intensities well above 140 jobs per 100 active residents.

Thus, greater centers tended to specialize ever more into job centers, growing in terms of job numbers while losing actives, and thus digging an ever growing imbalance between jobs and actives, to be brought from outside their limits. In particular, job intensity rises were spectacular in the five largest centers of the country.

4.8.1.6. Rank-size and job numbers by size classes: the rise of the middle classes

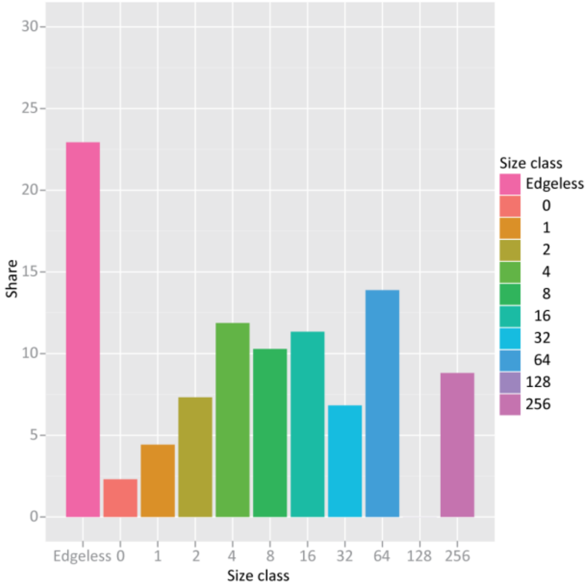


Chart 4-107: Job share by center size class, 2005

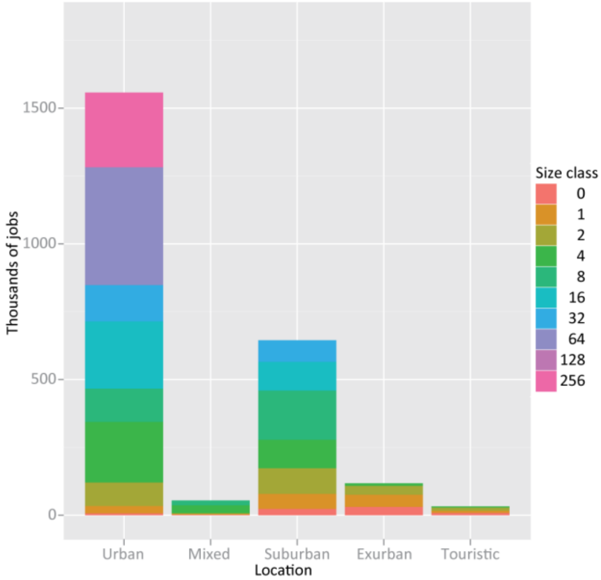


Chart 4-108: Job numbers by location and center size class, 2005

1991 had seen a return to some form of equilibrium, at least in the median size classes, which 1998 had seen greatly perturbed by the economical crisis (*Chart 4-107*). In 2005 as in 1991, the economical recovery brought again some equilibrium to the size classes, amidst subtle modifications which pointed all in the same direction. First, as always, the smallest classes, those grouping centers with less than 2'000 jobs, continued to decline. By 2005, those centers represented just 6.7% of all jobs in the country, about two thirds of its value of 1939, and 0.8 points lower than in 1998. It was especially the centers between 1'000 and 2'000 jobs that were hit on the long term, showing that this particular class had severely declined, in accordance with a departure from a Christallerian model to a metropolitan one. On the other side of the distribution shares remained stable, or even decreased a little bit. In all, the medium-sized centers, those with between 2'000 and 32'000 jobs took all of the growth, their job share up more than 2% at above 40% of the total.

Stability seemed to prevail in the size distribution of centers when controlling for their location (*Chart 4-108*). This was particularly true of the urban centers which kept essentially the same size distribution than in 1998. The main change was a significant growth of the 8'000 to 16'000 jobs suburban centers, which leads us to surmise that growth experienced by suburban centers between 1998 and 2005 may well have been trusted by medium- to big-size objects. This size class gained 7 members in seven years, while all other suburban size classes remained fairly stable. It will be particularly interesting to see how this played out at the cluster level.

4.8.1.7. Zipf's law, clusters and superclusters: metropolis progressing

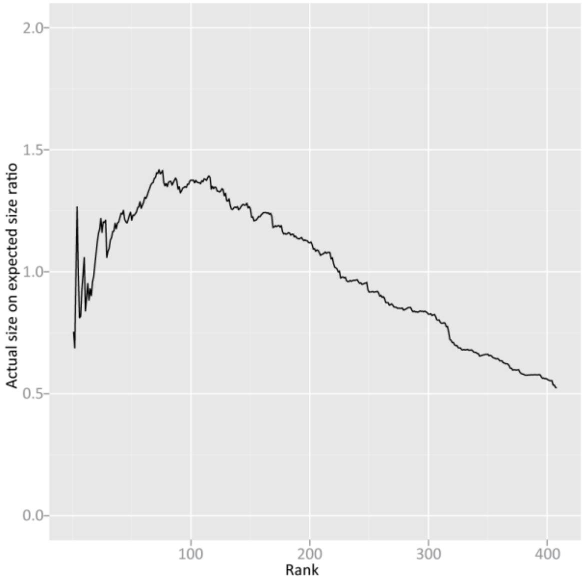


Chart 4-109: Units rank-size distribution compared to Zipf's law, 2005

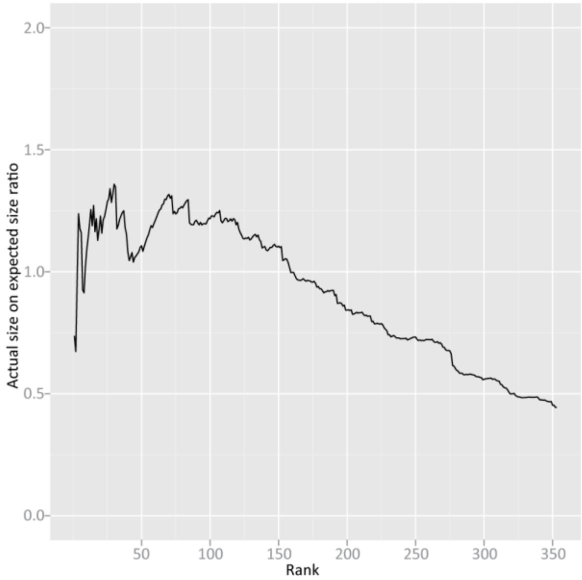


Chart 4-110: Cluster rank-size distribution compared to Zifp's law, 2005

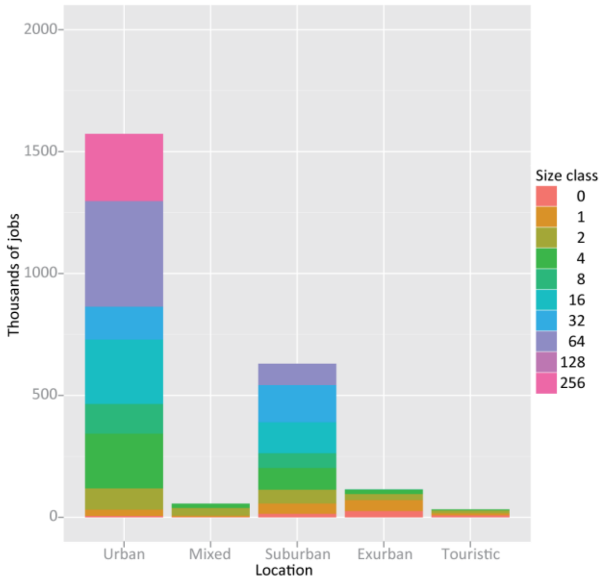


Chart 4-111: Job numbers by location and by cluster size class, 2005

As for the preceding period, stability remained rather evident during the 1998-2005 period regarding the rank-size behavior at the unit level (*Charts 4-109 & 4-110*). Subtle alterations were duly noted: mostly, a very subtle weakening of the largest cities, and an equally subtle reinforcing of the middle part of the distribution, a rather consistent result with the image of a metropolitan country, along with strings of suburban units. Somewhat surprisingly, the same distribution observed at the cluster size showed no major departure from this, meaning that the surplus of medium-sized centers wasn't due to an artificial segmentation in suburban centers, but to a real phenomenon: at the cluster level as at the unit one, major centers seemed to be smaller than expected, mid-level centers decidedly larger, and smaller centers ever smaller than expected: all this seeming to point to the constitution of a metropolitan network of cities and centers where mid-sized units were catching up and reaping the most benefits. That being said, the cluster level showed a reinforcement of medium-big units that the unit level didn't, which could only be due to the reinforcement of major suburban clusters.

The reinforcing of the central network was particularly sensible in mid-sized centers, which confirms the find made in the preceding paragraph (*Chart 4-111*). In urban centers in particular, the 16'000 to 32'000 job bracket grew strongly. In suburban centers, clusters above the 4'000 jobs

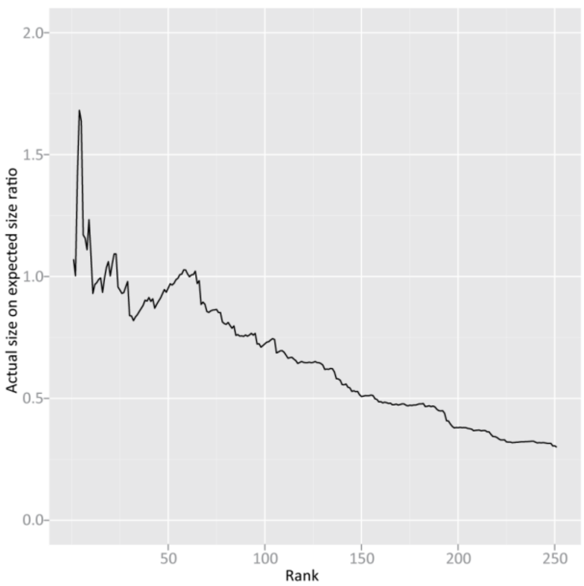


Chart 4-112: Supercluster rank-size distribution compared to Zipf's law, 2005

mark grew significantly, making suburban centers more and more top-heavy; in particular, units above 32'000 jobs seemed to progress pretty well.

At the supercluster level, the rank-size distribution seemed not to have evolved much (*Chart 4-112*). However, by looking at it closer it was notable that some of the largest superclusters had indeed progressed during the 1998-2005 period, bringing the curve closer to a general allure of overgrown major superclusters, normal middle-sized ones, and smallish lower ones. That, again, very strongly suggests a bend towards a general metropolitan direction of the country, away from a classical Christallerian network.

4.8.1.8. Aspatial conclusions: continuing stability, subtle changes

The seven years leading to 2005 saw a return to more favorable economic conditions and since economic conditions appear strongly related to urban growth and strengthening, it was expected to find a reversal of fortune of the urban network.

For the first time since 1991, the urban network as a whole regained units as well as jobs. As usual, the urban network gains or losses matched or exceeded those of the country as a whole, confirming if need be that the urban network was at the heart of the whole country evolution, and that by contrast edgeless locations were just a kind of buffer space without proper role, evolving as a negative of the urban network. The urban network regained some ground in terms of job share. The expected reversal had happened.

Classical urban centers remained of course the largest urban category, but with rather feeble gains only, which meant that their job share continued to gently slide, as it had done since 1955. Yet, the urban structure strengthened quite a lot during those years, with a jump in center mean size, job density and above all in job intensity. This return to intense job specialization means that the imbalance between jobs and actives grew significantly, while still remaining well short of the maximal imbalance registered in 1991.

Edgeless space, in all, decreased in importance during this period. Structurally it tended to stay stable, a new development meaning that it had probably attained a form of stability. Accordingly, its excess of actives remained fairly stable. However, the main interest of its evolution here is that it seemed at last having hit a bottom.

Between the two, non central urban spaces experienced a renewed boom during those years not completely unlike the one they lived during the late 1980s, although definitely more muted. Non central urban forms continued to progress in terms of job share. Another big development of the time was the true emergence during those years of the dynamical urban centers, classical urban centers that showed such dynamics as to mimic edge cities. The emergence of cities as centers of relentless growth is a very significant event of those years.

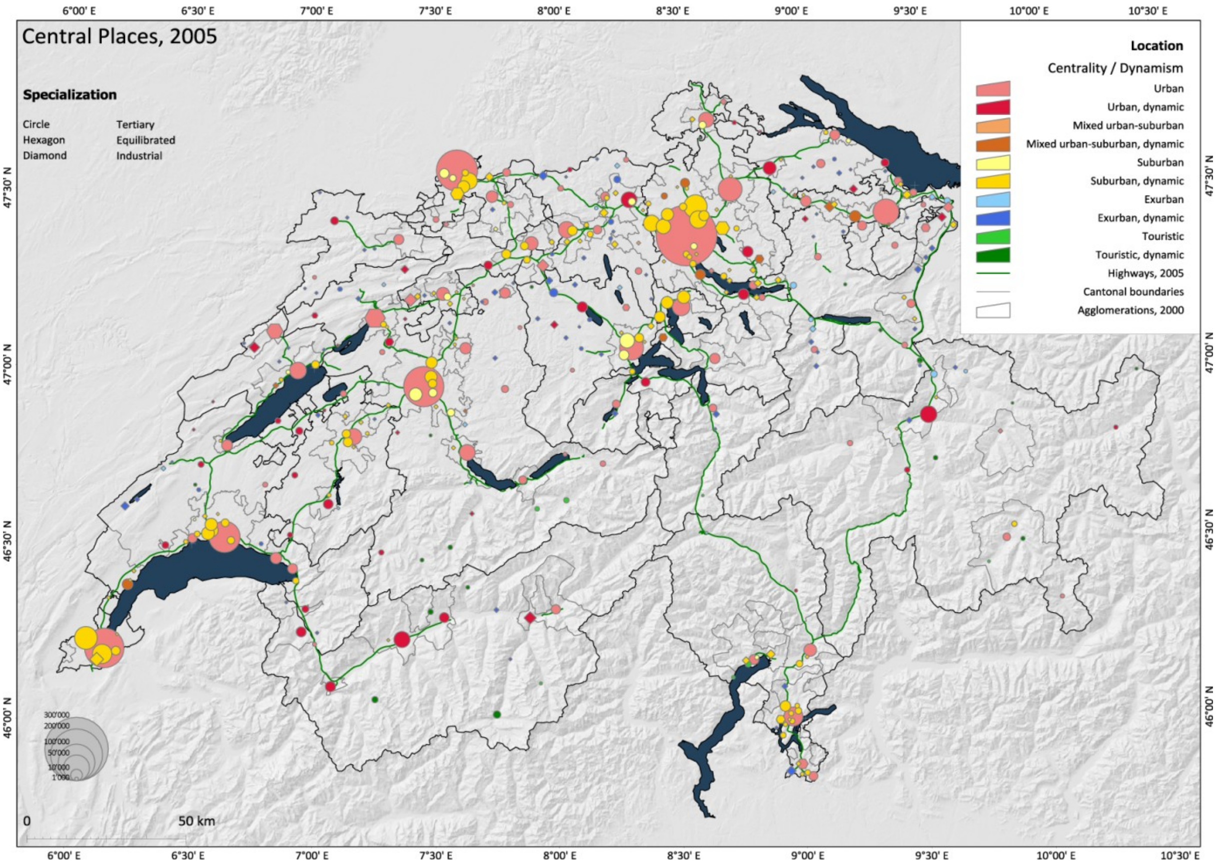
Suburban centers remained by far the biggest category of non-central centers. On all counts, they strengthened during this period, with very significant gains in job and in job density. A direct effect of these trends is that the job/active imbalance at long last started to really grow. At this time it seemed clear that suburban centers were growing more entrenched, more specialized, in one word more resilient at each economic opportunity. The same can be said of all dynamical urban forms, the most notable of which were the dynamical urban centers. As a result, their job imbalance also grew very strongly. As compared to suburban and urban centers, the two other dynamical center types remained more modest.

2005 marked a return to growth for the urban network, a return that was above all marked by the furthering of spatial specialization, with job intensities rising across the board, as well as by the growing significance of non central urban forms in the network. In all, edge cities progressed. However, the most significant turn of this period is the emergence of formerly classical cities turned dynamical. In the preceding period mixed centers were on the rise. This time, bona fide centers morphed into dynamical ones at a rate unseen before. While the general impression may have been that, all things being equal, the 2005 census resembles the 1991 one, in fact big differences exist between the two. In 1991, suburban centers were completely dominating the scene in terms of emergence. Fourteen years later, mixed and even more classical centers turned dynamic were playing a big role in the evolution of the urban network. Since 1991 when only sprawl was clearly visible, a form of return to centers, apparent first on mixed centers, then on classical ones, was taking hold. Moreover, the divide that had opened during the 1990s between imbalances in cities and in edgeless spaces was closed in great part by the development of dynamical centers, above all by suburban centers and dynamical urban centers. An imbalance between jobs and actives that had opened up in the 1990s and which resulted in an unprecedented wave of joblessness closed up quite a bit prior to 2005, but only with the help of new forms of urban development. What classical cities could not offer, dynamical centers would for a large part. More than one in four active residents in excess in edgeless space had now to commute to those new centers instead of classical ones, a new phenomenon. It can be said that while less impressive in sheer numbers than the 1991 emergence, the 2005 emergence was probably more significant than the former in what it represented for the urban network.

At a more national level, the emergence of new urban forms as major players along suburban centers demonstrated clearly that metropolitan processes were now clearly in command as how the central network evolved, by developing ever larger suburban clusters around its major urban nodes, by promoting the growth of mid-sized urban and mixed centers, many of which being deemed dynamical after having been swept up by those same processes, all the more since the smallest center levels had been severely depleted. Likewise, the sudden upturn in terms of structural strength, after decades of weakening, should not be underestimated. After decades of sprawling, it may have seemed that redensification was finally happening, at least in nodal cores of the new metropolitan forms that urban Switzerland started to adhere to.

4.8.2. Spatial patterns

4.8.2.1. The urban network pattern: urban stability, suburban and metropolitan progress



Map 4-28: Central places by size, location and orientation, 2005

The 2005 central network map shows that by and large, the urban network remained remarkably stable between 1998 and 2005 (*Map 4-28*). The big centers staved off further losses after then losses experienced up to 1998, and some of them even started to regain forces, even if gains made during those seven years were not matching the losses of the preceding period. Urban growth was then rather patchy, concerning above all the greater Zurich area, with cities such as Zug, Freienbach, Wetzikon or Frauenfeld. This pattern was clearly repeated with the overall growth of mixed centers, which per definition were situated in such areas. Examples include Bülach and Hinwil in the greater Zurich area, but also Gossau and Uzwil in Eastern Switzerland, and Nyon along the Lake Geneva shores. However, those big moves were the exception and as a rule, the urban network, and its mixed urban annexes, stayed put.

Once again, the suburban centers were the most dynamic units of the map, but unlike preceding periods there seemed to be a catching-up effect in the way they developed. The most spectacular progressions were made around Berne and Lucerne, which had respectively pretty few edge-cities up until then, or had lost it. Conversely, a strong regional effect was legible in the Zurich metropolitan area, where the effects of the Swissair bankruptcy were felt hardest. Areas of strong suburban growth encompassed notably the Zug-Lucerne corridor, parts of Aargau, especially western Aargau, Berne, Fribourg and Lake Geneva in general, the Geneva edge-cities in particular, and Ticino. Overall, suburban progresses were notable above all in former less-urbanized areas, such as Western Switzerland, Central Switzerland, Southern Switzerland, as opposed to the traditional heartland, and in that sense this was a time of convergence for the country.

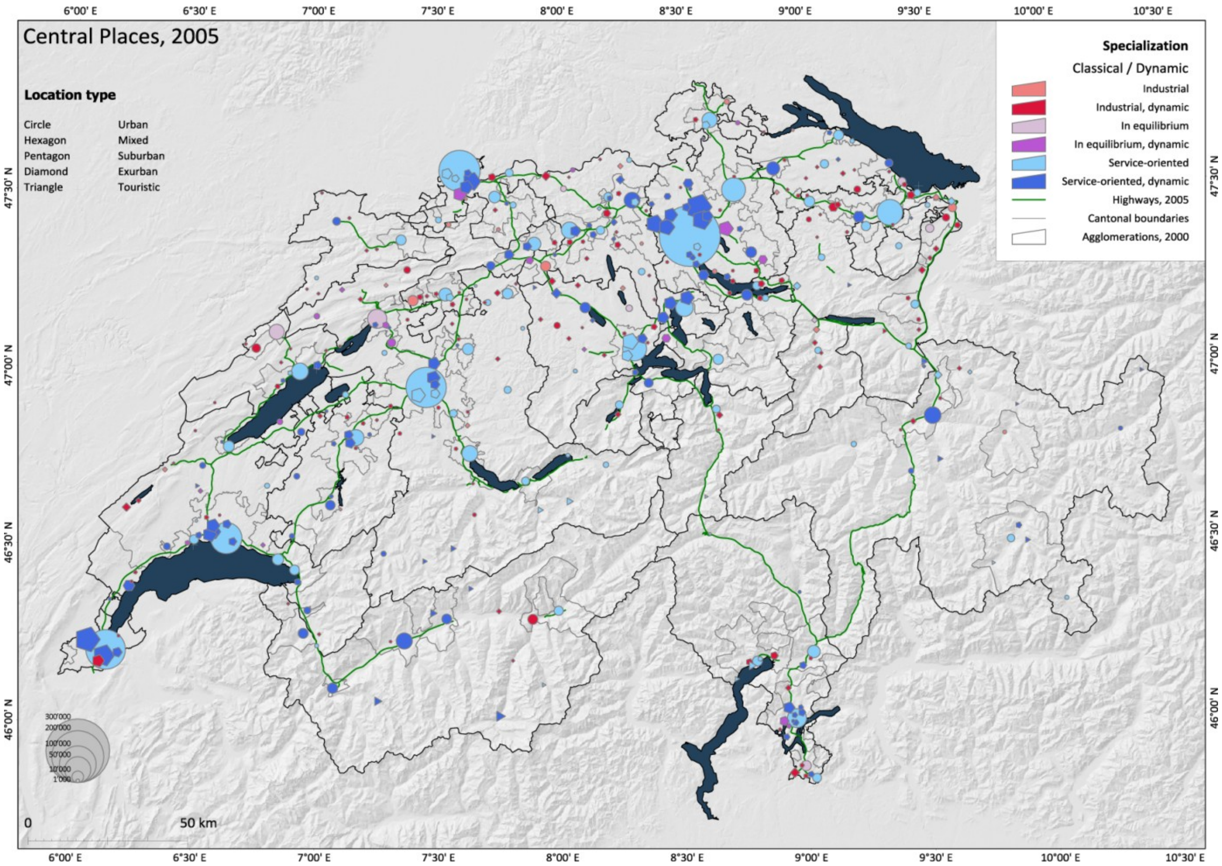
4.8.2.2. Center-periphery patterns at the national scale: a subdued center

In terms of national center-periphery relations, as we have clearly pointed out already, a double move was apparent. The first was that urban centers were progressing above all in and around major centers, in particular in the greater Zurich area. A second movement was that suburban centers were progressing more around former less urbanized regions, while at the very center of the country, the Zurich agglomeration, growth was clearly less evident, subdued maybe by the Swissair affair.

So, one witnessed a double move of concentration-deconcentration, a very clear emphasis on metropolitan and urban spaces, but especially peripheral ones, like in Mittelland or in Ticino, while the most central parts of the metropolitan space remained a bit behind, letting both its own outer belt growing larger, in step with the outer belt of the country. In all, this produced somewhat of a territorial rebalancing, although entirely metropolitan.

4.8.2.3. Differences according to agglomeration size: big not always beautiful

The double tendency hinted at in the preceding paragraph translated in a dichotomous pattern when looked at controlling for agglomeration size (*Map 4-29*). There was a significant difference between the two largest agglomerations of the time, Zurich and Basle, where the development



Map 4-29: Central places by size, orientation and location, 2005

appeared subdued, and the rest of the field, especially around medium and large centers, where development was clearly more sustained.

2005 was also notable for the fact that most of the remaining industrial suburban centers that had survived as such around larger centers had now turned away from industrial domination. Amongst them, the Upper Glattal unit around Volketswil, the Upper Birstal one in Reinach (BL), Emmen north of Lucerne, Köniz in Berne, the Lower Vedeggio west of Lugano all turned away from industry, leaving only the very heavily regulated Geneva unit of Plan-les-Ouates as predominantly industrial amongst all suburban units around mid- and greater cities. In essence, by 2005 industry was left entirely out of central metropolitan space. It survived only in very localized smaller towns and small suburban units around them, in dedicated industrial regions like Western Aargau, Eastern Switzerland and the Jura mountains.

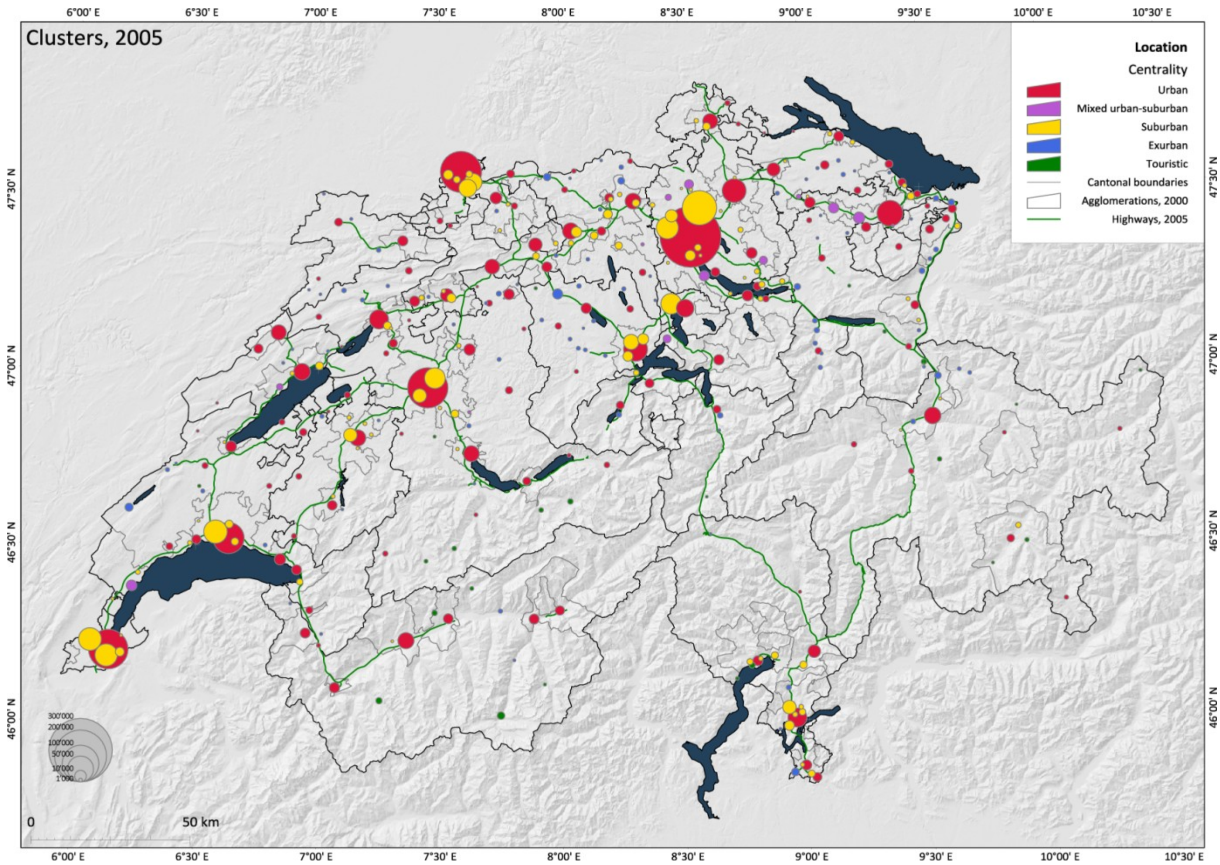
4.8.2.4. Regional patterns: the hour of the other metropolises

Regional effects that had not already be covered in preceding sections were extremely hard to pinpoint on the map. Regional effects were nonetheless present, and most of them were already hinted at. In all, the 1998 to 2005 period was one of increasing metropolitan processes and accordingly, metropolitan spaces grew quicker than other areas of the country. However, the main metropolis suffered some specific setbacks during the period which allowed the outer metropolises, that of Berne, the Geneva Lake area, and Ticino, to thrive more than the Zurich-Basle axis. In that metropolitan area, only the outer fringes, especially its southern ones – Zug, Lucerne, Ausserschwyz, experienced strong growth.

Elsewhere, regional effects were rendered more visible by the mostly complete disappearance of industry-dominated centers in the internal parts of metropolises. Industrial towns dominated now in regional terms, situated at the fringes, or wholly outside, burgeoning metropolitan spaces. Such industrial clusters were now more notable in the lower Rheintal in Eastern Switzerland, the western parts of Aargau, the Grenchen area and some clusters in the Jura mountains. Very clearly, industry was becoming increasingly peripheral, in geographical as well as in economical terms.

4.8.2.5. Mapping clusters and superclusters: western resurgence

As we have already abundantly told, suburban centers resumed their spectacular growth as soon as the economic conditions allowed it, and as already surmised, their growth pattern revealed strong regional bias (*Map 4-30*). While essentially no suburban cluster actually lost jobs during this period, big variations were seen. As already seen, the Zurich edge cities had a rather muted growth during the period under review. The Glattal cluster gained only 2'700 jobs at 87'840, stuill, by very far, the biggest of the country and more significant than Lausanne. The Limmattal complex gained 2'500 jobs at 36'000, the Furttal one gaining 1'000 jobs at 11'000. Likewise, around Basle, suburban clusters remained stable, Schweizerhalle gaining 300 jobs at 23'400, the lower Birstal gaining a bit more, 1'100 jobs, at 22'900. Elsewhere, progressions were clearly larger. In Geneva, Cointrin gained 5'000 jobs at 38'600, and La Praille gained a whopping 7'700 at 37'100, making the Geneva area the most dynamic one of the country. In Lausanne, the western complex gained a further 4'700 jobs at 40'700, strengthening its position as second biggest edge city complex of the country, and 10th center overall. In Berne, the Ostring complex gained 7'200 jobs at 31'700 jobs, while the Wangental-Köniz suddenly jumped into view with 13'700 jobs, up close to 10'000 jobs. Likewise in Lucerne, where the Reusstal cluster regained its former



Map 4-30: Clusters by size and location, 2005

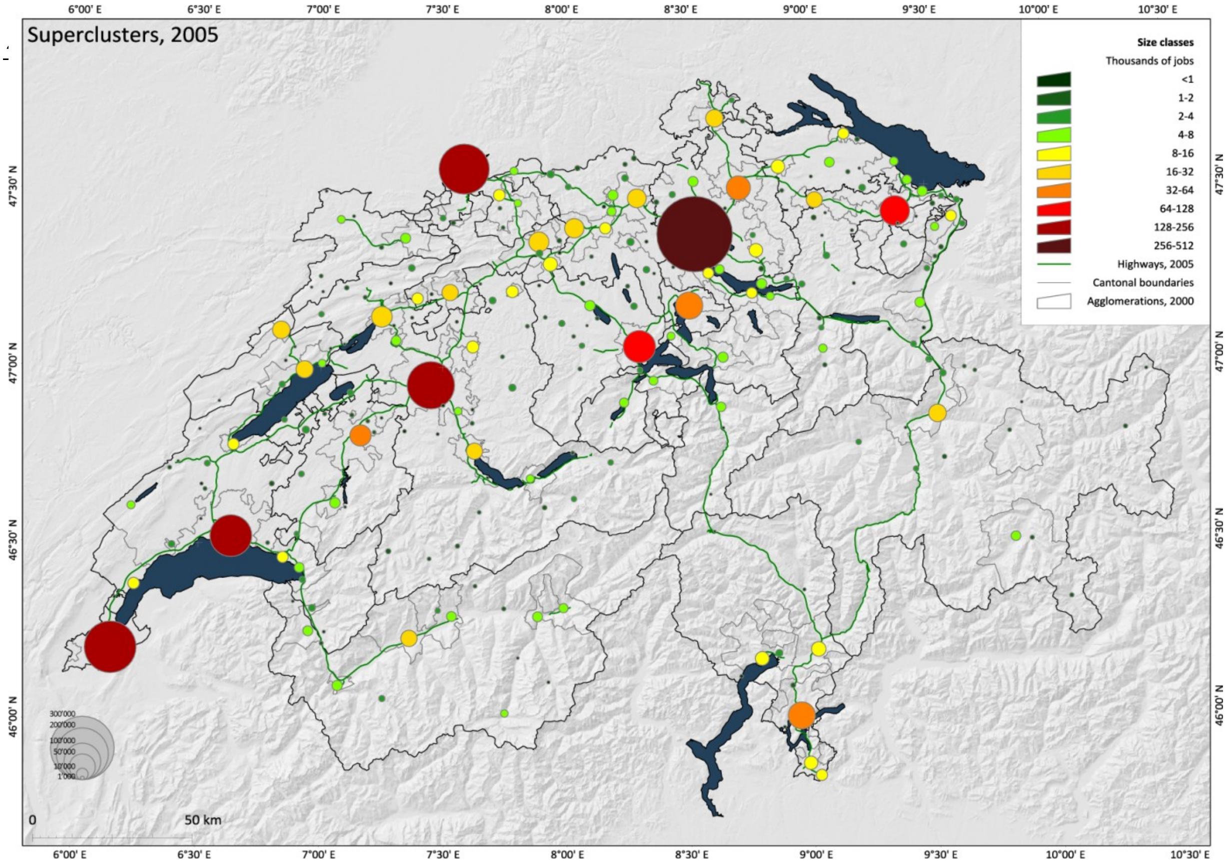
status with 17'100 jobs, up 7'900; close by, the Zug area also experienced very strong growth, the Zugersee complex gaining 4'400 jobs to 31'600, dominating but also uplifting its parent city of Zug, itself up 3'000 jobs at 23'000. Other notable clusters grouped the Gäu complex, with a thorough growth of 4'400 jobs at now 16'200, or more than its parent city of Olten, the Vedeggio complex with 13'500 jobs, up 1'500, and Fribourg-Nord, up 2'400 jobs at 13'100.

In general, most of the suburban centers did show a healthy progression, with the outside exception of the main Zurich area suburban clusters, but apart from this the picture of the cluster network remained fairly stable.

The last map of the series confirmed most of the finds made at earlier stages in the section concerning 2005 (*Map 4-31*). At the top of the network, if Zurich and Basle, as superclusters, resumed growth, they were less impressive than Geneva, Bern and even Lausanne, marking a clear reinforcement of the western half of the country against the eastern half of the country as well as a reinforcement of the immediate followers of the two major cities of the country. This was epitomized by the fact that the Geneva supercluster, sporting 197'700 jobs, overtook Basle and its 185'200 jobs. Till then, Basle had always been bigger than Geneva as a job place, the only change in the big five hierarchy which happened during the entire time span of our study.

Meanwhile, at the middle level, the situation was rather fluid, in a general context of stability. Regional effects were seen, with superclusters progressing in the greater Zurich metropolitan area: Zug, Olten, Lucerne and St-Gallen while in the western part Fribourg also progressed much. In contrast, the inner parts of the great metropolis progressed less, as did all superclusters in and around the Jura mountains, Basle included. In all, a multipolar metropolitan Switzerland was seemingly taking shape.

Map 4-31: Superclusters by size, 2005



4.8.2.6. Territorial conclusions: stability domine

The period spanning 1998 to 2005 was one of economic uncertainty and wobbling, starting with definite signs of recovery after the mostly depressed 1990s, followed by a short but severe recession around 2001-2002, and the by signs of another recovery towards 2005. As a whole the period under review showed a small increase in the total number of jobs, and can be qualified as slightly positive. Accordingly, after the major changes having happened between 1985 and 1998, the period under review appears a bit subdued.

Cities as a whole gained jobs during this period, while their numbers remained stable. In metropolitan areas very few changes were registered, except for one, which is that many classical urban centers turned dynamic at this time. Altogether those changes indicate that the urban network was still evolving, albeit at a far slower pace than what had been the norm in the two preceding intervals of time. Changes appear also to have a strong regional bias, with losses in peripheral regions, and gains in some central ones. The evolution of mixed centers (just the six of them) paints exactly the same picture than the urban centers.

Exurban centers remained fairly stable on the period under review, but at a very small figure. In terms of spatial distribution, albeit strongly than before, exurban centers tended to concentrate in the vast region west and southwest of Zurich, mainly in the Aare Valley and in the Lucerne Mittelland. Elsewhere, when exurban centers were present, they were quite small. Eastern Switzerland showed such a display. Elsewhere in the country, there were no identifiable concentrations of exurban centers. The phenomenon seemed to be recent – if the Aare Valley had always seen a concentration of exurban units, they were also present in strong numbers in the rest of the country; but as we crossed into the 21st century, exurban centers had more or less vacated their traditional areas, while concentrating in the keystone region of Aargau, Eastern Solothurn and Northern Lucerne.

As significant as those developments were, they were dwarfed by the evolution of suburban centers, which thrived again from 1998 to 2005. More urban centers now sported major edge cities. Berne, Lucerne, and Fribourg joined the select group of cities lined with at least one major edge city, thus far grouping Zurich, Basle, Geneva, Lausanne and Zug. Regionally, strong differences arose when comparing the destiny of major edge cities. In Geneva, Lausanne, Berne and in Central Switzerland they grew strongly. At the same time, edge cities in northern Switzerland suffered. In Basle, all suburban centers remained within 1'000 jobs from where they were seven years earlier. In Zurich, major shocks in the economy, most notably the collapse of Swissair, hampered suburban center development.

In terms of territorial distribution, it can be seen that major units essentially adorned major cities, while smaller towns got generally far smaller suburban centers, if any. However, there are several exceptions to the rule, the most blatant being the Lucerne-Zug corridor. As of 2005, this corridor was the most spectacularly decentered area of the whole country: edge cities there were competing successfully for first place with their parent cities. The two nearest cases were also medium-sized regional centers, Olten where the Gäu complex had also reached a life of its own, and Fribourg and Lugano where suburban centers grouped together were now hosting job numbers close to those of the central city. At the same time, all the biggest centers have maintained a clear lead on their suburban centers and still host at least two out of every three jobs in their agglomeration, or largely more than that. However, most regional centers do not see any competition from their edge cities, when they have one; and many do not sport any suburban center.

The geographical distribution of edge cities, like those of exurban centers, evolved through time to show strong regional differences. In 2005, major centers were all escorted by at least one major edge city, a feat that only four other cities could match. Those four centers were situated in metropolitan space, and indeed there was a strong case for making edge cities metropolitan markers. Outside metropolitan areas, edge cities were far less prevalent. When present, they are always way smaller than their metropolitan counterparts, as in Eastern Switzerland, and to a lesser extent around regional centers in Western Mittelland, and they were essentially absent of entire regions, most notably the two mountain ranges. There is a strong case indeed to be made that edge cities thrived in metropolitan areas, and that conversely strong edge city presence denoted such areas. Following this argument, it could then be said that the Berne-Fribourg couple showed strong metropolitan processes, as did the southwestern side of the greater Zurich area, joining thus older metropolitan areas such as the Greater Zurich area, Basle and the Lake Geneva area. On the contrary, the Alps, Jura and Eastern Switzerland appeared not to experience the same dynamics. In that way, the 2005 map seemed to reveal a return of the regional parameter into the equation, but this time morphed into a center-periphery which now blended with a metropolitan – non metropolitan component. Whole regions can now be described as central: the Zurich – Lower Aare Valley – Northern Central Switzerland complex, the Lake Geneva area, the Baselbiet, the Sottoceneri, and to a lesser extent the Bern-Fribourg duo appeared as central metropolitan regions, while the rest of Western Mittelland, Eastern Switzerland and the two mountainous areas remained as peripheries.

4.9. 2008: boom without bust

4.9.1. Aspatial results

4.9.1.1. Location and centrality: explosive growth and cities return

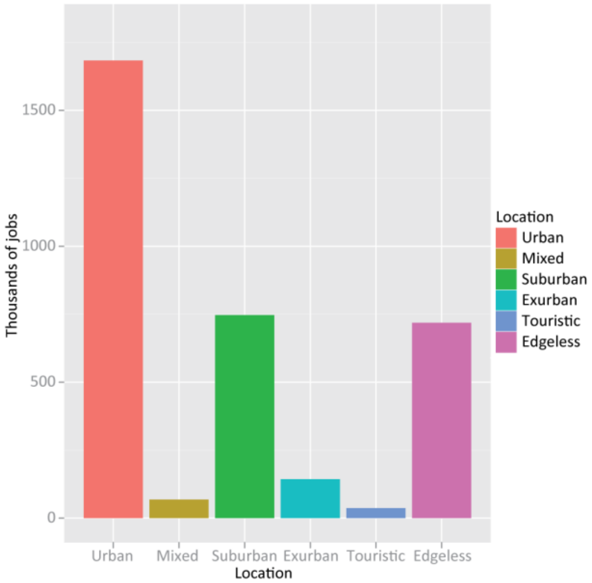


Chart 4-113: Job numbers by location, 2008

With the 2008 business census results we come to the last point in time which we could investigate (*Chart 4-113*).

The three years separating 2005 from 2008 saw a strong acceleration of the economic growth, of a sort not experienced by the country since the 1985-1991, only stronger, but shorter. During this period, the economy provided for a 2.8% annual growth of job numbers, against 1.8% between 1985 and 1991, and 2.4% during the decade leading to 1965. Thus, the period, albeit quite short by our standards, in fact more than half as short as the next shortest period we studied, was also quite remarkable given its economical outlook. In many senses, this was a true economic boom period.

Switzerland gained approximately 274'000 jobs in the three years leading to 2008. Almost all of these were recorded in centers, with only 2'000 jobs gained by edgeless space, and all center types experienced growth during this period. Accordingly, the central network saw its global job share reach 78.8% of all jobs, the highest figures since 1965, and very close to it. Accordingly, and again for the first time since about 1965, suburban centers were not the first recipients of this central growth, as urban centers actually took over with a growth of 126'000 jobs, for only one unit more. Structurally, urban centers progressed greatly, in density, intensity and mean size, as if there was a real "urban return", at least job-wise. But even if cities returned to prominence, it remained that their total job share continued to slip, albeit slightly this time, down 0.3 points at 49.6%.

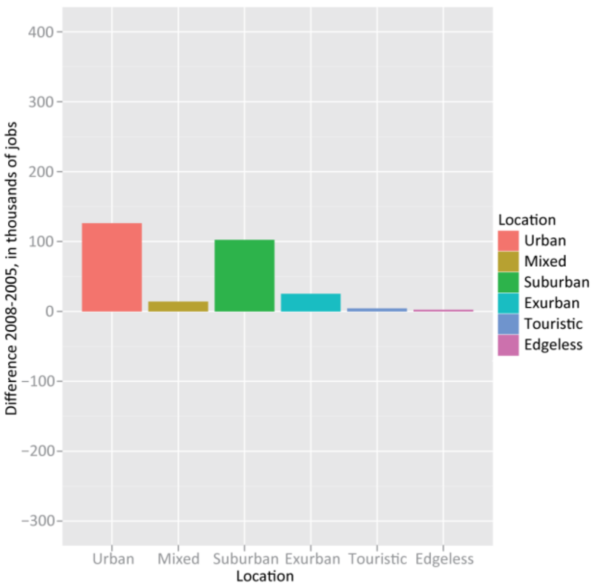


Chart 4-114: Job numbers difference by location, 2008-2005

So, the rest of the central network continued to progress and strengthened a small bit its job share at 29.3%, still holding three jobs for five held in urban centers (*Chart 4-114*). Amongst them, suburban centers progressed most, with 13 units and 102'000 jobs more than in 2005. As urban centers, they also progressed structurally, by gaining in density and intensity. The latter was now at 119 jobs for 100 actives, up 7 points since 2005. Density, for the first time, crossed the 15 jobs per built ha threshold, showing that densification was not only applied to urban centers but also to suburban ones. And while in absolute terms, suburban centers grew less than urban centers, in terms of job share they still gained, 1.4 points at 22.0%.

Exurban centers experienced some resurgence during the economic boom, as they had, indeed, during all economic upturns since the oil shock. Moribund since the 1990s economic crisis, they unexpectedly bounced back, gaining 10 units at 106, and 25'000 jobs, gaining also in structure, and even progressing 0.4 points to 4.2% of all jobs. With 111'000 jobs in all, this remained very small but the upturn was sufficiently surprising to warrant a mention here.

Less surprisingly perhaps, the mixed centers continued their forward march, gaining 3 units at now 16 and 14'000 jobs at now 68'000, still a very small part of the total, 2% of the total, but still progressing. As a group they remained rather weak units with both densities and intensities quite low, close to the respective thresholds, which tended to demonstrate that those former cities that had turned residential were experiencing difficulties at returning clearly to their former status, at least structurally. They remained fragile additions to the network and were at least till 2008 playing second fiddle to the more important and more significant suburban centers.

Edgeless space remained stable during the period, gaining only 2'000 jobs at 719'000, or 21.2% of all jobs, a very low number. As usual, edgeless space did not play any active role in shaping the organization of the space in which jobs were distributed and redistributed – instead, it played, throughout the period under study, a role of inert matrix, inert filler, ready to let the urban network evolve.

The strong economic recovery had one definite effect, in that Switzerland passed from a 122'000 strong job deficit in 2005 to an approximate 80'00 strong active deficit in 2008: there were now more jobs that actives in the country, and globally the imbalance had now reversed, for the first time since 1991 (*Chart 4-115*). This more than 200'000 imbalance reversal was purported first by urban centers, which imbalance grew from 492'000 more jobs in 2005 to 606'000 in 2008. Likewise, the suburban imbalance also grew importantly, from 66'000 in 2005 to 118'000 in 2008, the second major source of jobs for outsiders behind the urban centers. Other center types contributed only negligible amounts of jobs to outsiders. For its part, the reverse imbalance in edgeless space actually decreased a bit, from 704'000 more actives than jobs in 2005 to 682'000 in 2008. By 2008, all actives residing in edgeless space could be provided a job in central space; most of them in urban centers, but one job out of about six in suburban space.

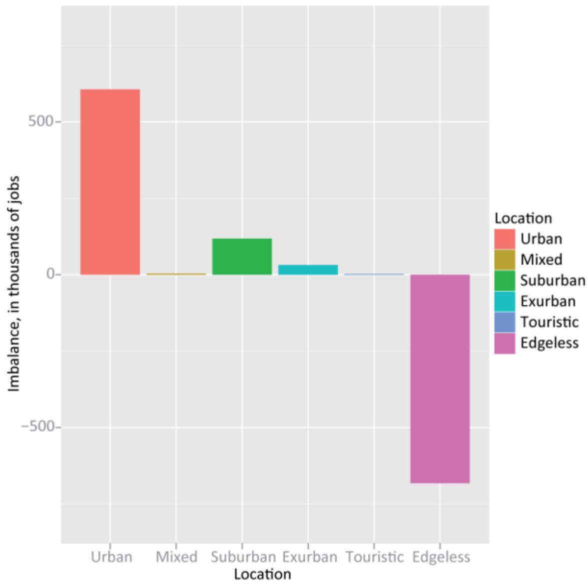


Chart 4-115: Jobs-actives imbalance by location, 2008

4.9.1.2. Dynamics: a strong return of classical urban centers

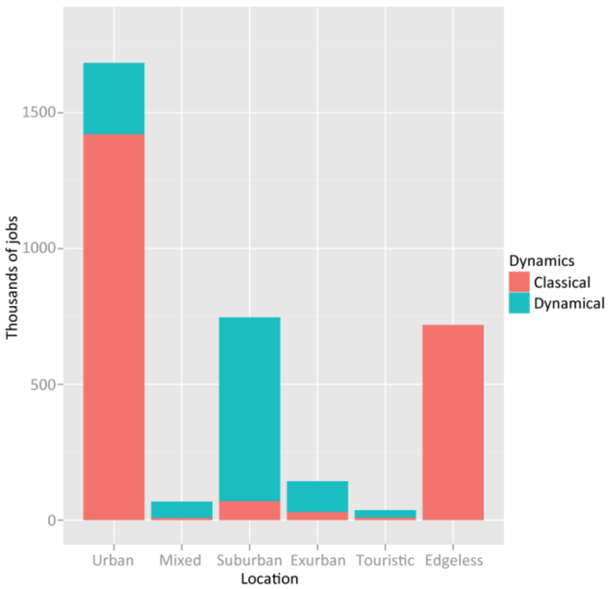


Chart 4-116: Jobs by location and dynamics, 2008

It would be expected that in times of great economic development growth would be above all devolved to dynamic centers (*Chart 4-116*). While this is mostly the case, the novelty of the time was that classical urban centers experienced strong growth, along with the expected dynamical ones.

Classical urban centers actually lost 3 units during this period but gained a large majority of all jobs gained by urban centers, with a push of 79'000 jobs at now 1'421'000 or 41.8% of the non-agricultural jobs of Switzerland. Structurally, the classical urban centers experienced quite a remarkable recovery, with massive progressions in job intensity – in fact, classical cities lost active population while they gained jobs, and their mean intensity reached now 160 jobs for 100 active residents, up 11 points in just three years, and way above anything known at this scale till then. Classical cities had never been so job-specialized than at the 2008 census.

Compared to these moves, the dynamics of the dynamical urban centers seemed almost meek. Dynamical centers gained 4 units at now 49, as well as about 47'000 jobs, to 262'000 or 7.7% of the Swiss jobs. Structurally they also reinforced, although less strikingly than classical centers. But even if their progression was somewhat overshadowed by that of the classical centers, by 2008, in terms of job share, dynamical urban centers were in fourth place, way behind classical centers, edgeless space and dynamical suburban centers, but way above everything else, and in particular all forms of exurban or mixed centers. Their rise, although less impressive than that of suburban centers, was nonetheless remarkable and significant.

As expected, dynamical suburban centers also progressed during the 2005-2008 period, gaining 14 units and more than 109'000 jobs, totaling now 676'000 or close to 20% of the total. As the rest of the center network, they also showed a strengthening of their characteristics, with a 7 point progression of their job intensity to 124 jobs per 100 active residents. Strong as these figures were, they were still less impre4ssive than those of classical urban centers. In terms of dynamics, the main story of the period leading to 2008 was the resurgence, in absolute terms if not in relative ones, of the classical urban centers: the classical cities were back, somewhat.

4.9.1.3. Orientation: industry, back from the dead?

The general upturn experienced in Switzerland between 2005 and 2008 had an impact on center orientation (*Charts 4-117 & 4-118*). Since 1965, the orientation had been a steady move from industrial dominance of the economy towards service activities. However, between 2005 and 2008, industry rebounded, in step with the general economy. Industry-dominated centers gained 5 units at now 169, and more importantly 44'000 jobs at now 286'000 or 8.4% of the total, up 0.6 points from 2005. While those figures could seem small, which they indeed were,

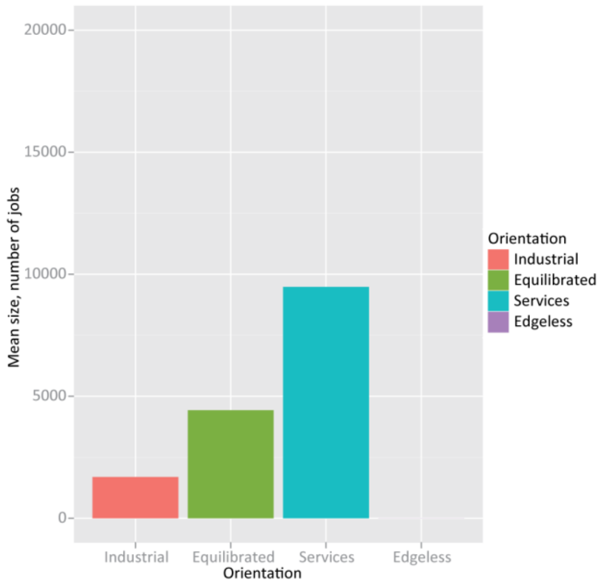


Chart 4-117: Mean center size by orientation, 2008

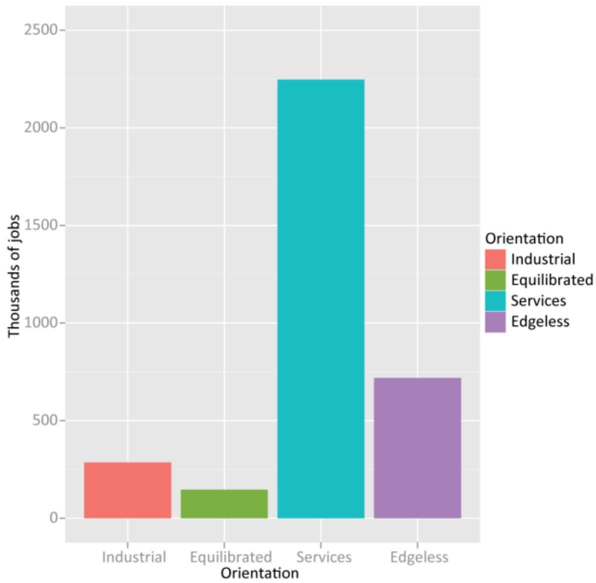


Chart 4-118: Number of jobs by orientation, 2008

they were oriented in a way they haven't been for decades. Likewise, everything went up: density, intensity, mean size, and job imbalance all grew up quite healthily, giving the impression that industrial restructuring was finally over, and that as dimensioned, industrial centers had a future.

That being said, it remained that the vast majority of the explosive growth Switzerland experienced during the 2005-2008 period happened in service-oriented centers, which gained 19 units at 237, 219'000 jobs at 2'247'000, representing a job share of 66.1%, up 1.2 points since 2005. Structurally, they were sounder than any otherwise oriented centers, being way bigger, denser and more intense than others. Furthermore, they were also strengthening, at the same pace, if not at a better one, than the industrial centers. Thus, while it remained that the industrial upturn was absolutely real and unexpected, it didn't amount to a reversal of fortune between industry and services. At the most, it may mean that industry had now regained pace and was evolving with, not against, the rest of the economy.

4.9.1.4. Form: an impressive strengthening move

As we have already seen in the preceding paragraphs, one of the characteristics of the economic boom experienced in Switzerland prior to 2008 was that units of all sorts experienced a general strengthening of their structure, in terms of job density, intensity and mean size (*Charts 4-119 & 4-120*).

This was very clearly and unequivocally seen when looking at centers while controlling for form. Complete centers progressed greatly, gaining 33 to 131 units and more importantly 308'000 jobs to 2'025'000. Complete center's mean size tumbled down 2'000 jobs at 15'500, signifying that a great many smaller centers had joined the complete category. In absolute terms there had never been so many jobs hosted by complete centers; in relative terms, at practically 60%, the job share of the complete centers had not been as high since 1965, a time, though, when it was clearly higher. The same progressions could be seen for dense-only and intense-only centers, while the "none" category clearly lost units and jobs to the aforementioned, more structured categories.

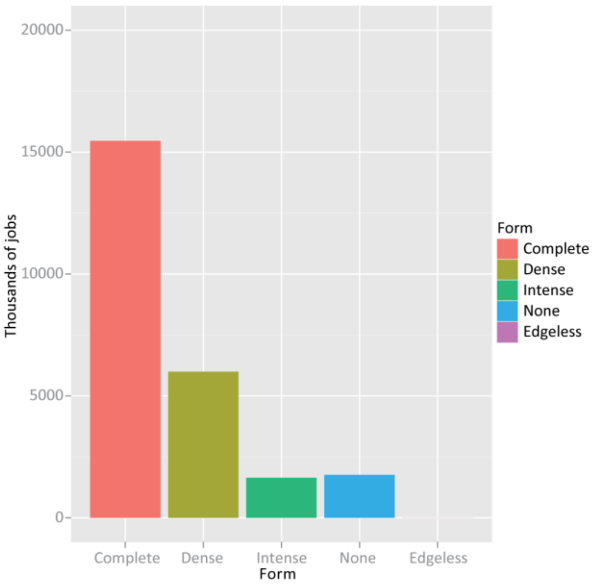


Chart 4-119: Center mean size by form, 2008

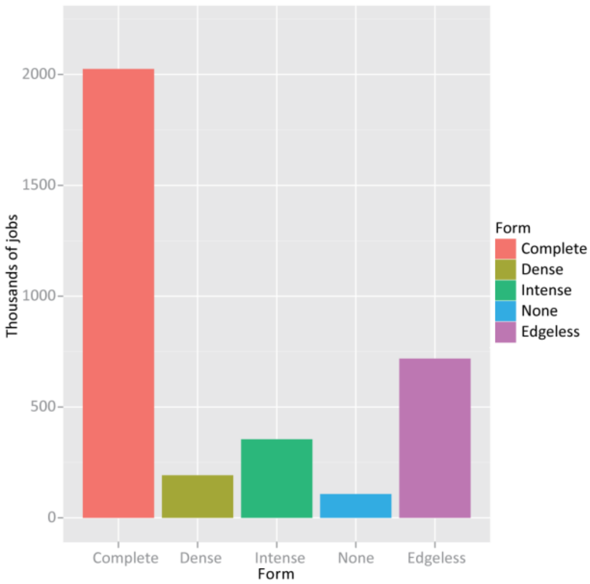


Chart 4-120: Number of jobs by form, 2008

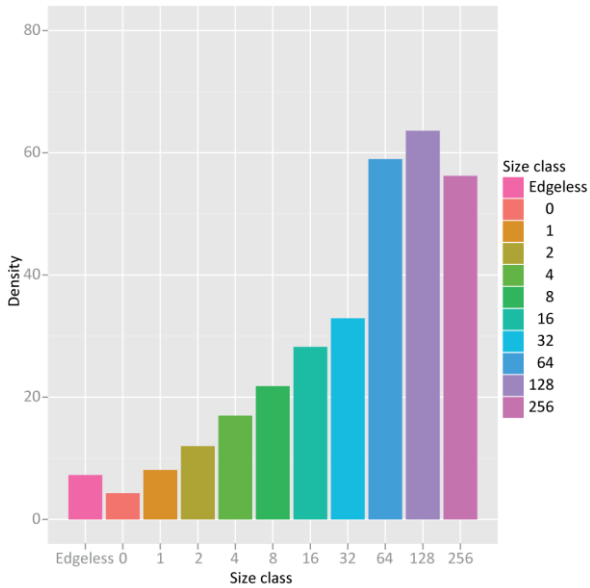


Chart 4-121: Job density by center size class, 2008

Thus, while this was no return to 1965 conditions, the central network did reinforce greatly during the 2005-2008 interval, such as to attain a structural strength not seen since the inception of large scale metropolitan processes in Switzerland. Not even in the preceding high point, 1991, had the structures of the Swiss center network been so strong.

4.9.1.5. Size: towards greater gradients

The main story about job density between 2005 and 2008 is that it seemed to go up (*Chart 4-121*). After half a century of continuous decline, job places were seemingly starting to densify again, although this could be an effect of lack of data in terms of land use for the periods after 2000. If this densification process could be confirmed – and it should be reliably measurable in the following years, it would signal an important and significant trend reversal which would warrant further information and research.

The general allure of job density remained fairly stable when controlled for size, in a general context of growth for this indicator. All size classes saw their job density grow. However, the growth, if general, wasn't equally apportioned on all classes: the bigger the center, the denser it got during the 2005-2008 period. The greatest gains were made in the five centers above 64'000 jobs, where it was now hugging the 60 jobs per built ha line, a growth that was probably correctly measured as those five centers had not had much space to convert to built space by 2005. Another point is that those five centers, at around 60 jobs per built ha, were very far above the figures of other centers. The next biggest class, that of centers above 32'000 jobs, sported a job density of about 33 jobs per built ha, a figure here likely to be slightly over evaluated, or just above half the density of the big five. Clearly, those had become very special places, that no Lucerne, St-Gallen or Kloten could match.

Under the 32'000 jobs threshold, things were clearly evolving more quietly, with a small but significant rise of job density, generally contained between a half and a full point, although in those categories it may well be that this rise was mostly due to the measurement problem we faced with the very recent built-up area evolution. To put it all together, it remained that a differential between the largest cities of the country and all the rest of the center population opened during the period under review, and that the density gradient according to size probably also rose prior to 2008. Density-wise, centers were getting more discriminated by size.

If job density seemingly showed a reversal of trend by going up again, this was also, and quite spectacularly the case of job intensity (*Chart 4-122*). Job intensity progressed strongly across all categories of places. When controlled for center size, they exhibited a clear reinforcement of the intensity gradients; as for density, places which were more intense to start with were getting ever more intense than more relaxed ones. This, however, was commensurate with size only above the 2'000 jobs threshold, as the 2'000 to 4'000 jobs centers exhibited the least intensity – actually had been since 1991. However by 2008 this singularity was clearly larger than before. Apparently, this size category could be the lowest one when we encounter real if small centers, while smaller centers could be considered specialized ones.

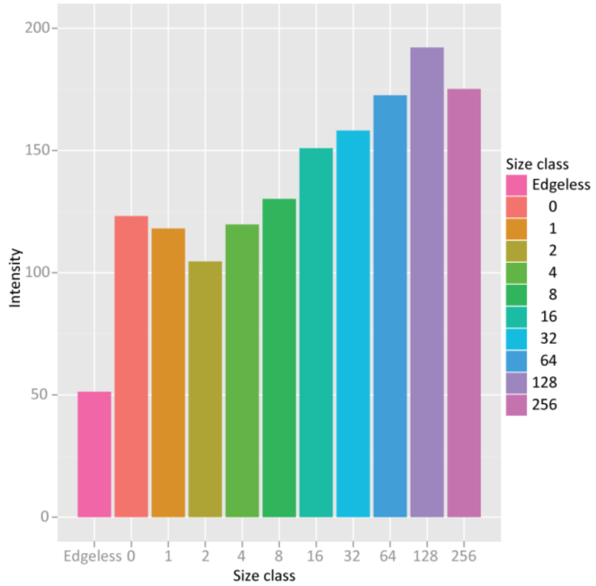


Chart 4-122: Job intensity by center size class, 2008

To the contrary of job density, the general rise in job intensity did not constitute a reversal of trend. Likewise, there was no major gap in intensity between the big five and the rest of the field. That result was attained by the fact that above 4'000 jobs, intensity grew largely according to size, with impressive rises in particular in size classes between 8'000 and 64'000 jobs, where they attained 10 points or more in just three years. The result was that by 2008, all centers above 16'000 jobs had very strongly specialized as job places, with job intensities topping 150 or more jobs for 100 active residents, a reinforcement which was particularly well seen in medium sized centers. Metropolitan processes, thus, seemed to imply a greater discrimination between job centers, getting by the way more numerous, and the rest of the country.

4.9.1.6. Rank-size and job numbers by size classes: the rise to prominence of midsized centers

That the middle levels of the center hierarchy were seemingly reinforced during the economic boom of 2005-2008 was plainly seen when looking at the job share of the size classes (*Chart 4-123*). For the first time since 1939, the distribution seemed to organize along an arguably quite skewed Gaussian curve, with midsized centers getting more share than smaller ones – a development seen almost since the start of our period of study, but also, and that was new, than larger

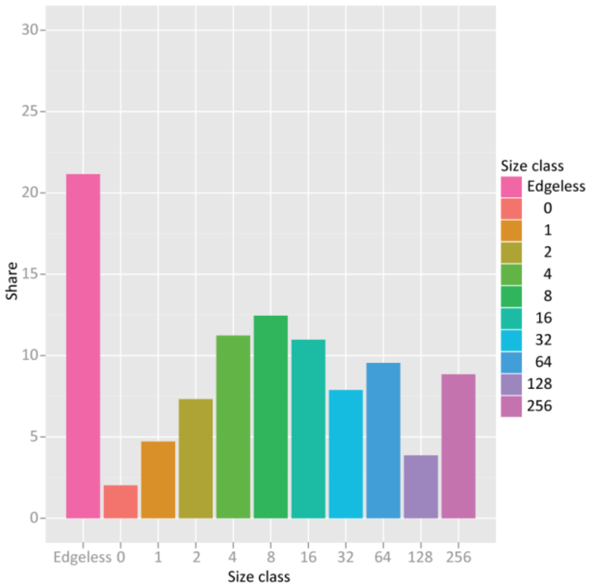


Chart 4-123: Job share by center size class, 2008

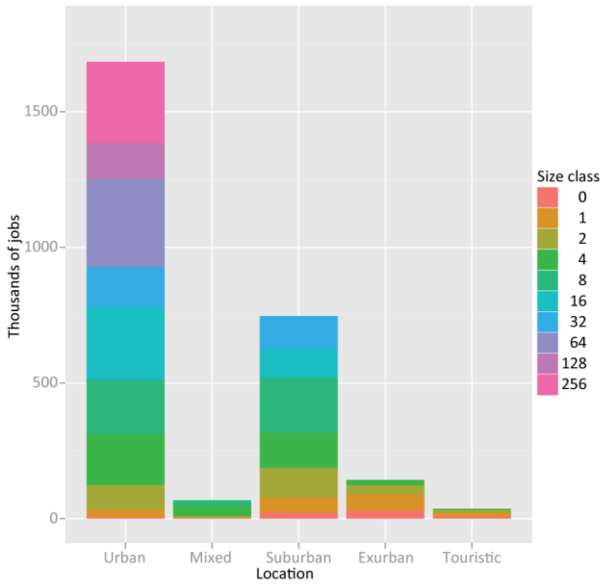


Chart 4-124: Job numbers by location and center size class, 2008

centers. True, the deficit was way larger in smaller centers than in larger ones, but the development was significant enough to pause upon. Metropolitan processes as they developed helped develop a network of midsized centers better than the one of greater centers. This could also be due to an inflorescence of new suburban centers stuffing the middle levels of the central hierarchy.

The look at the distribution of centers by size class further controlled by location was somewhat inconclusive (*Chart 4-124*). It seemed real enough that urban centers saw progressions above all in their middle classes, which also corresponded to the larger suburban centers classes, which were in turn the ones growing most clearly. That being said, it was very difficult to attribute the reinforcement of midsized cities to one or another cause – most probably both factors played a role.

4.9.1.7. Zipf's law, clusters and superclusters: metropolis progressing

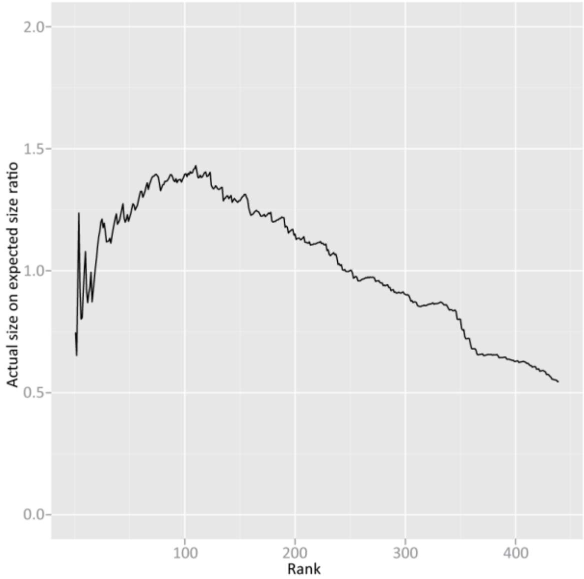


Chart 4-125: Units rank-size distribution compared to Zipf's law, 2008

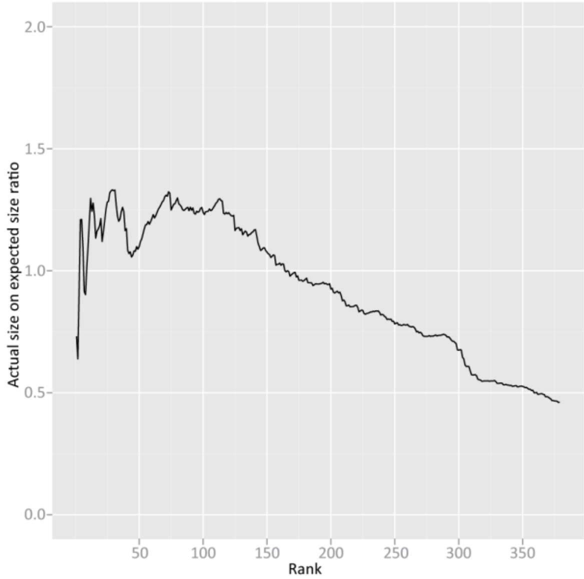


Chart 4-126: Cluster rank-size distribution compared to Zifp's law, 2008

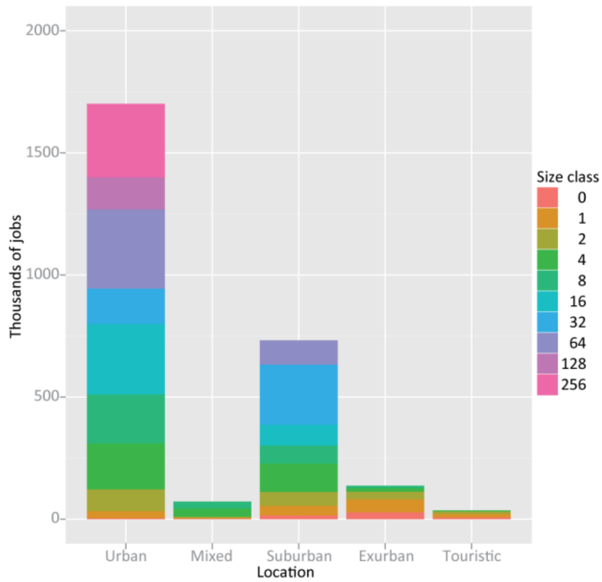


Chart 4-127: Job numbers by location and by cluster size class, 2008

At the unit level, the rank-size graphs confirmed, if subtly, the finds made in the preceding paragraphs (*Charts 4-125 & 4-126*): the largest centers had lost some terrain to the midsized centers in terms of job share and position in the network, the loss being particularly sensible at the very top of the network, with Zurich and Geneva growing less than other centers and thus dropping further behind their theoretical, Zipf-like size, while centers ranked around the 100th place, corresponding to about 5'500 jobs, seemed the most out of line with such a distribution. The passage at the cluster level did not show any major changes from the ones we just described. In that view, though, the greatest cities fared a bit better than the ones directly behind them, while a hump in the 10th to 40th ranks seemed to show that clustering suburban centers together provided for a reinforcement of those ranks – where they were indeed quite numerous, with about half of all units being of suburban origin.

Looking at the size class distribution of clusters controlled by location confirmed that suburban clusters had played a big part in the growing imbalance in terms of size distribution (*Chart 4-127*). Suburban clusters of all sizes grew, but particularly the bigger ones, which gave suburban clusters a vast imbalance of units above 32'000 jobs, which were holding, by 2008, almost half of the jobs held there; in the 32'000 to 128'000 jobs bracket, suburban clusters were practically on par with urban ones, and dominated clearly in the 32'000 to 64'000 jobs class. Thus, there was

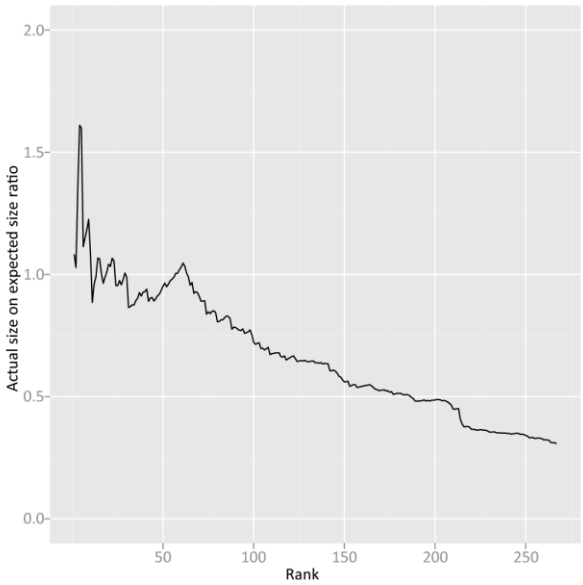


Chart 4-128: Supercluster rank-size distribution compared to Zipf's law, 2008

at least some truth in the idea that the development of massive edge cities had contributed to wreck the Christallerian, Zipf-like size distribution of centers.

A further indication that the changes we mentioned were primarily due to suburban effects is that when looking at the urban structure at the supercluster level, at last we find structural stability amidst growth (*Chart 4-128*): the rank-size curve at the supercluster level didn't evolve much between 2005 and 2008. All that had been happening to the center network since 2005 had been encased in a general pattern of growth at the supercluster level. The fact that no major change was seen at this scale seemed to accredit the hypothesis that changes in the rank-size distribution were primarily due to urban-suburban relationship changes, rather than metropolitan or regional-like effects.

4.9.1.8. Aspatial conclusions: a most intriguing time

In many respects, the period leading to 2008 was one of the most interesting that we had the chance to delve upon. While most of the periods we surveyed seemed to be dependent on long-term trends once the cyclical effects of the economic situation taken out, the 2005 to 2008 period was marked first by explosive growth of the central network consecutive to a very favorable economic period, while it provided several separate but linked reversals in many areas of the central network development under review.

As we have said, the period was above all remarkable for its overall growth pattern, which benefited all categories of centers. At the broader level the sudden economic upturn did not seem to shake the long term trends duly noted beforehand, such as the rise of suburban centers as major players in the competition for jobs, or the sensibility of edgeless space to economic conditions. Likewise, some other trends, such as the slow rise of mixed centers, were confirmed.

However, in many domains, 2008 proved trend-buckling. The most general of these was the reversal in job density evolution, which had been decreasing steadily all the way to 1998, and had stagnated until 2005. The 2005 to 2008 period showed instead that job density was going up again and that in all the central network experienced densification. As of today there is no sufficient data to confirm this trend as a real one, but there are indices that this trend isn't uniquely due to data artifacts. Furthermore, this density rise corresponded to general structural rises seen across the board, like the massive job intensity rises, or the general strengthening of the urban network.

Besides, there were many more areas where 2008 proved a turning point. At the location level, the first was that exurban centers resurged – although it may well have been just because of the favorable economic conditions, as before 1991. The second surprise was vastly more significant, as it concerned the largest category of all, the classical urban centers, in other terms the cities.

For the first time since 1991, classical cities progressed. They even progressed more than their dynamical counterparts, something they had not achieved, again, since 1991.

Even more significant was to our eyes the reversal of trend experienced by industrial centers. Those had been in free fall for decades since even before the 1973 oil shock, but seemed, between 2005 and 2008, to stabilize and even progress a bit, as if it had finally bottomed out in its fall and started to revive as a new form – although at a vastly reduced scale as compared to its former glory, up to 1965.

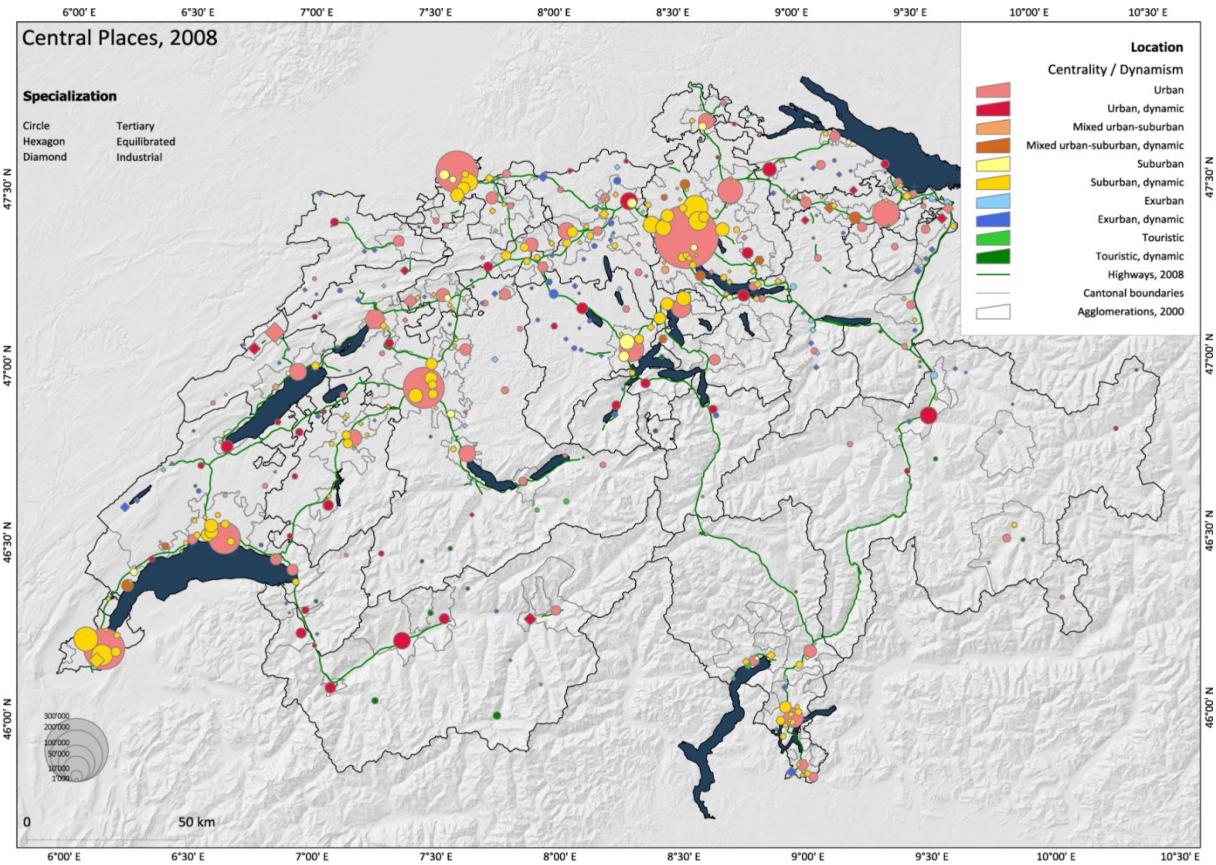
As noteworthy as those changes were, they did not dominate the general picture. Already noted long term trends, like the development of ever greater suburban centers and their rise to prominence in the urban network, the walkaway from Christallerian structures to metropolitan ones, continued to develop during the period under review. Furthermore, at the metropolitan level, a new equilibrium had seemingly been reached, as the rank-size distributions showed at different levels. At the supercluster level, structures were now stable, if quite removed from the Christallerian model. Large centers were in small deficit but adorned in vast metropolitan areas of numerous midsized centers, a good fraction of which were suburban in origin, and which had completely supplanted the local centers. At this scale, nothing moved much between 2005 and 2008, meaning that all significant moves were to be constrained by this invariant supercluster scale, which just grew a lot but in locked step. At lower scales, moves were evident, notably the reinforcement of suburban units but also of midsized urban ones, the general strengthening of structures, the increase also of density and above all intensity gradients with size.

In all, 2008 proved a second 1991, a pivotal time of its own. By 1991, edge cities had burst into view and had imposed themselves as the new big players on the territorial job market, but in a sense this was just a beginning – by 2008 suburban centers were clearly more important than in 1991 while cities were less. In a sense, 2008 was a more elaborate version of 1991, with structures strengthening again, far more accomplished restructuring, notably in the classical cities and in industrial centers, like a closure on what had opened after the industrial age ended. In one domain, though, this sense of accomplishment did not prevail, that of job/actives imbalances. The strengthening in structures, most notably in larger urban centers, were gained by getting ever more jobs per active residents, and while most indicators showed some sort of stabilization by 2008, transmitting this sense of new equilibrium, the fact was that job intensities and job imbalances were still growing unabashed. In that sense, 2008 seemed not to be the end of history – but it has to remain, in any case, the end point of our study.

4.9.2. Spatial patterns

4.9.2.1. The urban network pattern: growth, everywhere!

There were only three years between 2005 and 2008, a very short time to unleash major territorial changes (*Map 4-32*). The general context being one of uniform, or at least equilibrated growth, the first impression left by the map is one of overall growth. Carful inspection of the map reveals subtle patterns which strayed a bit away from this general growth wave.



Map 4-32: Central places by size, location and orientation, 2008

Urban centers as a whole progressed during this period, particularly the greater ones. Zurich, in particular, rebounded quite strongly with 25'000 more jobs in three years, getting back to its record levels of 300'000 jobs. Other big centers were far behind, but all progressing, Geneva and Berne more spectacularly than Lausanne and Basle. But in a general way the whole urban network grew during these times. Perhaps the most striking point we could make of the map is the real rise to prominence of dynamical urban centers. While all major centers remained classical, because they never managed to live a period of extraordinary growth, some very respectable centers had managed such a feat: in the Zurich greater area, a string of relay centzers like Baden, Frauenfeld, Wetzikon and Freienbach, in the Alps most of the centers including Sion and Chur, as in Central Switzerland save the largest ones of Lucerne and Zug, a pattern repeated further west, in the Western Mittelland, between Lausanne and Berne. Their location was not incidental – we will come back on that later.

Suburban centers, as usual, grew during this period, with strong upturns in the Zurich airport area – a comeback effect, maybe, after the Swissair debacle, around Geneva and in Western Lausanne, less so elsewhere. In Ticino and in Aargau, a string of small units showed strong progressions, which were all the more impressive in the Aargau case because they were parallel to a rise in exurban centers. Indeed there was something special about the territorial organization of the central Mittelland, with its superabundance of smallish towns, edge cities and exurban centers, most of which dynamical. The fact is that the upturn in fortune for the exurban centers seemed to concern above all the Aargau region, and more generally the greater Zurich metropolitan area.

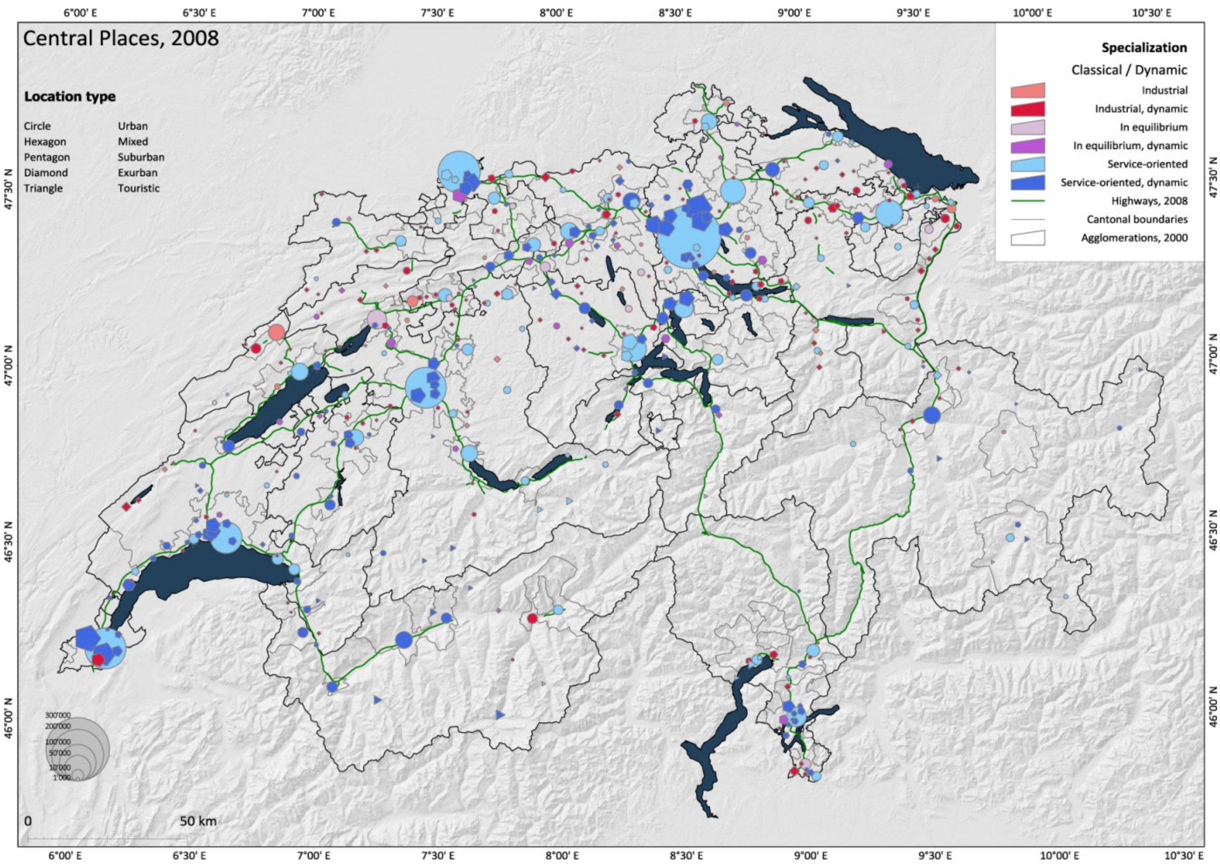
If not much could have happened during so short a time span, it remains that the period, apart from a general growth pattern, the overall picture seemed to be rather stable in the last decade of our study.

4.9.2.2. Center-periphery patterns at the national scale: the return of the metropolis

After a period of relative gains for the peripheries against the centers, 2008 marked a clear return to central dominance. As a city, Zurich grew clearly more than its immediate followers, its edge cities were especially dynamic, and farther away growth rates in its metropolitan area seemed to be larger than elsewhere. The reemergence of exurban centers also happened predominantly in this area. Similar phenomena were clear, except the exurban centers, in the larger Geneva area. Elsewhere, growth was more muted, if not absent, and it was less even: some centers grew, while others stayed stable. Thus, Sion, Bulle, Heerbrugg or Mendrisio grew a lot, while many of their neighbors did not.

The significance of this find should not be underestimated. While it is evident that metropolitan areas fared in all better than outlying areas, such a clear pattern favorisiong the hypercenter of the Swiss economy hadn't been found since 1985, and even since the 1970s, when regional policies started to kick in. It is no small coincidence that the great metropolis asserted its superiority at the very same time the Confederation abandoned the regional policies it had implemented following the oil shock and its devastating effects in some peripheral regions. In that sense, 2008 may well signify a return to natural evolution, a sort of economic Darwinism given full latitude for the first time in a generation.

4.9.2.3. Differences according to agglomeration size: this time, big beautiful again



Map 4-33: Central places by size, orientation and location, 2008

As we surmised in the preceding section, 2008 was the first census since about a generation to clearly show a preferential growth of big centers, big structures (*Map 4-33*). Historically, differences between agglomeration sizes were mirroring differences in economic orientation: the biggest centers had always been service-oriented, with smaller agglomerations more likely to host industrial activities. By 2008, though, the economy was thoroughly oriented towards services and industry had essentially retreated to select regions. Thus, apart from the fact that things seemed to discriminate more along metropolitan size than agglomeration size, there was nothing much to add, except regarding the industrial resurgence.

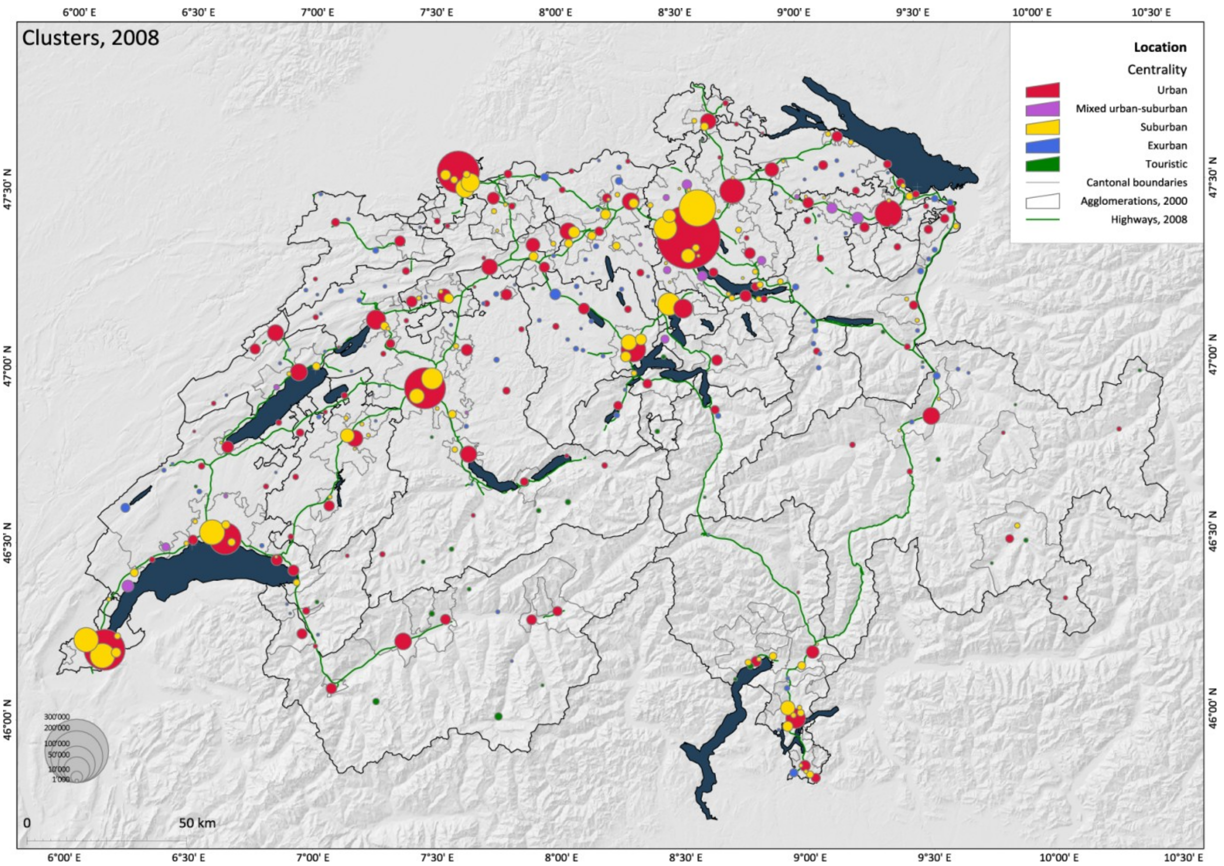
The industrial comeback happened on a very regional basis: in central agglomerations, whatever was left of industrial space continued to retreat, as the status changes of Volketswil or Zofingen attested. However, in industrial regions industry staged a real comeback, epitomized by the return to industrial dominance in La Chaux-de-Fonds; such strengthening was seen throughout the Jura Mountains and Piedmont, and up to a point in Eastern Switzerland. Thus, industry, while strengthening in its redoubts, still retreated to them.

4.9.2.4. Regional patterns: the triumphal return of Zurich

In a general context of strong growth, the 2008 business census revealed rather evident regional effects in the way this growth was apportioned throughout the country. The first and foremost, already described several times, concerns the great return of the central regions to the fore, Zurich and its agglomeration first, then its metropolitan area. In the Greater Zurich area, some areas fared especially good. As usual, the Zug-Lucerne corridor, the Lake Zurich shores, but also two other corridors: the Aargau one, returning to prominence with a sudden inflorescence of edge cities ans exurban centers. Less expected was a similar, if smaller, phenomenon in Eastern Switzerland, particularly along the A1 between Winterthur, itself growing at last, and St-Gallen.

Elsewhere in the country growth patterns were also clearly seen in other metropolitan spaces, in the Lake Geneva area, where the massive Geneva edge cities progressed while Lausanne spawned several new units. Elsewhere, developments were clearly more muted. The other metropolitan areas of the country, Berne, Basle and Lugano, shone above all through their edge cities, while the rest of the country showed stability, with some exceptions, like the strong rise observed in Sion. Rarely in the decades under study had been a spatial distribution of growth so unequivocally linked to metropolitan processes and areas.

4.9.2.5. Mapping clusters and superclusters: edge cities and metropolis



Map 4-34: Clusters by size and location, 2008

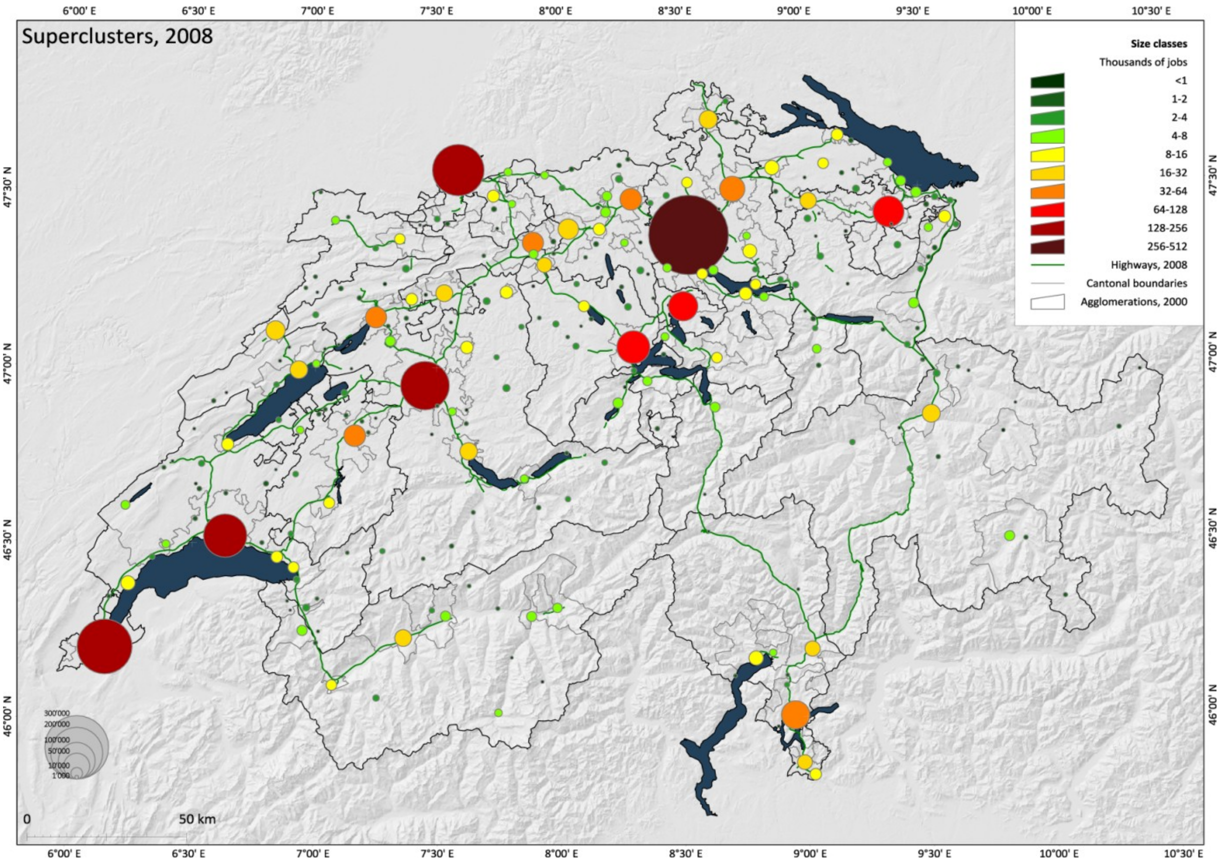
Since 1939 suburban clusters had never seen a true reversal of fortune, save for a minimal loss of jobs during the 1991-1998 period (*Map 4-34*). During the 2005-2008 period, edge cities resumed their relentless march towards prominence, gaining some 35'000 jobs each year, about the same figure than during the preceding boom, between 1985 and 1991.

The Zurich suburban clusters progressed massively during the period, Glattal up 11'700 jobs to just 99'500, still, by very far, the largest cluster of the country, double the size of the next largest units. The Limmattal complex went up 3'300 jobs at 39'300, the Lake Left Shore complex progressed greatly, 6'400 jobs to 14'100, making it a newcomer at above 10'000 jobs, the Furttal one relegated in regional fourth place, up 1'100 jobs at 12'300 jobs. In Geneva, the two massive complexes noth progressed, the Carouge-Praille reclaiming regional first place, up 8'100 jobs at 45'200, while the Cointrin cluster going up 5'800 jobs at 44'400. The Western Lausanne cluster was still the second largest in the country with 46'300 jobs, 5'600 more than in 2005. In Basle, the Birstal cluster claimed first place by gaining 2'700 jobs at 25'600, against 24'900 in Schweizerhalle, up 1'500. In Berne, The Ostring complex gained 1'800 jobs at 33'500, and Wangental-Köniz 2'600 at 16'300 jobs; by 2008, Bern had clearly catched up the other big centers in terms of suburban center development. The largest ubnits outside the big five were, repectively: Zugersee, up 5'900 jobs at 37'600, still more than its parent city of Zug, the only one to be on par, also with the biggest edge cities of the country; the second largest cluster outside the major centers was the Gäu complex west of Olten, with 18'900 jobs, 2'700 more than in 2005, and mors, here also, than its parent city. The Reusstal complex came in third position with 17'600 jobs, just 500 more than in 2005; the Vedeggio complex, west of Lugano, gained 1'800 jobs at 15'300, and

Western Fribourg, up 800 jobs at now 14'000. Those big units adorned cities that could all be described as pertaining to metropolitan space: absolutely certainly for Zug and Lucerne, very clearly for Lugano, more surprisingly for Fribourg. In a sense, the catching up of the Berne-Fribourg couple pleaded strongly for their inclusion as a burgeoning metropolitan area, which would fly in the face of conventional wisdom.

More interestingly, the 2005-2008 period revealed a string of lesser units that progressed greatly, around lesser centers. Those were particularly present in Aargau, with the Wynental complex south of Aarau at 9'400 jobs, the biggest exurban center of Switzerland in the Wiggertal area around Dagmersellen with 8'700 jobs, the Birrfeld comples, an exurban centers reborn as a suburban outlier of the Baden-Brugg agglomeration, with 7'500 jobs, the Rothrist area with 6'000 jobs, the outer Lenzburg complex at 5'000; almost half of the edge cities of this size class were situated in the greater Aargau area, and even more followed shortly.

In other areas, one was compelled to acknowledge the importance of mixed centers. In Eastern Switzerland, ans between Lausanne and Geneva, those were the main forms of urban development outside bona fide urban centers, with Gossau and Uzwil, Nyon and Aubonne; those developments practically killed off the possibility for classical edge cities to emerge and indeed they did not emerge the way they now adorned the landscapes of the greater Zurich metropolitan areas or the Ticino lowlands. To finish, this had been the longest enumeration of clusters we did in this work, and for a reason, which is that at no point in time before there was as many edge cities, grouping as many jobs, than in 2008. 2008 was an age of edge cities even more than 1991.



Map 4-35: Superclusters by size, 2008

The very last map of the series showed, as expected, a general trend of growth amidst a certain stability – again, it had only been three years since the last business census we checked (*Chart 4-35*). Besides, some effects were still plainly visible. First of all, major metropolitan centers and areas grew faster than the rest of the country. This was particularly evident in and around Zurich, as well as around the Lake Geneva area.

As a supercluster, Zurich won massively during those three years, up 48'000 jobs to 470'000, but furthermore, most of the other superclusters exhibiting such growth rate were also situated in the greater Zurich metropolitan area, as the progresses of Zug, up 10'000 jobs at 64'000, Baden, up 9'000 at 35'000, show. In general, the greater Zurich metropolitan area saw much progress, strongly reinforcing, in particular, the upper levels of its own center hierarchy, with the growth of Zug, now practically as important as Lucerne, and Baden, as important than Winterthur. In the upper Lake Zurich shores smaller centers also progressed greatly, Freienbach and Rapperswil in particular, mirroring the growth noted in other local centers, Bülach and Affoltern. In Aargau, which formed the western part of the greater Zurich metropolitan area, progress were seen in the Aarau-Olten-Zofingen triangle and elsewhere, mimicking the general dynamics the most central areas of the country had seen up to 2008.

About the same dynamics were seen in the second largest metropolitan area of the country, that of Lake Geneva. Geneva itself exhibited the same growth rate than Zurich, with 26'000 more jobs in three years, to 223'000, which installed it very firmly in second place, clearly ahead of Basle which it had undertaken only in around 2000. Furthermore, many centers of the metro area also grew greatly, first Lausanne up 9'000 jobs to 138'000, Nyon jumping 5'000 jobs to more than 15'000, clearly claiming its palce as third supercluster of the metro area. At a smaller scale, such progressions were also seen in Ticino, with Lugano gaining 5'000 jobs to almost 60'000, followed by big gains made in Bellinzona and particularly Mendrisio, which had clearly overtaken Chiasso as main job hub south of Lugano, one seldom feat. Elsewhere, growth was more muted, in the two remaining metro areas of Basle and Berne, in Basle more than in Berne. The general picture outside the greater metropolitan spaces was one of lesser growth, in Eastern Switzerland, in Western Mittelland, and above all in the Jura Mountains and the Alps.

4.9.2.6. Territorial conclusions: the true inception of metropolitan Switzerland

The three year period leading to 2008 was marked by a very strong economic upturn which generated hundreds of thousands of new jobs, which were spread over the whole country. Accordingly, growth was general, apportioned liberally to most center types, most center orientations, most center forms. The study we just concluded showed that indeed, growth was also spread rather equally across the country.

However, the general image rendered by the differing maps we used for the 2008 census gave back other messages. The most significant was that for the first time since 1991 the central part of the country clearly benefited more from the economic conjuncture than the rest of the country, as it had been for the economic boom of the late 1980s. This is an important point: Since at least 1965, Switzerland had known regional policies which were aimed at hampering major regional disparities to develop and correspondingly, since 1965 most of the periods under study showed lagging areas catching up. However, when it really counted, when new jobs were created by heaps of hundred thousands, then the central, favored areas were taking advantage the most. This may explain why, even if the periods where metropolitan space was clearly progressing better were few and far between, we ended up with a highly metropolitan spatial organization: when it mattered most, metropolises won. Quite significantly, metropolises won in 2008 along with central cities . For the first time in ages, the largest cities of the country were leading the growth process, even preceding, in absolute terms, their edge cities.

The late 2000s were certainly such a favorable time to overhaul the urban system. However, as compared to the larger moves made since 1939, it remained that the last part of the period under study, once we subtract from it the cyclical economic components, showed far greater stability than preceding periods. Up to 1965 Switzerland urbanized massively, then it deindustrialized and saw the massive emergence of edge cities. On the contrary, since 1991 the moves had been less impressive, as if the structures had more or less solidified, strengthened. The structures seen on the 2008 maps were, more or less, already largely present by 1991. The larger picture it gives is one of transition's end. From 1939 on, we saw a progressive departure of the urban structure from a Christallerian model to a new one; by 1991, this new metropolitan model was already largely in place, if more fragile than it looks by 2008.

Nonetheless, amidst general growth and some measure of stability, the moves seen between 2005 and 2008 were real. The two largest centers experienced massive growth, internally or by way of their edge cities. Other metropolitan centers fared generally better than centers outside metropolises. More importantly, units engulfed in growing metropolitan space fared especially better than units situated in peripheral space. This was especially true in the greater Zurich area, in which whole regions were lifted up, in Central Switzerland, Aargau, the Lake Zurich area, in the whole Canton of course and even, to a point, along the A1 corridor in Eastern Switzerland. Likewise, the Lake Geneva area also underwent spectacular growth, as, all things being equal, in

Ticino. Elsewhere, notably in what remained of peripheral space, growth was far more muted, in the rest of Eastern Switzerland, in Western Mittelland outside the metropolitan areas of Lake Geneva and Berne, and above all in the mountainous areas of the country, the Jura and the Alps.

Likewise, if the industry showed clear signs of stabilization, the first since 1965 and the end of the industrial age, this happened, territorially, under a very constrained regional framework. Industry did regain some dominance in certain centers, it did so exclusively in outlying areas; in metropolitan ones, industry continued its age-long retreat. Thus, as industry bottomed out and at last stabilized at an economically sustainable level, it also confirmed that it had, for the essential part, vacated the new metropolises in favor of outlying areas, generally with a strong industrial past. In those areas, though, industry tended to reassert itself as the driving force behind the local economy. There was, then a double move: a continuing decline in central areas, coupled with a reconcentration on what we could easily call industrial holdouts.

4.10. Urban Switzerland as of 2008

Thus, a new urban Switzerland, which had already appeared into view following the oil shock, was establishing firmly itself by 2008. It was formed of extensive metropolitan areas occupying what we could call the economical center of the country.

The largest of those metropolitan areas was centered on Zurich and extended, from here, towards all directions but especially towards Aargau, Central Switzerland, the Lake Zurich area, the Zurich Oberland, while seemingly penetrating less Eastern Switzerland, as if the long-term economical decline of Winterthur had hampered developments in that direction. The Zurich dynamism had in particular seeded the massive development of Central Switzerland, Zug being first, then Lucerne and Ausserschwyz, now spilling over towards the Linth, Unterwalden and even Uri. As it spawned this giant dynamics in a reputedly backwards region, so it did in the Aargau region, building a metropolitan tentacle covering tens of kilometers westwards of Zurich, all the way to the Gäu complex which epitomizes the country's keystone. In this big metropolitan core of the country everything showed dynamics pretty much in step with that of Zurich.

The position of Basle regarding the larger Zurich metropolitan area is difficult to assess – certainly, there was no dynamic along the A2 and A3 axes between Basle and respectively Olten-Zofingen and Brugg-Baden, which could not be linked directly to Basle. This was clear, notably, along the A3 corridor towards the Fricktal area, where edge cities and exurban centers were all very much linked to the chemical industry of Basle. Dynamics, also, in the Basle area was not akin that of the Zurich space. For all these reasons, it is probably easier to consider Basle as a separate metropolitan area, a small and stagnant one at that, where the overwhelming center pretty much killed off all possible independent developments: a sort of huge, overbearing head resting on a maligned body.

Compared to the Basle-Zurich link, it is certain that the Geneva-Lausanne link seemed far stronger – the two cities were linked since 1964 by a highway, fully thirty years before such a direct link was opened between Basle and Zurich. And indeed, while the inclusion of Basle in the Zurich metropolitan area seemed difficult to justify, such wasn't the case of Lausanne and Geneva. Both cities evolved in step, Geneva clearly taking the lead, and the area between them following the same dynamics. It seemed recently than the same dynamics extended to the whole Lake Geneva basin, as well as towards the north and the northeast, towards Yverdon, Bulle and Monthey.

The Berne area was more difficult to characterize. Traditionally, the literature didn't count it as a separate metropolitan space, though this was contentious. Our study certainly showed that early on this was unwarranted. However, one of the big differences between the mid 1980s and the late 2000s is that while in 1991 Berne and Fribourg weren't adorned by big edge cities the way other metropolitan centers were, in 2008 they did sport them; that being said in the long run, only Berne looked clearly metropolitan-like, and it had failed to carry relay centers with it – since 1991, all likely candidates: Biel, Fribourg, Thun, Solothurn had stagnated at best. Thus the Berne-Fribourg couple could be described as a metropolitan core, except that the surrounding regions weren't that metropolitan to start with.

The Ticino story was somewhat inverse to the Bernese one – here, metropolitan processes started rather early, arguably from very modest beginnings, so that by 1991 the region was barely recognizable, so much it had grown in about half a century, and created a mini metro area with Lugano firmly in command and three outer poles in Bellinzona, Locarno and above all the Chiasso-Mendrisio duet, the whole thing complete with edge cities attached. However, comparing 1991 and 2008 showed surprisingly that essentially no evolution had happened since 1991 in the region. While its structures still were clearly metropolitan, its dynamics had deserted, in the long run, the Ticino metropolis. As for the Berne case, it was now difficult to assign full metropolitan status to the Ticino complex.

With the Ticino case we leave metropolitan space for outlying ones. The closest outlying space there was to metropolitan space was probably Eastern Switzerland. It had inherited from earlier periods a very dense network of medium and small-sized centers, some quite considerable – Winterthur, St-Gallen, and Schaffhausen, mostly industrial in orientation. To the contrary of metropolitan space, almost no edge cities developed in Eastern Switzerland, and practically none of its urban centers developed as dynamical ones. Instead, the region, for the most part, really showed stability – or stagnation, and its few developing poles were of an original sort: mixed centers, which have had an earlier urban story. Another specificity of Eastern Switzerland is that it retained some of its industrial qualities – by 2008, it hosted a fair number of bona fide industrial centers, including its most dynamic units.

Western Mittelland, the space around Berne and Fribourg and all the way to Lausanne, was very different. Here, history had merely produced smallish administrative centers to control the vast expanses of the best arable lands Switzerland had to offer. There, a brand new urban network expanded during the period under review, but it was almost exclusively based on the preexisting structure, without anything looking like an edge city. However, the region was by 2008 almost exclusively marked by dynamical centers. So small had they been that the general urbanization processes of the country had dredged up those centers very rapidly. Thus, by 2008, from Yverdon to Bulle, from Orbe to Lyss, a formerly most rural space had seen its armature of small cities dynamized by the general trends the country experienced – it remains to be seen if this is metropolization. Certainly, those areas could be on the brink to experience true metropolitan processes by now, but we found no compelling evidence of this up to 2008.

Very different, again, are the Jura Mountains. Historically they resembled Eastern Switzerland, with a dense network of medium and small-sized industrial towns and villages, and to a point it shared its history, staying away from metropolitan processes. The main difference was in the timing of their decline, which had already started in Eastern Switzerland by 1939, while the Jura lived its own version from 1965 to about 2000. Thus, according to out time span the Jura was the region which experienced the most decline of all, the one which lost most between 1939 and 2008,and in fact from 1965 on. From Ste-Croix to Solothurn and from Biel to Boncourt, the 1965 levels have never been attained anymore, the sole region of Switzerland where this happened, and even if some suburban centers spawned in the area – in fact only in the Piedmont, along the Neuchâtel-Biel-Solothurn axis, they remained small, and often industrial. As in Eastern Switzerland, the 2005-2008 period saw a resurgence of industry there.

The Alps, in fine, showed extreme dynamics towards the start of our period of study, spawned by their strategical importance revealed during WWII and acknowledged during the cold war, a spectacular take-off also rendered possible by the sheer state of underdevelopment it was in 1939. One of the alpine areas, Ticino, evolved in a generation all the way to metropolitan status, although it has proved fragile. Somewhat similar developments affected the main administrative centers in the rest of the Alpine regions, with Sion and Chur amongst the fastest growing cities just after the war. However, since the end of the cold war the region has suffered several setbacks and slowly retreating compared to the rest of the country. For this region, the 2005-2008 evolution wasn't good news, with metropolitan spaces pulling ahead and leaving it further and further behind. After half a century of federal pampering, and twenty years of subtle abandonment by the center, by 2008 the future of the alpine arc appeared really problematic.

The management summary for chapters 4 and 5 is to be found at the end of chapter 5.

5. The way things go: long-term trends in the evolution of Swiss job centers, 1939-2008

5.1. Introduction and goals

With the 2008 census we closed the path we opened by studying the 1939 census. During this first part, we explored in detail what were the urban network moves, as recorded from census to census, first in rather long intervals of a decade or more, and since 1985 in shorter time spans. In the next part we take the broader picture into view and try to discern several long term trends that may not be readily apparent throughout the detailed review we just accomplished. We will start by reviewing each of the angles we used through our censuses: location, dynamics, orientation, form, and size, on the long run, diachronically, from 1939 to 2008. We will then review each type of urban form and study its evolution throughout the period in order to detect the long term character of their evolution; then we will use these finds to conclude on a history of the long-term trends noted.

5.2. Location

5.2.1. Units numbers: stability and suburban rise

Quite logically, the total number of units evolved in step with the general economic outlook of the period (*Chart 5-1*). Thus, the unit numbers went sharply up from 1939 to 1965, with a growth of about 60%, from 250 units to about 400. Notably, the network growth was shared by all location types, such as the general distribution between the different locations remained relatively stable, with a strong progression, though, of exurban centers. The 1965 to 1975 period marked a change, with a decline of unit numbers – down more than 50 – and the start of the suburban unit numbers rise. From 1975 to 1991, the network gained again approximately 100 units to 450, most of them in suburban locations, so that the overall structure of the network appeared to suburbanize massively. The 1991 to 2005 period was marked by a decrease in unit numbers – about 50, borne out mostly by urban and exurban centers, while suburban centers continued to disseminate. The last three year period saw a reversal of evolution with a gain of a bit less of 50 units, mostly in suburban and exurban space.

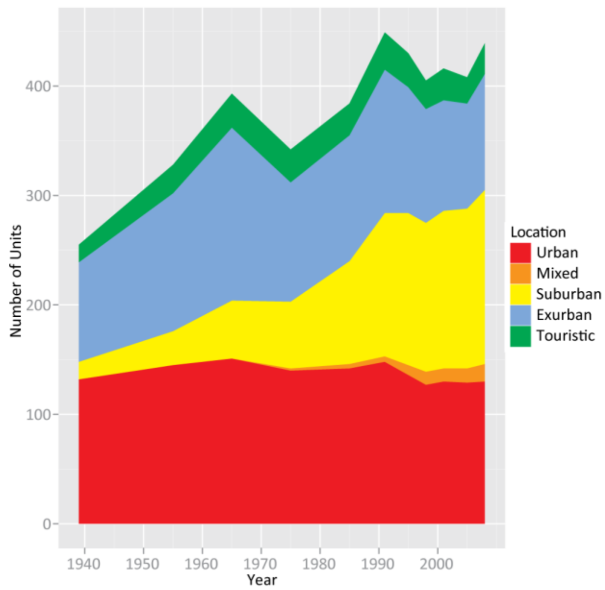


Chart 5-1: Unit numbers by location, 1939-2008

In all, urban centers numbers remained mostly stable since 1939, while the evolution befell essentially on suburban and exurban centers, the former progressing throughout but especially since 1965, the latter progressing essentially until 1965. In terms of numbers, suburban centers have progressed massively, from about 20 in 1939 to 160 nowadays, without having ever paused except between 1995 and 1998. Exurban centers numbers grew from 1939 to 1965 and have been decreasing ever since, the gains made during economic upturns never matching the very severe losses experienced during economic crises.

5.2.2. Job numbers and share: a tale of urban and suburban centers

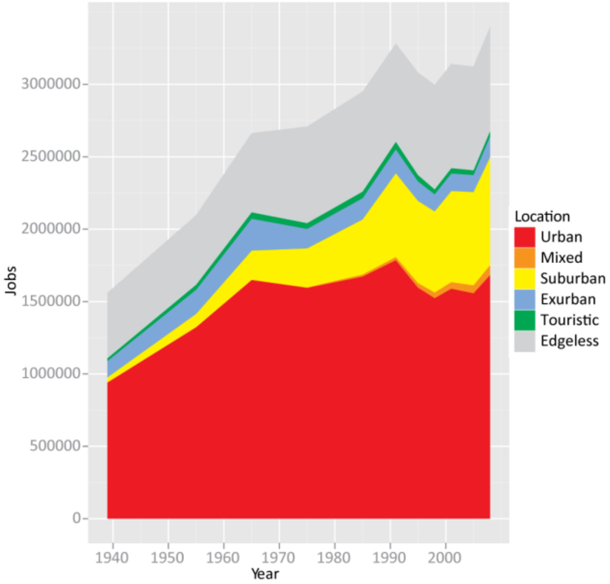


Chart 5-2: Job numbers by location, 1939-2008

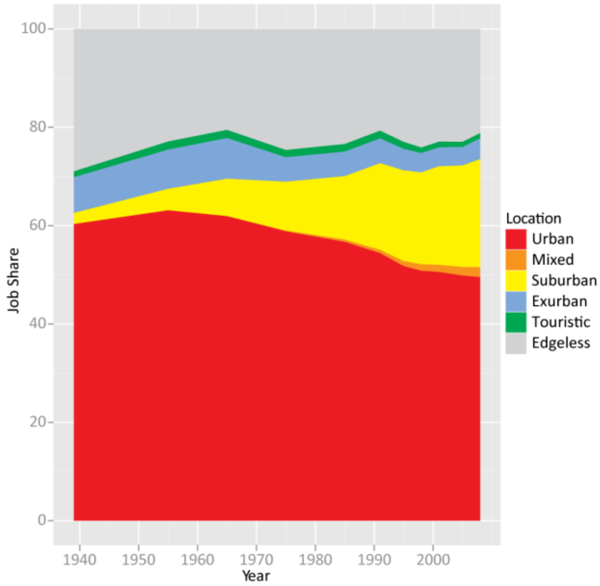


Chart 5-3: Job share by location, 1939-2008

The long-term evolution of the job numbers and shares is linked to the one of unit numbers, but it admittedly gives quite different results (*Charts 5-2 & 5-3*). The general trend for the whole period, in terms of job numbers, is one of growth – indeed, jobs grew all the way from 1939 to 1991, their numbers doubling in that half century, from 1'600'000 in 1939 to about 3'200'000 in 1991. Even the oil shock couldn't reverse the trend, just slow it down. From 1991 on, though, net job losses were recorded at the national level, with a total 1991-1998 loss of about 250'000 jobs, which had since then been regained in two steps, up to 2001 and then from 2005 on.

The history of jobs allocated by location was twofold. Urban centers led the network growth up to about 1965; afterwards, the numbers of job held in urban centers remained remarkably stable, and subsequent moves pertained above all in suburban centers. Exurban centers, which were an important, if not major, provider of jobs around 1939, saw their numbers tangentially dwindle with time. As well, a point has to be made about the very small significance of touristic resorts as job places in the grand scheme of things. For its part, edgeless space developed following a trend inverse to that of the economy of the time: it grew during crises, and shrank during economic upturns, acting in fact as filler to the general economy.

The central network, as a whole, occupied a rather stable share of total employment from 1939 on. At first the central network job share grew regularly, from about 70% in 1939 to 80% in 1965. Then, it remained stable in the long run, reaching three optimums, raising its share to close to 80% of all jobs, in 1965, 1991 and 2008, that is to say at the tail end of economic booms. During crises, their job share decreased, without plunging, to about 75% in the seventies and the late nineties. In that relatively stable framework, long-term trends seemed evident. Urban centers declined from 1955 on, a gentle but very stable and enduring tangential loss of importance. Exurban centers saw their job share also decline, although in a less constant way, with strong decreases during economic downturns, such as the 1965-1975 and 1991-1998 periods. Allthose declines were compensated by the relentless growth of the suburban centers, which progressed throughout the period under study, but especially since 1965, and which hasn't abated up until now.

5.2.3. Job density: a general trend towards real estate consumption and waste?

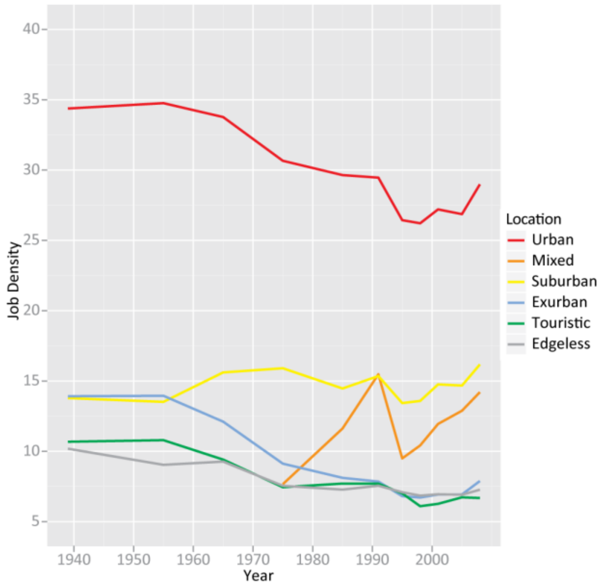


Chart 5-4: Job density by location, 1939-2008

As a whole, job density tended to decline for most of the period under study, with a slight possible upturn towards the very end of our period of study (*Chart 5-4*). On the whole period urban centers were by far the densest places in the central network, and even if it went down, from 35 jobs per built ha in the fifties to between 25 and 30 now, it remained very much higher than any other location type. Furthermore, the decrease seen in cities was not higher than the general one, and other location types experienced similar declines, while they sported very much lower densities to start with. Suburban centers ducked the trend by keeping their job density about constant during the whole period, starting very low at about 13 to 15 jobs per built ha, and maintaining such figures throughout the period under review. Exurban centers had about the same density than suburban centers in the early years, but starting in 1955 they experienced a very sharp decline in density such as by 1990 they had basically the same job density as edgeless space. While suburban and exurban space started basically as kin spaces, sharing many characteristics, they very much diverged afterwards. On the contrary, the mixed centers, while starting with very low densities as they emerged from residential functions, showed clear convergence with suburban centers. Density wise, mixed and suburban centers are very close to one another. At last, density in edgeless space also tended to decline, but more interestingly, by 1990 both exurban and touristic centers sported about the same job density as edgeless space.

In all, several conclusions can be reached. The first is that cities remained cities and showed their difference. The second is that suburban and mixed centers started with critically low densities, or as specialists in space-hungry activities but managed to fend off tendencies towards further deconcentration, most likely by getting activities requiring less space. On the contrary, exurban centers lost much of their density, losing jobs more than built area and not being able to renew those areas. As a result, density-wise, there is now no difference between an exurban center and edgeless space, a remark also valid for touristic centers.

It has to be noted again that the general job density rise observed since the late nineties could be due to the fact that no new data for built area was available at the time of this study; the noted upturn could be somewhat off.

5.2.4. Job intensity: from equilibrium to massive specialization

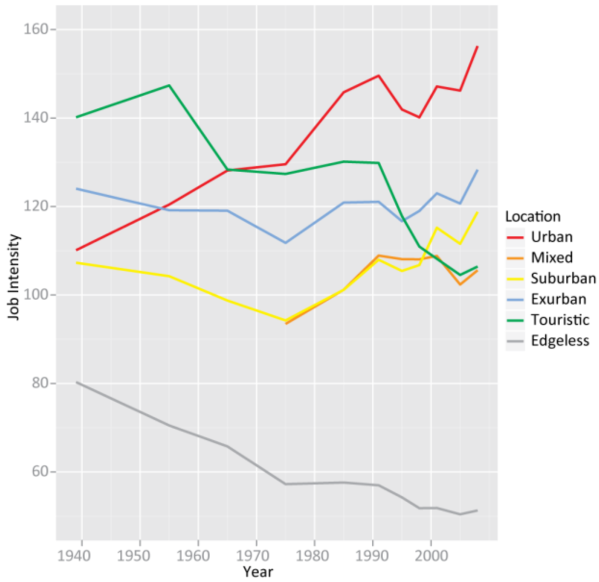


Chart 5-5: Job intensity by location, 1939-2008

Job intensity proved a potent discriminator between our differing location categories (*Chart 5-5*). The main phenomenon at hand is one of segregation between central space on one hand, and edgeless space on the other hand. In 1939, those two categories were rather close to one another, but the steadily grew apart during our period of study, highlighting the growing territorial specialization between job centers, where the tendency was to specialize ever more towards jobs, and residential space geared towards hosting residents instead of jobs. It has to be noted, though, that in recent years it seems that this segregation process started to bottom out, as shown by the relative stability shown by job intensity in edgeless space since about 1990. As often, urban centers, i.e. cities, were the driving force of the specialization move, with intensities steadily climbing from a near equilibrium in 1939 to close to 160 jobs for 100 active residents in 2008, a move mirrored by that of edgeless space, itself not too far from equilibrium in 1939, but which now counts two active residents for each of its jobs.

Other locations had more complex stories. Suburban centers, while developing as job places, were engulfed in the massive suburbanization processes which hit Switzerland between the end of WWII and the oil shock of 1973, such as even if they grew as job centers, they generally grew even more as residential ones, meaning that their job density decreased up until 1975, to very low figures, under parity – at this time, suburban centers were growing but quite weak structures. The upturn happened after 1975, with suburban job intensity slowly but steadily rising, now at about 120 jobs for 100 active residents. Mixed centers appeared to follow the same track than suburban ones, with a clear divergence towards the end of the period which shows that it remained difficult for them to specialize into job centers, given their residential functions. The exurban centers curve shared the same allure as that of suburban centers, except that exurban intensities had always been clearly higher than suburban ones, showing that if exurban centers knew very low job densities, they had always been specialized job centers importing some of their workers from the outside. While suburban centers space was largely occupied by residential functions, such wasn't the case of exurban built space, which was geared towards land-hungry activities. Lastly, tourist resorts evolved in a very peculiar way. They had been the most intense places throughout history, and are now close to equilibrium – an expected position for far-away places. It may well be that their active population was vastly underestimated in the past, especially before the nineties when large parts of their workforce was made up of seasonal workers.

The last period under review showed a dramatic increase in job intensity, shared by all units; the rise seemed to be real enough and can't easily be discounted for absence of recent data about the active population. This fact seems to correlate with the job density upturn noted in the preceding section and could be correlated with it – making the job density find more credible.

5.2.5. Mean size: big and beautiful

The history of center mean size is one of growth, and more specifically of urban growth (*Chart 5-6*). Urban centers grew bigger for the whole period under study, first by growing as units, which lasted until 1965, then preferentially by shedding smaller units while remaining ones grew larger still. In that sense, the relentless growth of urban center mean size after the 1965 stabilization of its job numbers is a powerful indicator of ongoing urban metropolitan processes as we understand it.

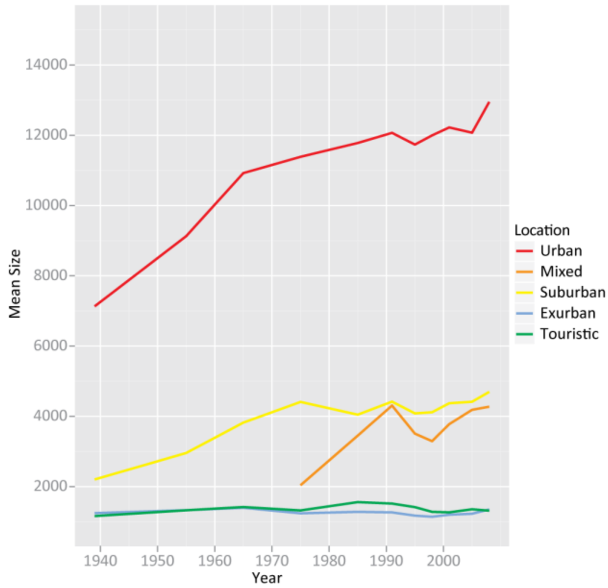


Chart 5-6: Center mean size by location, 1939-2008

Suburban center mean size underwent a similar evolution, first growing internally while the unit numbers remained fairly stable, that phase lasting up until 1965, then by adding new units to the network such as their mean size remained constant while their total job numbers grew. Lately, mixed centers showed a propensity to hug the suburban curve, getting approximately the same mean size than their more numerous counterparts. Indeed, on many plans mixed centers appeared to be close cousins of suburban centers, way closer, in effect, than to bona fide urban centers. Exurban and touristic centers, for their part, were overwhelmingly formed by very small units, which remained that way throughout the period under study.

5.2.6. Job-active imbalance: an urban-edgeless pas-de-deux

For most of the period under study, the job-active imbalance was related to the relationship between center and periphery, here between urban centers and edgeless space (*Chart 5-7*). Those two locations mobilized most of the imbalances for most of the time. Their imbalances grew together, from relatively humble beginnings in 1939 to ever growing and mirroring imbalances, as edgeless space specialized into residential space, while cities specialized ever more as job centers. From 1939 to 2008, the imbalance grew sevenfold, while the jobs just doubled during the same period. There were clearly massive territorial reorganization going on during the period under review, the move from a local-based relationship between work and home being replaced by spatial discrimination between the two, very probably underpinning the metropolitan processes which modified the urban network of the time.

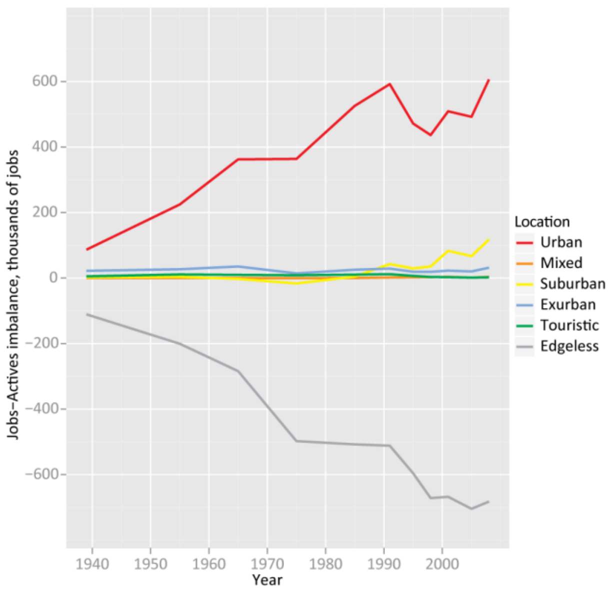


Chart 5-7: Jobs-actives imbalance by location, 1939-2008

Compared to that major imbalance, other location types played almost no role, with the recent exception of suburban space, which developed a significant imbalance starting about 2000; however its effect remained relatively small, if not inconsequential, when compared to the one of cities and edgeless space. Other categories effects were negligible.

5.2.7. Locational conclusions: from Christaller to metropolis

Taking it all together, the most important move of the period under review seemed to be the ongoing segregation between job places on one hand, residential space on the other hand and the concomitant and massive rise in movements between the differing units. While the 1939 urban system was pretty well self-contained – most of the people living and working in the same community, those communities serving hinterlands in a very Christallerian way, by 2008 it had separated in two very different spaces, the job places on one side, about one in five or six communities grouping about four fifths of all jobs, of which they retain vastly more than they host actives, and residential space geared towards hosting beds instead of job places. It is very tempting to link this evolution to the advent of easy transportation, that is of the automobile, which allowed people to spatially choose where to live amongst a vastly wider territory than before. It is also very tempting to link this evolution with the generalization of metropolitan processes, the slow erasure of the Christallerian network in favor of metropolitan forms of spatial organization, with fewer, greater centers vastly more interlinked and developing in common, based on metropolitan centers sporting massive edge cities.

The evolution of the different classes of objects we delved upon showed that for all their decline, urban centers remained, by far, the largest player in terms of job places, with the rising suburban places a distant but significant second. The rise of the latter is indeed impressive, but took quite some time – it was certainly not an explosive growth the like of those experienced in some parts of the southern and western USA. By 2008, there were still twice as much jobs in central cities than in their immediate surroundings, and besides, job imbalances were still held by central cities. Nevertheless, the advent of suburban job centers, if not extremely sudden, is quite significant, as they pretty much marked the metropolitan processes. We believe edge cities can only exist because of the automobile, we believe that the automobile was the driving force behind the long-term changes we just indicated, and as such edge cities are true markers of metropolitan processes. Their rise is then an indication that we are entering a metropolitan age, after a Christallerian one.

5.3. Dynamics and dynamical units

5.3.1. Units numbers: domination except in cities

The definition we gave of dynamical units tends naturally to augment their importance with time, as it is easier to get in than to get out of the category (*Chart 5-8*). Nevertheless, even taking this into account, results found when controlling for dynamical status across location categories remain interesting.

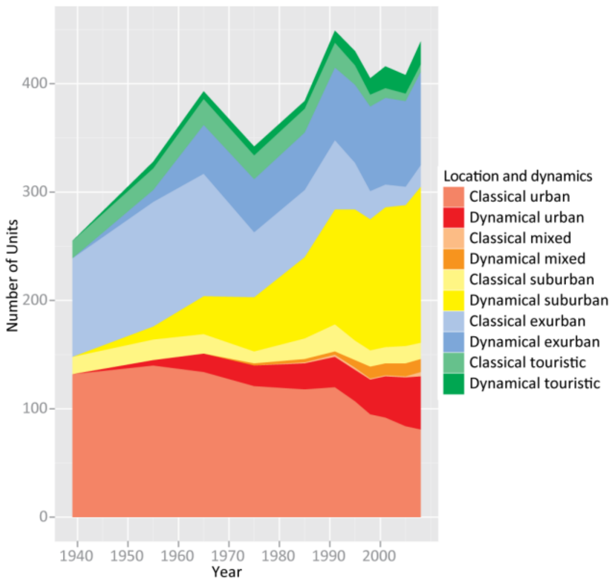


Chart 5-8: Units by location and dynamics, 1939-2008

In terms of unit numbers, the general allure is one of slow but steady transition from a world of classical centers to dynamical ones, in all locations except urban centers. In urban centers, though, dynamical centers represented in 2008 a full third of all units. In general terms, it means that apart from classical cities of a respectable size, most everything which was by 2008 part of the central network had undergone at least one phase of unbridled growth during the last seven decades.

In terms of locations, there is a general find that true dynamical unit emergence started by about 1965. At that time, dynamical units were already the majority in suburban space, and for the first time appeared in sizeable numbers in urban and exurban centers. By 1975 they represented a half of all exurban units and a clear majority of suburban ones, while mixed centers were dominated by dynamical units right from their inception. By 1991, dynamical units were totally dominant in suburban space, but still even in exurban space and hadn't progressed very much in urban centers, such as dynamics was by then essentially a suburban phenomenon. Since 1991, though, dynamics has invaded most spaces, such as by 2008 it is exclusive in suburban space, strongly dominant in exurban and mixed areas, and has made considerable inroads in urban space. In fact, it could be said that an urban upturn has been underway since the mid-1990s based on the sudden flowering of urban centers turning dynamical, while traditional numbers keep going down in a more and more metropolitan landscape.

5.3.2. Job numbers and share: the suburban domination

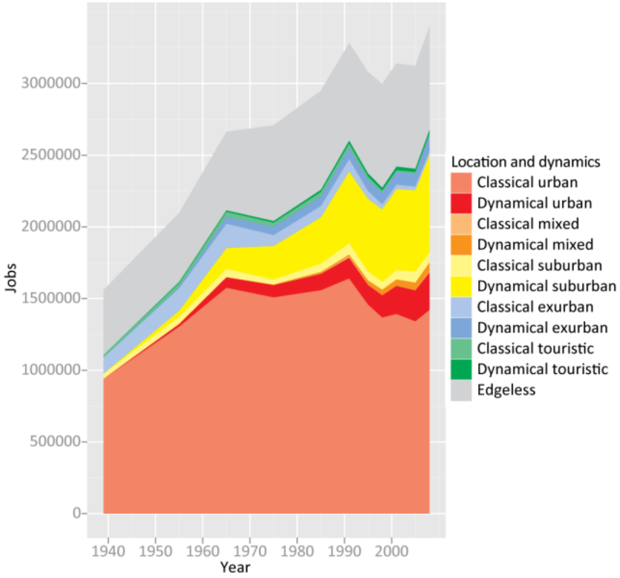


Chart 5-9: Job numbers by location and dynamics, 1939-2008

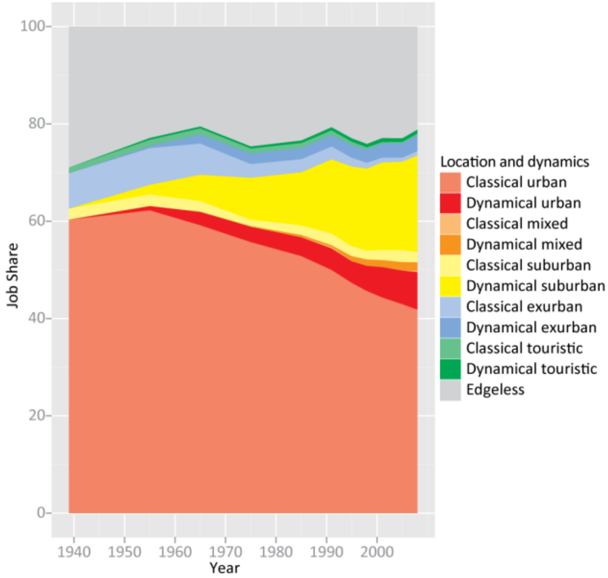


Chart 5-10: Job share by location and dynamics, 1939-2008

The invasion of dynamical units in terms of job numbers look less impressive than in terms of numbers of units, which emphasizes the fact that dynamics affected above all smaller units – which is logical, since it requires less absolute numbers to grow in relative terms in smaller units (*Charts 5-9 & 5-10*).

That being said the first big difference between unit and job numbers in that the share of jobs held in dynamical urban centers looks less impressive, at about a fifth of all urban jobs in 2008. Likewise, the shift between classical and dynamical exurban centers looked more like an extinction of classical units, with dynamical ones surviving. On the contrary, the emergence of dynamical suburban centers looked no less impressive in job numbers than it had been in terms of units, with a near total wipeout of classical suburban centers. While in terms of units, dynamics pervades almost all locations, it remains that in terms of sheer numbers, they are nowhere as significant as they are in suburban surroundings.

5.3.3. Job density: A three tier distribution

Job density discriminated by location and dynamics shows several trends (*Chart 5-11*). First, a long-term trend towards gentle density decline is seen across the categories under review. However a definite upturn is noted starting in 1995, and which affected location types differentially. Edgeless space, touristic and to a large extent exurban locations weren't affected by the upturn, although they definitely stabilized. Urban center, especially classical ones, saw the most striking upturn of all, while locations situated in-between those two extremes: dynamical urban centers, mixed and suburban ones experienced moderate reversals of density. In all, at least in relative terms, the general trend of job density decline seemed to have been halted, especially in the densest areas: in urban centers, and to a point in suburban centers processes of job densification seem to have taken hold in the last decade of our study.

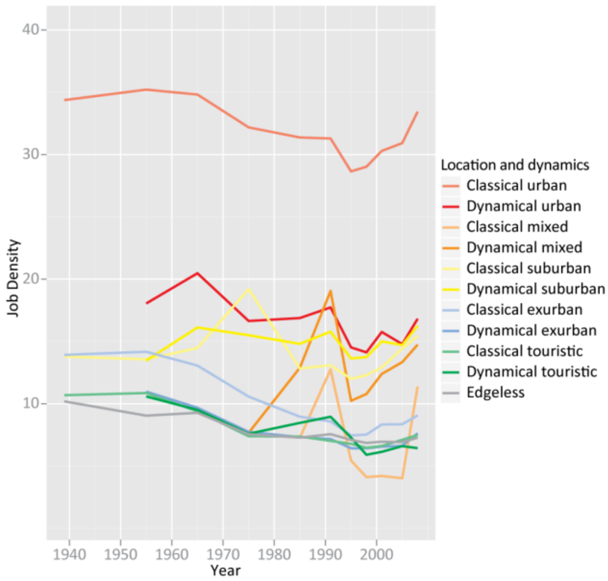


Chart 5-11: Job density by location and dynamics, 1939-2008

As we have already pointed out, the magnitude of the job density upturn could be an artifact due to the lack of recent data on built areas. However, the differences between differing space types could only be annulled by very improbable recent developments, which would see area consumption resume very strongly in established cities, moderately in inner and outer suburban areas and not at all in exurban, touristic and edgeless regions. Those developments seem largely implausible, in particular because they are exactly inverse to the general trend of the latter 20th century, which saw space consumption affect above all external and peripheral areas. If we postulate that the general area consumption went on after 1995, which is indeed possible, broadly along the same lines than previous evolution, it would reduce the density growth to probably nothing, but it would not obliterate the differences in evolution which saw, at least, a differential densification affecting central areas – and that results seems to us solid enough to point out, whether we have access to new data on built environment or not.

Secondly, job density very strongly discriminate the classical urban centers from everything else, and this difference is temporally invariant. Classical center density was systematically at least more than double the density experienced by any other location. Dynamical urban centers exhibited job densities which very quickly converged with those of suburban centers, classical and dynamics. In terms of structure then, it seems that dynamical urban centers share at least some characteristics with the vast suburban center family. And up to a point this is also the case of mixed centers, although their low numbers preclude the possibility to delve much on their results. On the contrary, exurban centers, once fairly similar to suburban centers in terms of job density, steadily diverged from them by registering massive losses from 1965 on, such as by 1991 they essentially rejoined the group constituted by edgeless and touristic areas. This is to say that a differentiation had intervened during the 1965-1991 period, where suburban space maintained a minimal density while exurban space totally specialized in land-hungry activities.

5.3.4. Job intensity: the specialization of classical cities

Two very different periods seem to mark our time span when studying job intensity controlling for location and dynamics (*Chart 5-12*). The first period ranged from 1939 to about 1975, and saw a double movement of steady job intensification in classical urban centers, and of loss of intensity everywhere else. This marked the first period of differentiation between job-specialized place, the cities, and residential specializing places, about everything else, and explains in particular the loss of intensity experienced by suburban and exurban centers, as they were "drowned" by a wave of suburban newcomers which came to live there.

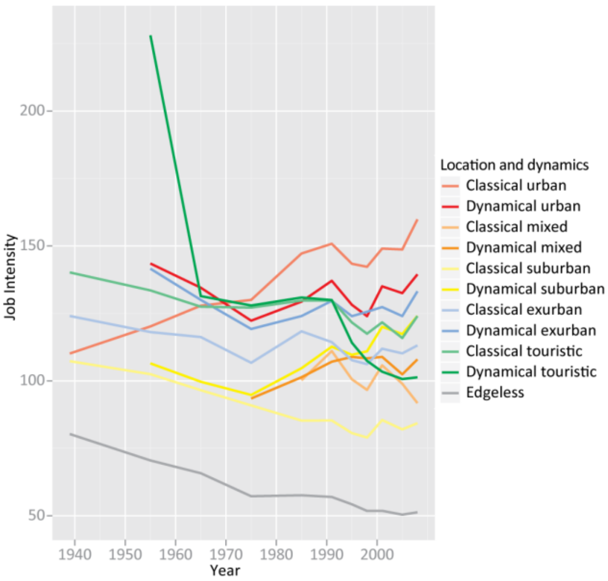


Chart 5-12: Job intensity by location and dynamics, 1939-2008

The second phase started in 1975 and saw job specialization, while affecting more and more classical urban centers, starting to conquer other locations. The upturn in job intensity is near general, leaving out only edgeless space, quite logically, classical urban centers, a dying breed, and the peculiar tourist resorts. Since then the evolutions has been largely controlled by economic conditions, with job intensity rises in good economic times, and corresponding losses during crises. Since 1991 job intensity growth has settled in most spaces. Exceptions are the classical urban centers, and the dynamic suburban centers, where the long term trend remains upward, and conversely classical suburban, touristic and edgeless space which continued to lose intensity. On the long haul, specialization as job centers, which was in 1939 the domain of exurban industrial villages and touristic resorts, became an urban characteristic. By 2008, the most intense places were urban centers, classical or dynamic. The three groups seen when studying job density weren't seen at the intensity level, each category seeming to occupy a niche. On the long term, there are signs of convergence between dynamical suburban centers, which are steadily intensifying, to the point of catching up with dynamical urban centers, while mixed ones remained rather marked by their residential past. For their part, exurban centers, especially dynamical ones, maintained a rather strong intensity, heritage of their small but highly specialized past.

5.3.5. Mean size: Again, a three tier distribution

The long term trend about center mean size through time when controlling for location and dynamics is the relentless growth of the classical urban center mean size, from about 7'000 jobs in 1939 to 17500 in 2008 (*Chart 5-13*). The growth has been regular, first by the general growth of the country and its units, then, i.e. after 1965, by gradual discarding of the smaller units. The net effect is that by 2008, classical urban centers are between 3 and 4 times larger than anything else in terms of mean size.

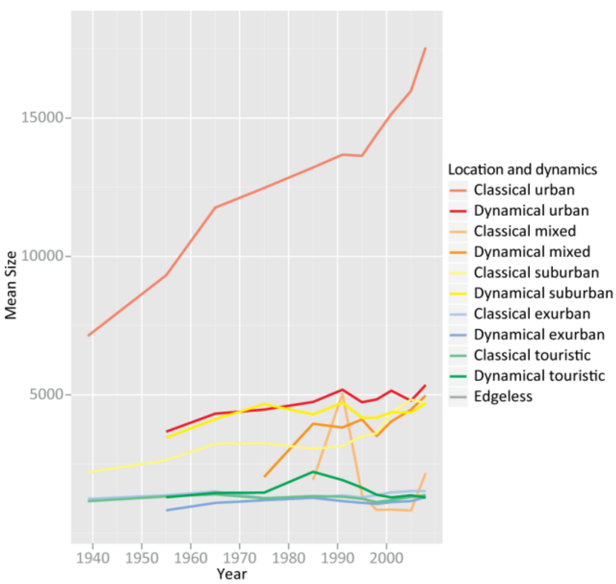


Chart 5-13: Center mean size by location and dynamics, 1939-2008

Surprisingly, most other location types have kept a relatively stable mean size during the years. A first group formed of dynamical urban and suburban centers hoivered just under the 5'000 jobs mark for most of their history. They were joined of late by the classical urban centers, which mean size rise can be linked to a dropping of their smallest units, and of mixed centers, especially dynamical ones. All those spaces seem to share a global size distribution quite close to one another.

A third group is formed by exurban and touristic units, which all remained with a very small mean size, just above 1'000 jobs per unit, stable on the whole period and indicative of a third kind of size distribution, essentially composed of very small units and without anything larger.

The same three tier distribution is thus seen here which is already noted in terms of job density – apparently job density and mean size, or size distribution, are linked. And of all categories, major changes in size distribution apparently happened only to classical urban centers.

5.3.6. Job-active imbalance: dynamical centers gaining significance

The job imbalance history of units controlled for their dynamical status is very close to the one described in general terms for locations (*Chart 5-14*). For most of the period under study, from a starting situation of near equilibrium, there has been a steadily growing imbalance between jobs and actives, with classical urban centers hosting more and more jobs, and edgeless space hosting more and more residents. Net flows between the two categories thus grew larger and larger.

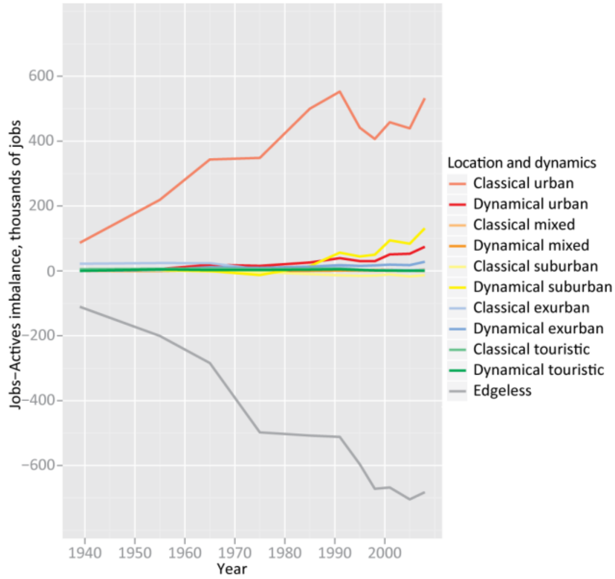


Chart 5-14: Jobs-actives imbalance by location and dynamics, 1939-2008

Dynamical centers have only recently played a role in this duet, with dynamical suburban centers starting to grow a significant job imbalance since about 1991, followed by that of dynamical cities and lastly of dynamical exurban centers. Those two categories helped to mitigate a sudden and very sharp drop in imbalance experienced by classical cities – in a sense they took over the share that classical cities couldn't cover anymore. In that sense, 2008 is quite different from 1991.

5.3.7. Locational conclusions: the rise of dynamical units

In all, what is the significance of dynamical centers? As we already pointed out, the way we devised dynamics centers tend to favor their emergence and to emphasize, with time, their importance. And, in fact, they have indeed become quite relevant as they represented, by 2008, a sizeable share of all units and jobs. In particular, they are now the dominant form in many locations, like mixed, suburban and exurban space. In all those areas, it means that the current network of centers is built up on units which experienced massive, boomtown growth at at least one time in their recent past.

Conversely, urban centers remained till recently very much dominated by classical centers, such as the main armature of the Swiss center network has remained largely in place, at least at its upper levels. The biggest urban center deemed dynamical by 2008 was Baden, with about 22'000 jobs, far less than the biggest dynamical units of all, Kloten-Lower Glattal and its 46'000 jobs, and than three other dynamical suburban centers. That being said, at the lower levels of the urban hierarchy, dynamical centers do play a significant role, meaning that if the upper levels of the hierarchy are indeed inherited from times past, the mid and lower levels of the same urban hierarchy are populated in a significant way by centers which underwent strong growth; after all, with Baden, three dynamical urban centers of nearly the same size are found in Sion, Chur and Frauenfeld. In many areas, especially outside metropolitan ones, the lower levels of the urban network are very much held by dynamical urban centers, like in Eastern Switzerland or in Western Mittelland.

In that sense, dynamical centers pervades every kind of space nowadays-Switzerland has to offer. In metropolitan space, although classical urban centers still were the major structures of the network, they were adorned by massive edge cities which were almost all dynamical, while further away, a mesh of dynamical urban, mixed and exurban centers covered the outer metropolitan belts. Outside metropolitan space, where the traditional urban network has held more or less, many of its units had underwent dynamics not expected of urban centers. Thus, on the long run, slowly, the center network is being colonized by centers which have a dynamical component, which has now come to dominate all but the most central areas of the country.

5.4. Orientation

5.4.1. Units numbers: still a very large number of industrial towns

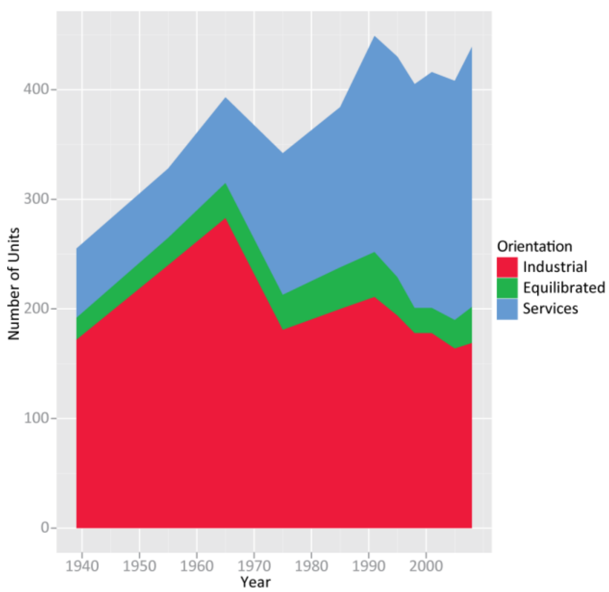


Chart 5-15: Units by orientation, 1939-2008

In terms of units numbers by economical orientation, two very distinct periods seem to happen (*Chart 5-15*). The first, up to 1965, saw a strong domination of industrial units over service-oriented ones, which persisted as the central network grew, which meant that the center growth of that time was largely industrial. After 1965, things changed with the massive losses in industrial centers experienced in the 1965-1975 period, followed by an upturn to 1991, albeit weaker than the one experienced by service-oriented centers, and then by a second period of decrease, from 1991 to 2005. Conversely, the service-oriented started their around 1955 and since then their rise has been unwavering. In terms of numbers, while they represented about a quarter of the industrial centers from 1939 to 1965, their share has grown steadily ever since, overtaking the industrial centers by the early 1990s, and now clearly dominating with about 240 centers, against 170 industrial ones. Meanwhile the equilibrated centers never took off, which gives an indication that they were probably no more than a transitional form, through which centers transited on their way from industrial to service-dominated economy.

5.4.2. Job numbers and share: the disappearance of industrial centers as a relevant force

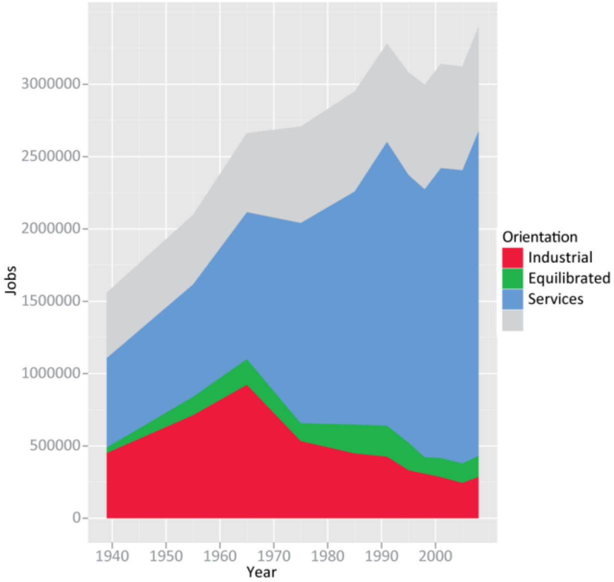


Chart 5-16: Job numbers by orientation, 1939-2008

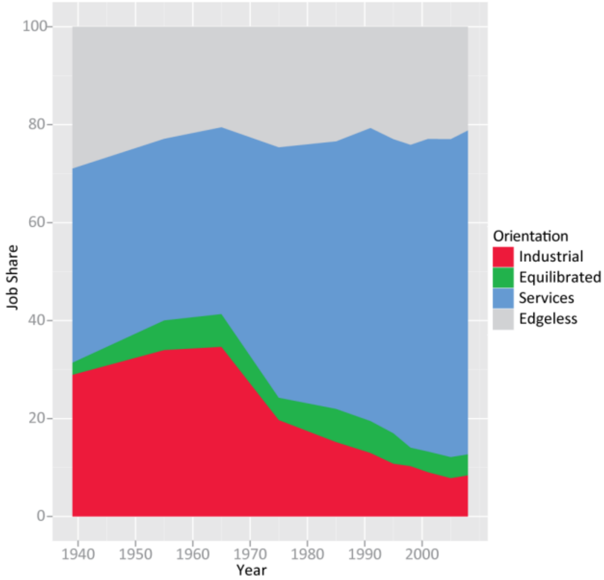


Chart 5-17: Job share by orientation, 1939-2008

The distribution of jobs by orientation through time is similar to the one about units and can be read in two parts, although the numbers involved are absolutely not the same (*Charts 5-16 & 5-17*). Service centers have always hosted more jobs than industrial ones, but up to 1965 this advantage was, and remained, slim. The 1973 oil shock provoked a hemorrhagic loss of jobs in industrial centers, which only experienced job losses afterwards, before a small upturn between 2005 and 2008. The job loss was recorded in absolute as in relative terms.

Meanwhile, everything that was lost by industrial centers was gained by service-oriented ones, at least in relative terms, such as the total share of the central network remained the same. One important point is to be said, is that when both sectors were approximately equal, i.e. up until 1965, the job shares of each sector were approximately equal to those of the centers orientation, which means that by and large, industrial jobs were to be found largely in industrial centers, while service jobs were found in service centers. By 2008, though, the industrial job share was more than three times bigger than the industrial centers job share, meaning that industrial centers had retreated so much that in general, more than two out of three secondary sector jobs were found in centers other than industrial – by then, industry had really become a secondary activity to services.

5.4.3. Job density: similar evolution, differing stories

Two facts come to mind when studying job density controlling for orientation (*Chart 5-18*). The first is that at all times, the service-oriented centers were vastly denser than industrial ones. This is easily explainable by the fact that industry consumes a lot of space for its machinery, while many service activities, particularly the office-oriented ones, need vastly less space per worker to achieve its aim. The second immediate fact is that, for both activities, density went strongly down. But similarities end there.

The loss of density by industrial centers is probably due to two factors. The first is that industrial centers underwent many restructuring periods which saw mechanization and automation

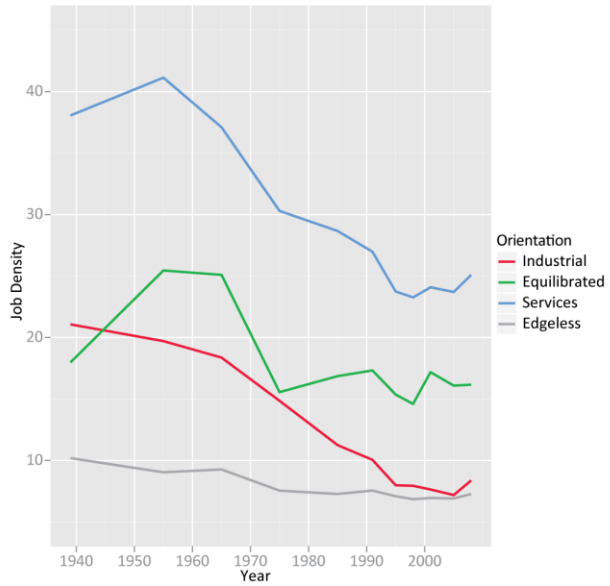


Chart 5-18: Job density by orientation, 1939-2008

replace workers, while more and more former industrial space went unused, which automatically sent job density down. The second factor, which picked up from 1965 on, was that more and more former industrial centers turned towards services, especially the bigger, denser ones, leaving as industrial centers only the smallest, least dense units.

In service centers, the processes are somewhat different. First, up to 1955 service center density actually increased, in a period when both service and industrial centers grew in step, showing an intensification of job use of the then select service centers. Then, after 1955, density went down regularly for four decades, which can at least in part be linked by the fact that more and more industrial towns turned to service activities, which meant that less and less dense places to start with entered the service center network. Besides, a second explanation of the service center density loss is the fact that some service activities started to consume a lot of space, in particular peripheral shopping malls, transportation and logistics.

5.4.4. Job intensity: the rise and pause of service centers

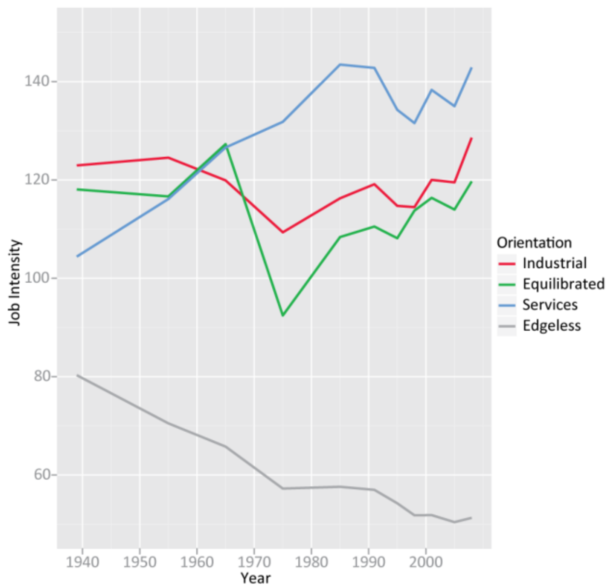


Chart 5-19: Job intensity by orientation, 1939-2008

To the contrary of job density, the evolution of job intensity segregated by orientation shows very different evolutions between industrial and service-oriented centers (*Chart 5-19*). Industrial centers remained remarkably stable throughout our period of study, at around 120 jobs for 100 active residents, with a dip in 1975 and a recovery since. In 1939, industrial centers were in fact the most intense places of all, already drawing sizeable amounts of workers from villages close by. The noticeable slump experienced in 1975 was probably due to real job losses experienced by industrial towns then, the recovery to their return to form.

On the contrary, service-oriented centers started from a relatively low point, just above 100 jobs for 100 active residents in1939 to climb steadily to about 140 jobs per 100 actives around 1985, and have hovered around that mark ever since. The few service centers which were existing in 1939 were the biggest centers of the time and as such hosted most of their workforce in-house, on their communal territory. As time passed by, residential suburbanization took hold and major cities, which had always been service-dominated, saw their job intensity regularly rise. However, it is more difficult to explain why service centers did not progress beyond that number after 1985. A probable explanation is the fact that after 1985 service activities colonized smaller and smaller units, where job intensity was noticeably lower than bigger ones. This, however, will have to be tested further down.

5.4.5. Mean size: again, a link with job density

The long term trend about center mean size as measured in job numbers through time when controlling for orientation is quite similar to the one about job density (*Chart 5-20*): that is, that service center mean size was vastly bigger than industrial center mean size at all times, and that their evolutions was somewhat similar once the discrepancy in mean size taken into account.

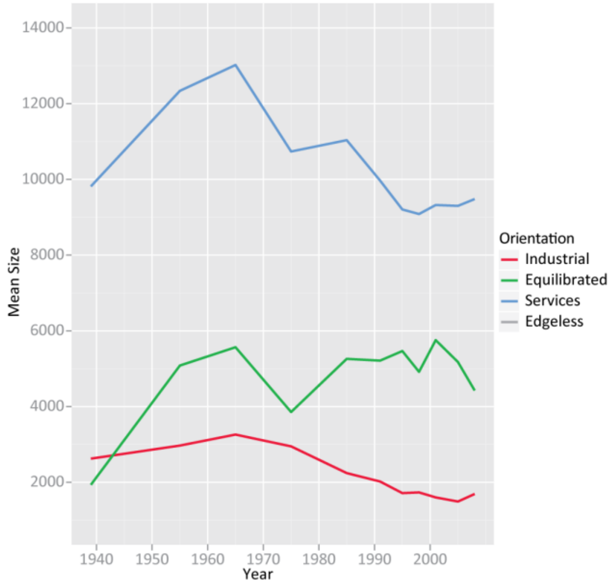


Chart 5-20: Center mean size by orientation, 1939-2008

The fact is first that service-oriented centers were vastly bigger than industrial ones, the mean size of service centers being about four times larger than the industrial one, a ration which remained roughly constant throughout our period of study: at all times, the largest centers in the country have always been service-oriented, while, as we have already seen, there has always been a rather large number of smallish industrial centers.

Both orientation categories show a growing mean size from 1939 to 1965, which means that during this period the whole network was growing at least partially by sheer internal center growth. After 1965, though, the trend reversed, and both categories started to see their mean size decrease – although for very different reasons. Industrial centers were hard hit by the 1973 oil shock so that as a category they genuinely lost jobs. At the same time, many greater industrial centers turned towards services after 1965, such as they were lost for then industrial category. The same phenomenon, in reverse, accounts for most of the mean size loss experienced by service centers after 1965 – that is the period when service activities went out of the biggest centers to start to colonize medium and lower levels of the central hierarchy. To note, also, the median position of the equilibrated centers, closer to industrial centers than to services, especially after 1965, as to confirm the fact that equilibrated centers were a transitional form that centers went through when on their way to become service-oriented.

5.4.6. Job-active imbalance: an imbalance of service centers

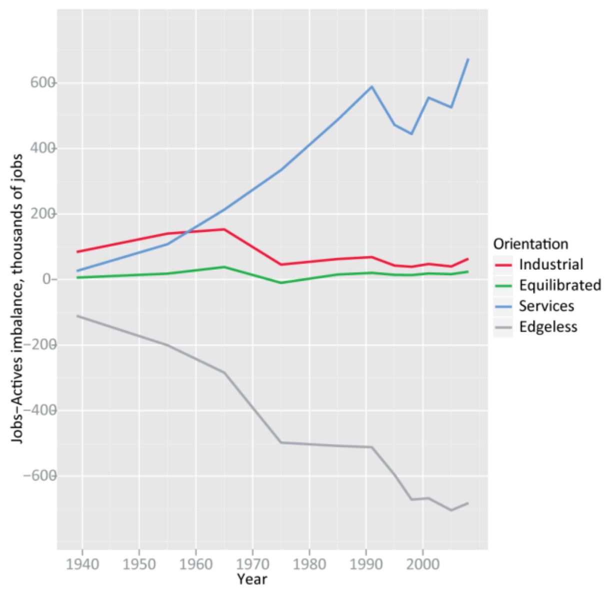


Chart 5-21: Jobs-actives imbalance by orientation, 1939-2008

The job imbalance history of units controlled for their orientation shows a two-period history again (*Chart 5-21*). The first period, again, covers the 1939 to 1965 years and shows that industrial and service-oriented centers accounted for job imbalances in similar proportions, with actually the industrial centers holding the lead until the 1960s, and the service-oriented centers taking the lead in 1965. Then, the stories diverge wildly. Industrial centers lost most of their imbalance by 1975 while service centers double theirs; since then most of the imbalance has been the feat of service-oriented centers.

The sudden decline of industrial centers in terms of imbalance is rather difficult to interpret. One hypothesis would be that 1975 marked the time when many industrial centers of the future metropolitan areas turned service-oriented, and when remaining industrial centers were retreating to peripheral areas, where imbalances are far less pregnant as most of the workers still work in the communities they live in. In all, it remains that the remarkable point about the evolution of imbalances when controlling for orientation is that the imbalance rise coincides with the establishment of a service-oriented economy.

5.4.7. Locational conclusions: a central network turned completely towards services

In one stroke, the history of orientation is that the central network, indeed the economy at large, transited from an economy in which industry played a large and even dominant part to one totally dominated by the services. While the transition has been gradual a turning point is clearly noted between 1965 and 1975. Up to 1965, industry was more or less on par with the services, be it in terms of units or job numbers, in terms of imbalances also.

After 1965, the two categories diverge completely, with a near death experience for industry, which lost almost all its significance, at least as a geographical category. If industry as job purveyor gave way to services, this was even more the case in terms of remaining units. While industry lost its significance, and what remained of it were held more and more in units that had turned service-oriented. Of course, service-oriented centers experienced the inverse evolution, getting more and more dominant to the point of near exclusivity by 2008. In all, it begs the question as to which extent this orientation distinction is still valid, still explanatory, by 2008, so big has become the dominance of service-oriented centers.

5.5. Form

5.5.1. Units numbers: a very large number of intense centers

The form describes in our classifications whether a center qualify as such according to its job density, job intensity, both, or none (*Chart 5-22*). A center can thus be complete – passing thresholds both in density and intensity, dense-only, intende only, and nothing, which is a transitional form, either a dip in a center's history, or more often an emerging center that gets promoted despite a job intensity below par.

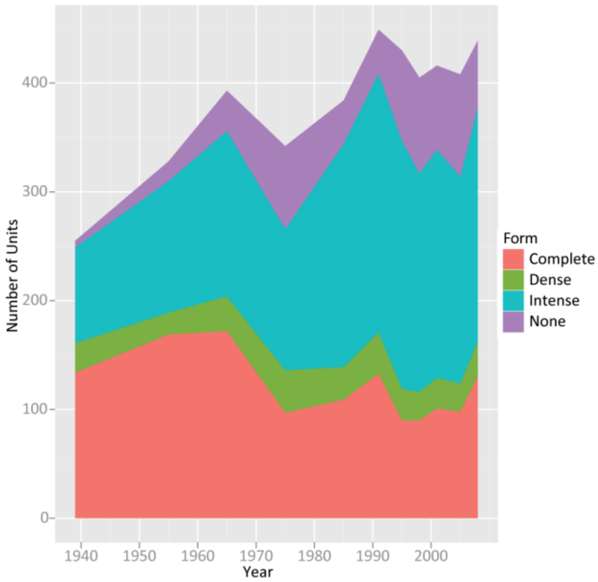


Chart 5-22: Units by form, 1939-2008

In very general terms there is a trend towards smaller numbers of complete centers, and slowly growing numbers of intense-only and none centers. Worthy of note is also the big discrepancies between categories in terms of unit numbers, complete and intense centers being far more numerous than dense and none centers. Of particular interest is the discrepancy between intense and dense centers, as if in most cases when centers are not complete, they tend to be intense units – places with large expanses of built-up space, few residents and which import a significant part of their workforce, instead of dense units – places with dense job places but immerged in even denser residential surroundings, such as having a negative job-active imbalance. Intense-only places can be found in suburban and exurban industrial parks, dense-only centers are mostly found in dense residential areas, especially in upscale neighborhoods. As we said, they tend to be in vastly smaller numbers than intense-only centers, and complete ones.

In terms of unit numbers, the history shows, again, two distinct phases. The first goes until 1965 and shows a growth of all unit categories, about in step; then things change with a sudden diminution of the numbers of complete centers, to be compared with the rise of intense-only units, and, in times of crisis, also of none centers. This shows an important development: that is, the transition from a central network dominated by complete centers, to one where specialized centers, most of them intense-only, had taken a significant part of the network. This denotes also a change in the way centers are organized, with more and more centers taking advantage of their spatial qualities, most notably their real estate availabilities, and of the generalization of commuting, to flourish as intense-only centers. In contrast, dense only centers show practically no variability through time, as if they were somehow protected from the vagaries other categories have to endure. Finally, as expected, centers with no such qualities flourish above all during crisis times, as edgeless space, to which they are somehow related.

5.5.2. Job numbers and share: the complete centers as network armature

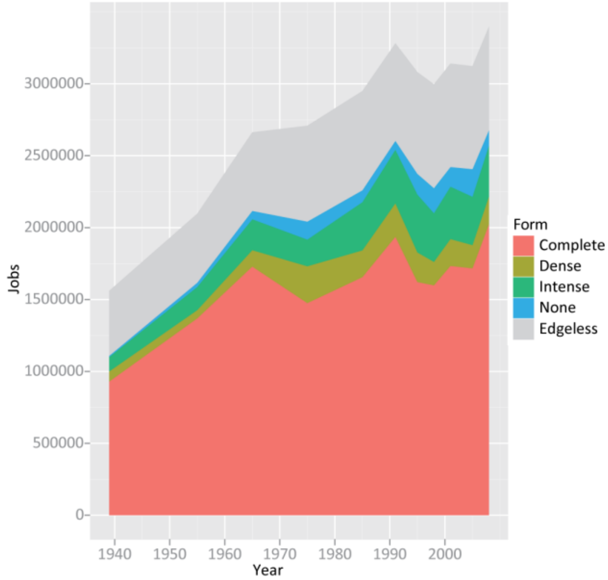


Chart 5-23: Job numbers by form, 1939-2008

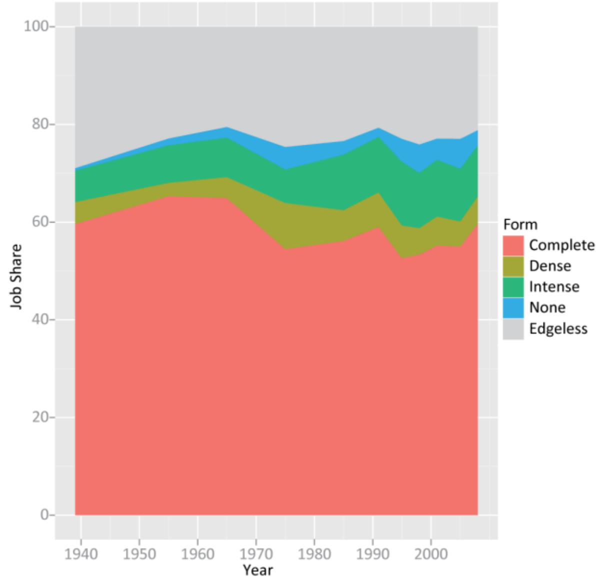


Chart 5-24: Job share by form, 1939-2008

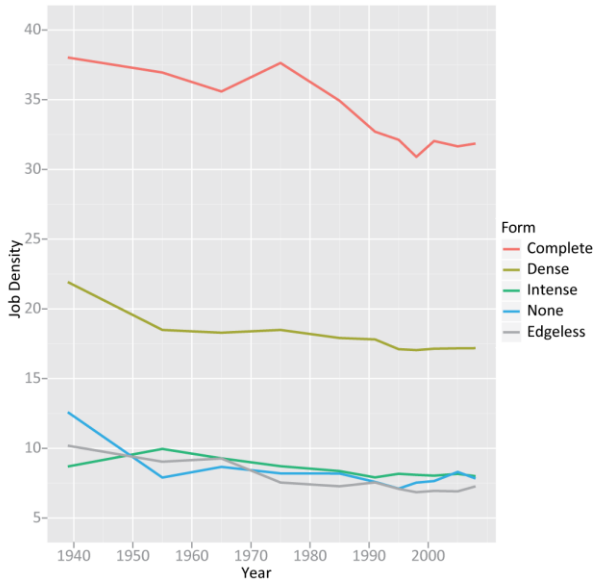


Chart 5-25: Job density by form, 1939-2008

Essentially, the same moves that were seen in units were seen in job numbers, although with a major difference (*Charts 5-23 & 5-24*). In terms of job numbers, complete centers remained very dominant throughout the period under study, which confirms that the network armature is composed of fairly dense and intense centers.

That being said, the dominance of complete centers eroded somewhat after 1965, so that the share represented by other center forms rose significantly between 1965 and 1975, whereas up top 1965 complete centers had reinforced their numbers and share. Just after 1975, an interesting twist is that dense-only centers were dominating intense-only ones in terms of job numbers, signaling that dense centers are vastly larger than intense-only ones, if vastly less numerous. Intense centers gained on dense ones only in latter times, after 1985, which means that in terms of specialized centers, there were, after 1965, two distinct periods, one which lasted to about 1985 when dense centers dominated the field, and a second one, since then, where intense centers started to get more dominant.

5.5.3. Job density: the continuing domination of complete centers

Two facts stand out when looking at the evolution of the job density when controlling for form (*Chart 5-25*). The first is that, at all times, complete centers are vastly denser than all other forms, always over 30 jobs per built ha, whereas the dense only centers are always situated just above the 15 jobs per built ha threshold. For their part, intense only centers are indistinguishable from edgeless space in terms of job density, largely under the threshold.

This allows us to the following conclusions. First, the densest centers are also intense and there are practically no centers that sport a large job density without also showing sufficient intensity. Thus, all centers with clear central qualities are contained in the complete form. Conversely, dense-only centers are part of a fringe category, objects that are able to just cross the threshold in density while not showing anything in terms of intensity. The same remark can be made about intense-only centers and none ones, which at no point in time can distinguish themselves from edgeless space.

5.5.4. Job intensity: the rising domination of complete centers

One would expect to see about the same pattern in intensity than the one seen about job density, but the conclusions here are quite different (*Chart 5-26*). First of all, if complete centers now are quite clearly more intense than any other center form, it has acquired this quality during the period under study: in 1939, in terms of job intensity, complete centers were no different than intense ones. Job intensity grew above all in complete centers, such as by 2008 it established itself at about 160 jobs per 100 active residents. Complete centers were thus the main beneficiaries of the transition from a locally based urban system to a commuter-oriented one, gaining a clear lead in terms of job intensity.

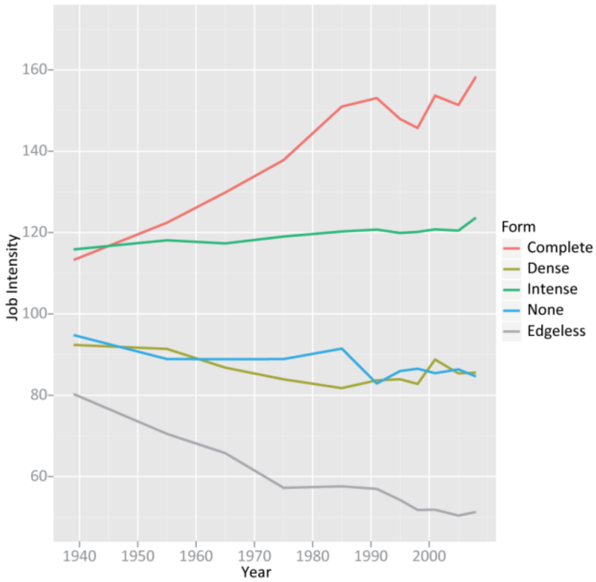


Chart 5-26: Job intensity by form, 1939-2008

Intense-only centers, meanwhile, have had a relatively high intensity, around 120 jobs per 100 actives, well above the threshold of 100. This means that to the contrary of dense-only centers, one could find very intense centers which didn't have any density, meaning also that again, to the contrary of dense-only centers, the intense-only class of object is probably not a fringe, marginal category, but a really distinct one. At all times, one could find very intense centers that had no density.

The last difference is that in terms of intensity, both density and none centers were distinctly different than edgeless space in terms of job intensity. All those finds make us think that job intensity, more than job density, is a defining indicator of the changes which pertained to the central network.

5.5.5. Mean size: a link between complete and dense-only centers

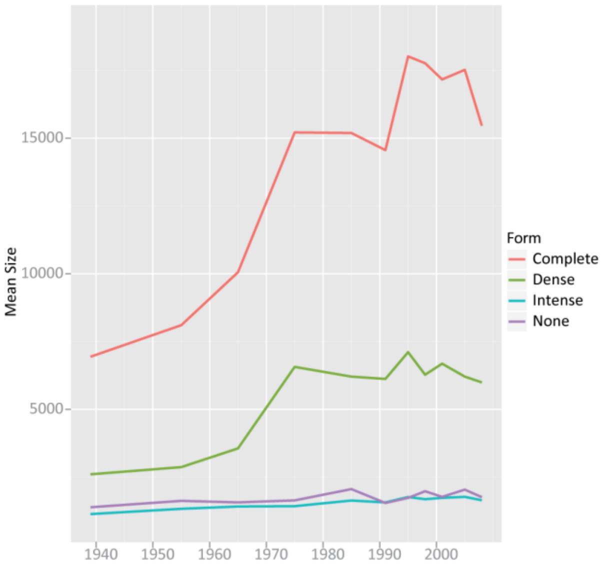


Chart 5-27: Center mean size by form, 1939-2008

There is not much to say about mean size evolution when controlling for form (*Chart 5-27*). As expected, complete centers tend to be the largest ones, meaning that there was a link between size, density and intensity. On the long haul, dense centers were also significantly larger than intense and none ones, which qualifies somewhat the fact that dense-only centers seem to belong to a marginal class: demonstrably, they are quite big marginal units. Another qualification is given by the allure of the curve for dense-only centers, which is similar to that of the complete centers: both curves show a sharp upturn between 1965 and 1975, while the curves for intense and none centers essentially remained at the same, very low level, throughout the period under study.

With respect to the mean center size there is a distinct link between complete and dense-only centers, which mean size jumped around 1975, most likely by dropping their smaller units. This tend to demonstrate that dense-only centers were closer to complete centers than to other units, and as complete centers tend to be predominantly urban, this means that dense centers were probably closer to urban centers than intense ones, which share characteristics with outlying areas such as edgeless and exurban centers.

5.5.6. Job-active imbalance: the absolute domination of complete centers

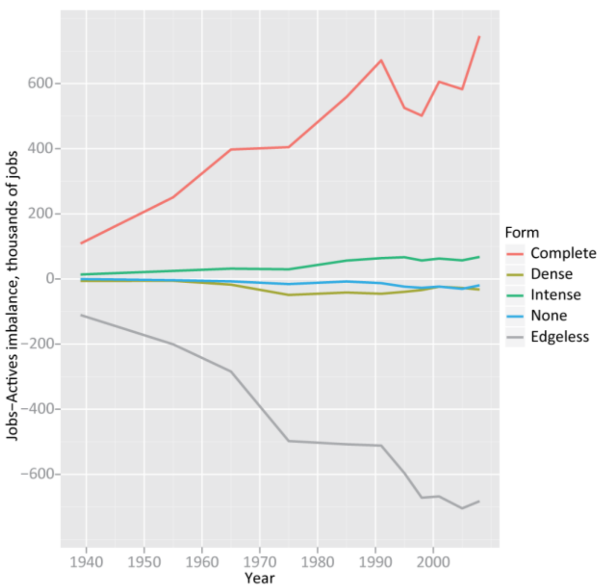


Chart 5-28: Jobs-actives imbalance by form, 1939-2008

The job imbalance history of units controlled for their form shows, again, the dominance of complete centers over other forms, confirming that they were constituting the armature of the central network and it seems that they were practically the only relevant central form in terms of job imbalance, with the very partial exception of intense-only units (*Chart 5-28*). This seems to confirm quite clearly that the complete centers were mostly in charge of the central network and that all other forms were clearly secondary, at least in terms of impact on the central network system.

5.5.7. Locational conclusions: a clear dominance of complete centers, and a revamping of industrial villages

The main finding of this part is clearly the very strong dominance of complete centers over all other center forms present in the central network. This tends to show that in all there is a correlation between job density and job intensity, as centers with a respectable figure for one are very likely to have a high one for the other. This seems to indicate that complete centers were at the center of the central network, and that all other forms were more or less situated at the margins, being degraded forms of some sort – this is probably true of dense-only centers, a degraded urban form, and of course of "none" centers.

This is however less true of the intense-only centers, which numbers and intrinsic qualities distinguish from the other classes. There is a possibility for a center to exhibit a high job intensity, without a matching job density. Those places are thus structurally distinct of the other forma, and they are relatively important, at least in terms of unit numbers, as they are quite numerous. This means that a class of objects emerged that took full advantage of the transition towards a commuting-oriented spatial system, a quintessential metropolitan form, combining a very high intensity – that is a very strong net influx of workers as compared to its resident population, with ample land use, such as be suitable for land-hungry operations like transportation, logistics or miscellaneous industrial activities. Those characteristics looks pretty much like a revamped, actualized version of the industrial village, only now they adorn metropolitan spaces instead of railroad equipped valleys and dales.

5.6. Size

5.6.1. Units numbers: the rise of larger centers

In terms of unit centers, the history of the network is twofold (*Chart 5-29*). First, from 1939 to 1965, there was a general rise of center numbers which ecompassed all size classes. After 1965, though, the rise concerned above all centers greater than 4'000 jobs, while smaller centers saw their numbers stagnate at best.

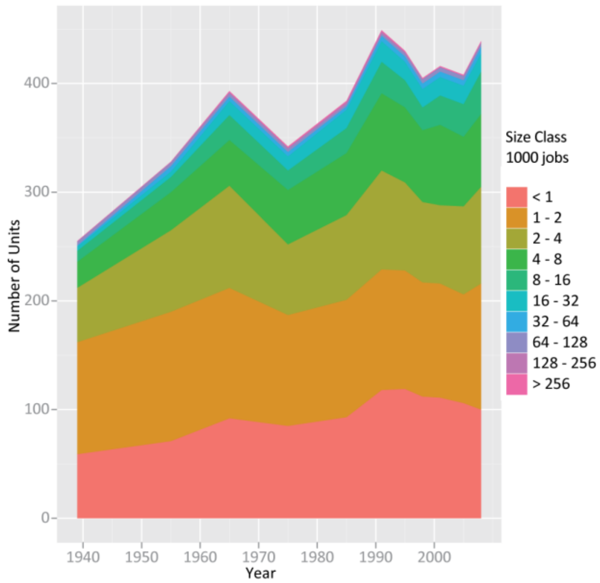


Chart 5-29: Units by size class, 1939-2008

Interestingly, the numbers in the smallest class under consideration, the ones between 500 and 1'000 jobs, saw their numbers actually climb during most of the period under review, diverging thus from their closest size classes. One has to remember that the selection of those very small centers is conditioned for only one sector to attain the 500 jobs threshold, which was rendered easier with time with the rise to ever more prominence of the service sector, which allowed more and more micro-centers to reach this threshold.

In other size classes, though, the 1965 rupture is clear, with the numbers of centers below 4’000 jobs stagnating and the ones above that continuing to grow. More recently, the numbers for centers between 4’000 and 8’000 jobs started also to abate, so that it seems that a very long term trend is at play, which see the progressive growth stop of ever greater centers, to the profit of larger units.

5.6.2. Job numbers and share: the big five and the rest

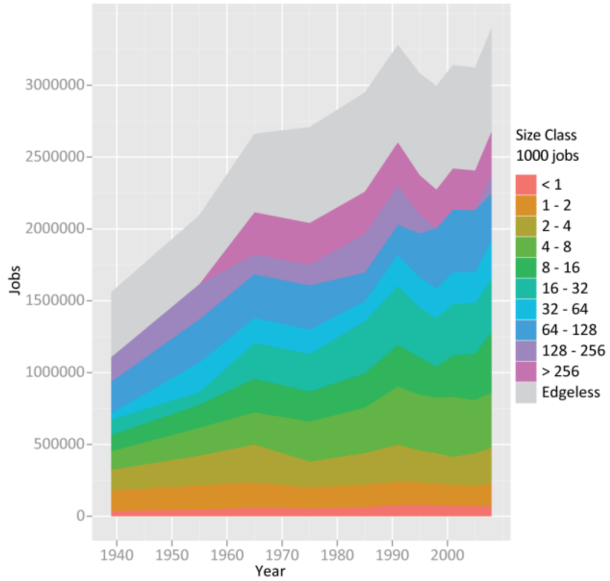


Chart 5-30: Job numbers by size class, 1939-2008

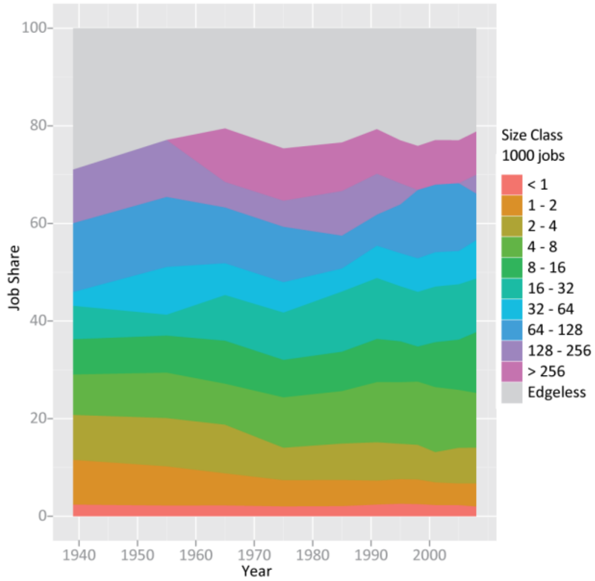


Chart 5-31: Job share by size class, 1939-2008

The evolution of the center network in terms of size classes is more readable when looking at job numbers than when looking at unit numbers (*Charts 5-30 & 5-31*). As we recall, if the network was strictly Christallerian then all size classes should have the same number of jobs, a situation more or less respected, at least in the middle levels of the hierarchy, in 1939.

Throughout the period under study, however, the smallest class sports distinctly lower job numbers, for reasons that have to see with the way those centers were selected, as they had to meet somewhat more stringent criteria than centers in larger classes. From then up, three different histories can be seen. Centers smaller than 4’000 jobs lost in job share, a general trend which reinforced strongly between 1965 and 1975. Midsized centers, those counting from 4’000 to 32’000 jobs, showed an opposite evolution with a reinforcement of their job share, which had started to manifest itself by 1965 and continued more or less regularly up until now. Finally, centers above the 32’000 job limit started by growing ever heavier till about 1965, but showed since then a tendency to lose a small share of their job share. Today there are vastly more jobs in midsized centers than in smaller ones, and somewhat more also than in the largest centers of the country.

In the upper levels of the hierarchy the evolution shows more variability, which is to be expected as there are few units with that many jobs in Switzerland, and that when one changes classes their impact is evident. That being said, two things come into view. First, the paucity of the 32’000 to 64’000 jobs class, throughout the period under study, suggests that there is a center size gap between the largest units, above 64’000 jobs, and the rest of the fray under 32’000, and that this gap maintained itself since 1939. Secondly, a similar gap has opened more recently between the largest center of the country, Zurich, with more than 256'000 jobs, and the four other great centers, of which only one manages to cross (recently) the 128'000 job threshold. In that sense, there is a rather robust double gap in the upper levels of the urban hierarchy which separates clearly the "big five" from the rest of the field, and inside those big five, Zurich from the four other centers.

5.6.3. Job density: the strongest size effect of all

Four facts stand out when looking at the job density evolution when controlling for size (*Chart 5-32*). The first and foremost is that job density has always been, and still is, very much correlated to center size: the larger the center, the denser its jobs. The second major find is that as a whole, job density decreased with time. However, in the long run the job density decrease somewhat abated such as the very high losses of density experienced from WWII to about 1990 have been replaced by somewhat shallower losses, or job density stagnation. There was also a correlation between job density level and loss rate, as the larger centers, with more density, lost job density at a higher rate than the smaller centers. Furthermore, the decrease rate itself decreased with time, such as the changes affected more the first decades under study than the last ones; in fact, in the last decade it seems that job density actually picked up in midsized centers, a move not found at the extremes of the size distribution. A third find is that the smallest centers have always been practically undistinguishable from edgeless space in terms of job density, a remark now true for all centers under 2'000 jobs. Likewise, the job density of centers between 2'000 and 4'000 jobs is now under the threshold of 15 jobs per built ha, meaning that those smaller centers derive their central qualities from job intensity far more than from job density. As of 2008, the smaller centers are such because they have strong job intensity. They are specialized, but ample, places.

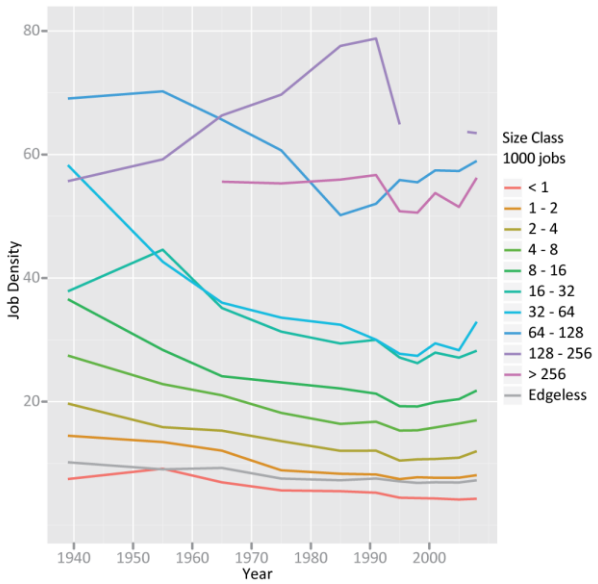


Chart 5-32: Job density by size class, 1939-2008

The fourth fact worth mentioning is that there is a strong behavioral difference between the largest centers and the rest of the field. As a group, centers above the 64'000 jobs threshold, which counts the big five only, do not show a strong tendency to lose density with time. This meant that as time passed, those centers slowly detached themselves from the rest of the field by sporting more and more exotic density figures. By 2008, the big five sported job densities close to double those of the next densest class, that of centers between 32'000 and 64'000 jobs. Thus, we can safely conclude that density wise, there is an undisputable specificity of the big five as compared to the rest of the field.

5.6.4. Job intensity: from intense small centers to intense large ones

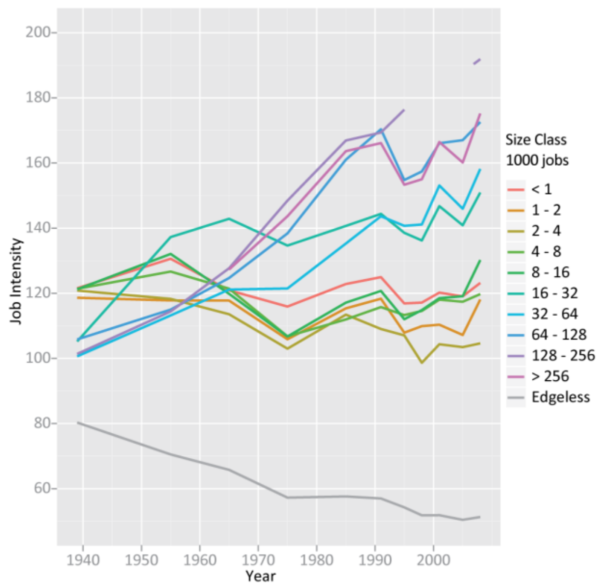


Chart 5-33: Job intensity by size class, 1939-2008

The job intensity history is clearly different than the job density one (*Chart 5-33*). First, there has always been a clear and strong difference between edgeless space and center space, regardless of the actual sizes of the centers considered. Secondly, if there is now correlation between center size and job intensity, it has only recently materialized. The passage to a pattern exhibiting such correlation has happened during our period of study.

From this point of view, we can group size classes in three generic groups. The first one is that of smaller centers, a large gathering of centers with up to 16’000 jobs, which have always been somewhat intense, starting out in 1939 with job intensities at about 120 jobs per 100 active residents. At this point of time they were the most intense units, and they were structuring the commuting patterns around them. As time went by, though, they essentially maintained the same level of intensity while the overall urban landscape evolved from a local-based territorial structure towards a metropolitan one marked by a massive commuting increase. For most of the group indeed, the advent of massive suburbanization was marked by a loss in intensity, as many of the concerned centers were swamped by newly arrived actives. Only recently have they been able to reverse the trend and see their intensity climbing back to approximately their former levels.

At the other end of the size distribution, the big five, the largest centers with more than 64’000 jobs exhibit the opposite behavior: they started out as self-contained autarkic centers in 1939, with a very low proportion of their workers coming from over their communal boundaries. Then, the country underwent the massive territorial reorganization which went with the advent of residential suburbanization and metropolitan processes. The big five were natural focal points in those processes and massively specialized as job centers; their job intensity grew relentlessly from 1939 to 1991, when they reached about 170 jobs for 100 actives. Since then job intensity somewhat stabilized at these levels, although there are strong hints that it started to grow again by 2008.

A median class of objects is represented by centers sporting between 16’000 and 64’000 jobs, which underwent an evolution between the two main classes we just discussed. Centers this size started out much like the big five, with very low job intensities, which points to the fact that medium-sized centers were also predominantly autarkic at the time. They followed about the same evolution than the greater centers till 1965, especially the smallest units (16’000 to 32’000 jobs) which intensified greatly during this period. Somewhere between 1965 and 1985, though, they decoupled from the big five, a difference which they still sport today, with intensities about 20 points lower than the big five.

Two conclusions can be reached from these proceedings. First of all, the territorial organization of the country changed from a local-based exchanges system where big centers were autarkic and smaller centers the principal focus point of commuting workers, to one where regional, then metropolitan systems has taken over with larger centers the main destination for commuting from widespread residential suburbs. The second conclusion we could make is that by 1985, the five biggest centers had detached from the rest in a rather spectacular fashion, and formed a category of its won, which is also found when looking at job density. This, to us, is testimonial to the fact that those five centers, and no others, had become focal points for the metropolitan processes at play.

5.6.5. Job-active imbalance: the power taking of the big five

Although the graphic representation here is rather difficult to read, it confirms the finds made in the two preceding sections (*Chart 5-34*). In a context of growing job imbalances throughout the period under study, the pattern evolved as to which size classes played the most active role in creating those imbalances. Early on, i.e. till 1965, those were above all the smaller classes, centers with 8'000 jobs or less. Progressively, they were replaced, as imbalances in general grew, by larger and larger size classes. The centers between 16'000 and 32'000 jobs dominated in 1965, then Zurich took the lead in 1975. Since then, the big fibve has clearly dominated the imbalance, meaning that a very large part of it – about 40% in 2008 – is to be found in just the five largest centers of the country, a testimony of the power of metropolitan territorial change if there was ever one.

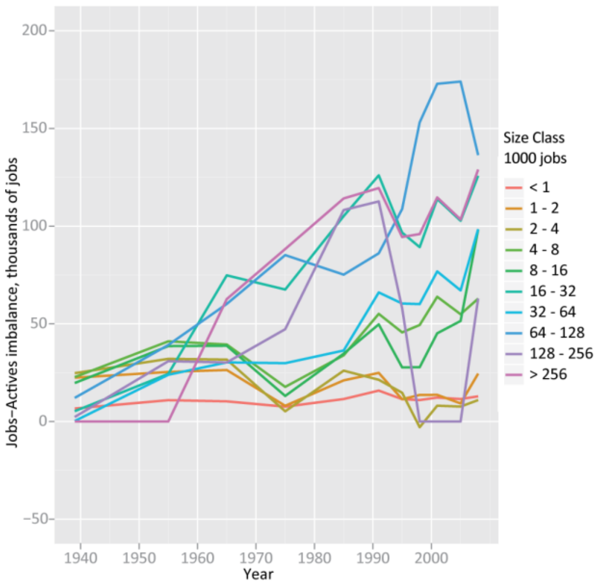


Chart 5-34: Jobs-actives imbalance by size class, 1939-2008

5.6.6. Locational conclusions: size as the best discriminator

The picture depicted by looking at the evolution of the center network discriminated by size classes is perhaps the most informative of all. In three domains: density, intensity, imbalance, conclusions are reached that seem to resume all others made in the preceding sections, and depict a general picture of the evolving center network in Switzerland.

The first characteristic of this network is that during the period under review, as the logic of the spatial relationship changed from a local-based to widespread territorial specialization at the regional and national levels, the country saw the true emergence of its five major centers which became something very different from the rest of the country, places with way more job density and intensity than anywhere else, the nodes and pillars of the metropolitan system developing. It is even possible to date this emergence rather precisely, somewhere between the late 1960s and the early 1980s; before then the big centers hadn't really detached from the rest, by 1985 they had their unique qualities. As they represent a massive share of the total jobs and imbalance, this is maybe the most remarkable fact to be gained from this section.

At the other end of the spectrum, it is shown that small centers have special qualities of their own, the first of which is space. This is also the result of an evolution. Early on, small centers were above all noticeable because of their commuting patterns, which they were pretty alone at having. They have more or less kept this imbalance throughout our period of study, but all other size classes have developed greatly since then, such as there is now no real specificity of the small centers in terms of intensity. What they have developed, though, is a propensity for space-hungry activities, which sent their job density down. In that, they mirrored the evolution of the greater centers which managed to keep their high job density, while most land-hungry activities migrated from the internal parts of the urban agglomerations to their external parts, or even farther away, into these classes of small centers. Thus, the territorial specialization was not just one of economy vs. residential, but also, inside the economy, one of competition for real estate in prime locations, which benefited the major centers by maintaining their job density, and smaller centers by letting them compete successfully for land-demanding activities. This probably shows also that there was hierarchy involved – center dumping on periphery what they didn't want any more at home.

5.7. Rank-size distribution

5.7.1. The unit level: a slow departure from the Christallerian equilibrium

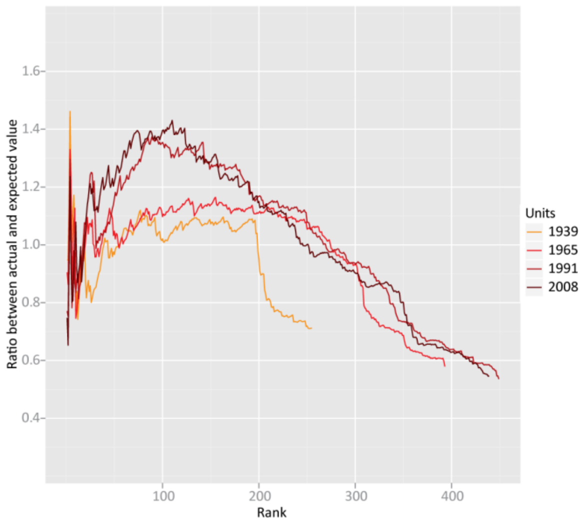


Chart 5-35: Units rank-size distribution compared to Zipf's law expected value, for selected years

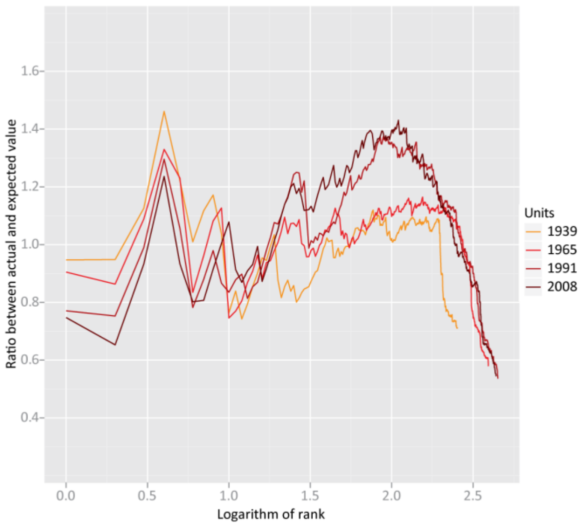


Chart 5-36: Logarithmic units rank-size distribution compared to Zipf's law expected value, for selected years

In this and the following sections, we will return to our graphs describing the deviation from a strict Zipf-like rank-size distribution, and compare its results at four different times, which are 1939, 1965, 1991 and 2008 (*Charts 5-35 & 5-36*). While the first choice seems obvious as it represents our starting point, the three other dates have been chosen as they all represent economic optima: 1965 heralded the height of the industrial prosperity of the country, 1991 and 2008 two high points in economic booms that marked the late 1980s and the late 2000s. Thus, all three periods show the rank-size distribution of the central network at moments of plenitude – the variations we will find will not be attributable to economical crisis. This comparison will be made at the unit, cluster and supercluster levels.

At the unit level, three points are readily makeable. First, the general allure of the uppermost levels of the urban hierarchy has been somewhat maintained, with the two first centers somewhat smaller than expected in a pure Christallerian network, while the centers ranked three to five are very much larger than expected – a further confirmation that the urban network seems to be a “pentarchy” made up of five dominant centers which somewhat hampers the first two to truly dominate but helps the three following to detach themselves and to get bigger than expected.

Then, in terms of dynamics, a triple move is readily observable: first, the network gradually evolved away from a Christallerian network which it more or less respected in 1939 – hence the relatively flat line seen between the 30th and the 200th ranks for that date. One can see that the lines for 1965, and above all for 1991 and 2008, do not show any plateau as the one for 1939 shows. Instead, they show a more and more pronounced bump at these ranks.

More precisely now, up to maybe the 12th rank, units have tended to grow smaller and smaller as time went by: the more the network evolved, the more the biggest centers were getting smaller as compared to the rest of the network, meaning that more of the growth was occurring in smaller centers than in the biggest ones, certainly a surprising result. Conversely, mid-sized centers, from about the 15th to the 150th rank, have shown a very strong progression, which took place essentially between 1965 and 1991. By then, the centers in that rank bracket were systematically bigger than expected, and they remained so afterwards. Thus, there is a double phenomenon: greater centers are getting smaller, while smaller centers are getting larger.

Finally, the cutoff seen in 1939 towards the 200th rank, and in 1965 at about the 300th rank and which marked the dissolution of the Christallerian organization into edgeless, then rural, space, had totally disappeared by 1991, replaced in fact by the general downward tilt of the curve which means that by 2008, from the 100th rank downwards, the decrease in size of the centers was greater than a Zipf-like distribution would have postulated, meaning that basically the center network had by then assumed an inverted U shape, with both the largest and smallest centers somewhat smaller than expected and a midfield with larger centers.

5.7.2. The cluster level: the suburban impact

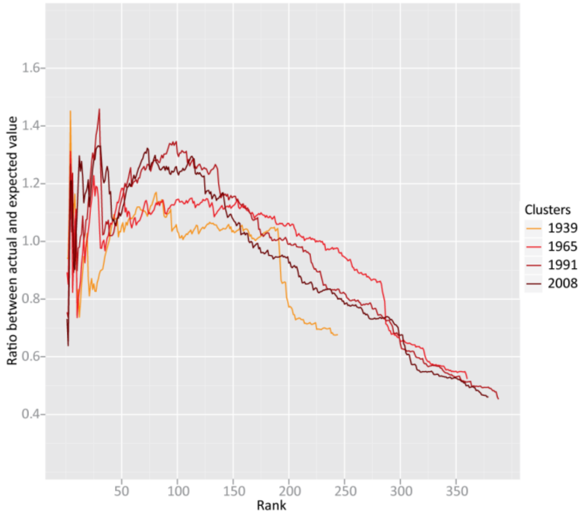


Chart 5-37: Clusters rank-size distribution compared to Zipf's law expected value, for selected years

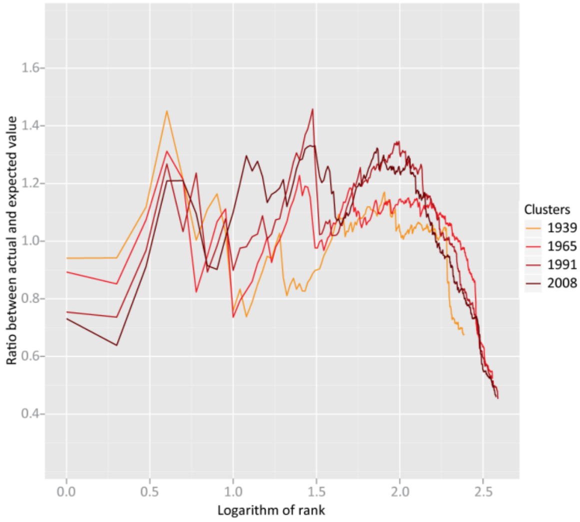


Chart 5-38: Logarithmic clusters rank-size distribution compared to Zipf's law expected value, for selected years

The cluster level allows us to group suburban units that are connected into single units; changes between the curve allures between unit and cluster levels brief us about the behavior of suburban space, which is the main interest of studying it (*Charts 5-37 & 5-38*).

As it unfolds, the study of the curves at the cluster level shows a significant departure from those studied at the unit level between the 10th and the 40th ranks, where a strong divergence appeared in 1991 and was confirmed, albeit more spread out, by 2008. It points out to the fact that the numerous units which make up the bump at lower ranks at the unit scale are indeed combining to create a bump higher up when looking at the cluster levels. In plain language, this means that the bump seen in units by 2008 is indeed due to the inflorescence of plenty of suburban centers, many of which can be then grouped in larger clusters. Those clusters are the ones which create the imbalance seen higher up the hierarchy at the cluster level.

This is further confirmed by the fact that the formation of those clusters depleted the lower levels of the hierarchy, which is plainly seen for both the 1991 and the 2008 curves as compared to the 1965 one from about the 100th rank down, and also for the 2008 curve as compared to the 1991 one. Thus, it appears that the general departures from the ideal Zipf-like rank-size distribution seems top be due largely to the development of suburban centers and clusters. In short, the emergence of edge cities signaled the demise of the Christallerian network.

5.7.3. The supercluster level: the establishment of the metropolis

The idea behind studying superclusters is to test the robustness of the Christallerian theory under the assumption that an urban center and its suburban surroundings can be conceived as a single entity in terms of centrality, and that it may be that under this assumption the traditional structure of the center network holds (*Charts 5-39 & 5-40*).

In fact, the conclusions we can reach by looking at the evolution of the rank-size curve for four points in time are twofold. The first is that, to the contrary of what's happening at the unit and cluster levels, the big five centers continuously reinforced their position, a position that has always be above expectations, even for the first center of all. This means that if the urban centers

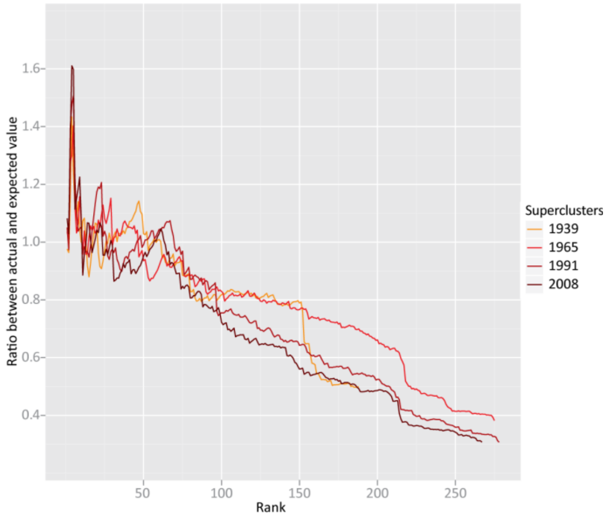


Chart 5-39: *Superclusters rank-size distribution compared to Zipf's law expected value, for selected years*

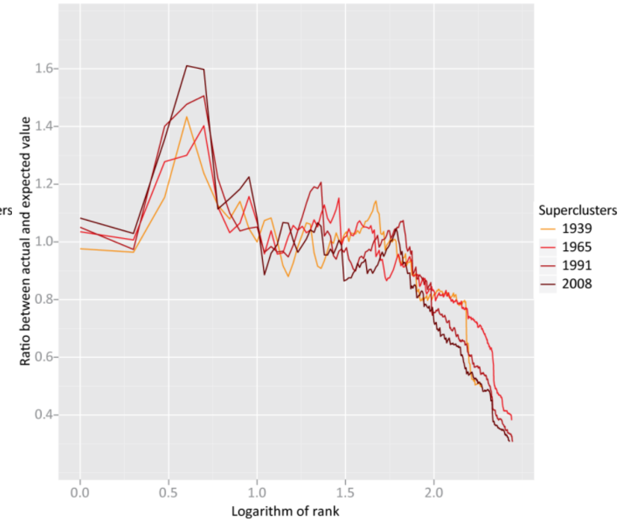


Chart 5-40: *Logarithmic superclusters rank-size distribution compared to Zipf's law expected value, for selected years*

of the five biggest agglomerations of the country did lose some importance, when considering the agglomerations as a whole, they actually reinforced: what they lost in urban central space, they more than gained in their suburban belts.

The second fact which stands out of the graphs is that the depletion of smaller units is far clearer at the supercluster level than at the unit or cluster ones, meaning that the relative resilience noted at those levels was at least largely due to suburban units which are grouped with their urban parents at the supercluster level. At this level there has always be a relative paucity of suitable centers, already in 1939, and the slope of the curve has never been flat or positive, which signals that at the supercluster level there was already a systematic tendency for smaller centers to be smaller than expected in a Christallerian network; however this tendency reinforced strongly, especially between 1965 and 1991, which is the age of advent, at a massive scale, of suburban centers in the center network of the country.

5.7.4. Rank-size evolution conclusions: a sea change, revealed

When compared with the evolutions at the unit and cluster levels, the study of the rank-size relationship evolution with time at the supercluster level allows us to reconstruct the theoretical evolution of the network. First of all, all things considered the network has always been somewhat top-heavy: its greater centers were and still are larger than what the Christallerian theory would postulate, while its smaller centers are smaller than expected. Secondly, at the supercluster level, this tendency has been reinforced with time, with the apex of this reinforcement happening between 1965 and 1991. We are strongly inclined to consider this change as a sign of ongoing metropolitan processes, which favored larger center over smaller ones by the "tunnel effect" of the automobile which suddenly allowed people to move at their convenience farther away than before, and thus placed larger centers closer, in a far more accessible position. This goes a long way to illustrate the rising prominence of larger and larger centers at the regional level, creating what we understand as metropolitan space.

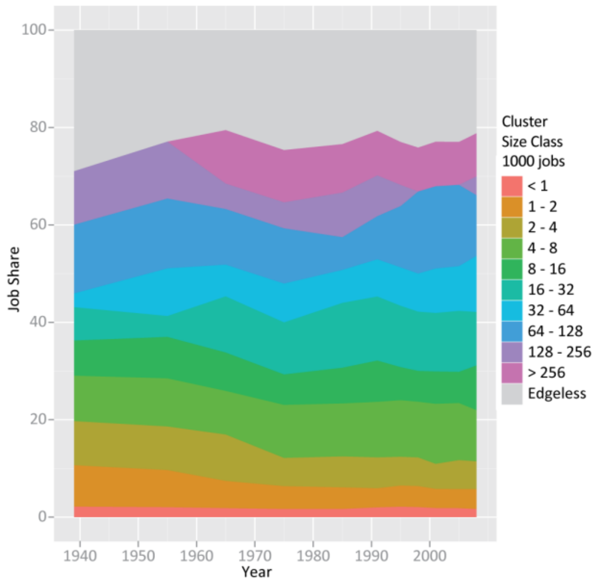


Chart 5-41: Job share by cluster size class, 1939-2008

Some further confirmation is found when looking at the evolution of the job share distribution by size classes at the cluster level (*Chart 5-41*). The same three classes noted at the unit levels are found, with smaller centers losing job share, midsized centers gaining some, and largest centers staying more or less put. What changes with the passage at the cluster level is the levels at which the transitions between the classes occur. Once suburban centers grouped as clusters when advisable, the impact is that all centers under 16’000 jobs have seen their job share fall with time, which was compounded by the fact that the midsized classes, now restricted to the 16’000 to 64’000 jobs bracket, grew more strongly than when counting the unit. This implies that the 8’000 to 16’000 job class was holding its own at the unit level only thanks to the presence of numerous suburban units which can then be grouped in larger clusters, which in turn boost the 16’000 to 64’000 jobs bracket – indeed there are numerous suburban clusters of these sizes. Furthermore, we can see that the 64’000 to 128’000 job class also boomed, thanks to the integration of the Glattal, the largest edge-city complex of the country with close to 100’000 jobs in 2008, more than Lausanne.

At the local level a strong territorial specialization took place at the same time, for the same reasons, that is it was becoming easier to live removed from the work place while still being able to commute to it; likewise it became also easier to remove people from the urban centers while still keeping the jobs there and getting them filled. The spatial specialization of the country at the agglomeration level also allowed the formation of suburban centers, which are accessible primarily by car and functioning along the same logic of easier commuting and taking advantage of the ample space they can provide as compared to urban centers. Thus, there was indeed a double move of concentration and dispersal: at the regional level the economy concentrated on larger centers to the detriment of smaller ones, which stagnated, declined or disappeared from the network. However, at the local level this concentration move was counterbalanced by a dispersal move which saw suburban belts take away many of the functions of the urban centers.

5.8. Spatial patterns

Lastly before concluding this empirical chapter, we return to have a look at the maps to search for territorial implications and developments in the long run. For the reasons already mentioned we will look at the maps in four points in time to search for long-term deep trends in the way the Swiss territory changed during the 1939 to 2008 time span, with 1965 and 1991 chosen as byways.

5.8.1. The network seen at the national scale: a general growth spillover effect

When looking at the long term trends of the general geographical structure of the center network, basically the movements are as follow. First, at the heart of the system, the greater centers have lived a double move, first of sheer growth up to 1965, then of growth by spillover on their suburbs, seen in 1991 and 2008. In the big five, central growth stopped essentially after 1985, while for many midsized towns and centers, some growth persisted up until 1991, albeit at a far smaller rate than during the two decades following WWII. Essentially, though, all urban growth had ceased by 1991 and most of the subsequent growth had to take part elsewhere.

Suburban centers went from practically inexistent in 1939 to clearly noticeable in 1965, although they really burst into view in the next period, with a massive rise, most notably around the largest centers of the country. This growth continued afterwards, but at a reduced rate, a taming especially noticeable around the biggest, most developed centers. Further away, or around less-developed urban centers – Berne comes to mind – the growth remained rather healthy, which seems to show a general spillover effect in the territorial growth pattern of the suburban centers: first they developed close to the largest, economically most significant centers of the country, and then, with a time lag, they spilled over to other parts of the country, most notably towards lesser centers suburban belts, and in outer metropolitan space. Such effects are particularly visible in the Aare Valley, and in the greater Zurich metropolitan region, but they are widespread.

Most close peripheries of Switzerland pertained to the histories we just delved upon. In two regions, though, evolution was different. In the Alps, first, two periods are to be distinguished. The first runs from 1939 to 1991 and was a period of very dynamic and relentless growth in these parts, which were then lifted from poverty and economic retardation. From 1991 on, however, a reverse movement is discernable, with the abetting of the main center growth – Sion, Chur, and more importantly with the disappearance from the network of numerous local centers. Thus, from an central network point of view, the Alps, which had integrated themselves into the network prior to 1991, seem at risk of being stalled again from the rest of the country.

In all, there is a distinct general spillover effect, starting with the development of the urban centers, then of their suburban belts, then of their metropolitan spaces, as growth abates in regions where it had previously dominated – a real ripple and spillover effect originating in the largest centers of the country.

A history of the development of the urban network would then list as follows: it started after WWII by an all-out growth benefiting above all the urban network and the peripheries, and which lasted to 1965. Then, up to 1991, growth abetted in urban centers and transferred to suburban belts, which experienced explosive suburban development. Afterwards growth diffused largely as a spill in whole metropolitan spaces whereas urban centers more or less stabilized, and peripheries returned to peripheral status.

5.8.2. Differences according to agglomeration size: the industrial retreat

In terms of long term trends in the evolution of the economic orientation of the center network's units, on can find great similarities with the trends which we already mentioned. Apparently, the local to suburban to metropolitan logic we described in the previous section. In 1939, most of the urban network was dominated by industry, save the largest centers which were already commanding the economy and thus dominated by the services, and the occasional administrative or touristic center. By 1965, the pattern had not evolved much as everything grew. However, a first change was seen with the advent of relatively large suburban centers, most of them heavily oriented towards industry, which illustrated a first phase of exfiltration of the industry towards peripheral locations – in 1965, those were the suburban belts and their newly created industrial zones.

By 1991, a sea-change had occurred, as most of the urban network had turned away from industry towards services, while massive edge cities had developed around the cities. Many of those had already turned their backs to industry and were now dominated by service activities – this was particularly true outside the traditional industrial regions of the country. In industrial regions of the country some industrial edge cities remained, although the closest and biggest ones had already turned towards services. Industry could also maintain itself in some select industrial regions of the country – for instance in non-central Ticino, extensive parts of Eastern Switzerland, some parts of Aargau and Solothurn, and in the Jura Mountains. By 2008, the suburban industrial centers were mostly gone, transmuted into service-oriented centers, and generally the patches seen in 1991 in metropolitan space were fading away, like in Aargau, the greater Zurich area and in Ticino. However, the holdouts situated outside metropolitan space had more or less held, especially in Eastern Switzerland and particularly in the Jura Mountains where industry managed to stage a comeback.

The history of the Swiss transition from an industry-based economy towards a service-oriented one is thus as follows, in terms of territorial implications. Up to 1965 territorial moves were rather subtle, except that the biggest centers were turning more and more service-oriented, while their industries tended to locate in newly-formed suburban industrial zones. The two and a half decades which followed saw a near complete disappearance of industry as a dominant form of activity in Switzerland, as it maintained itself only in several select edge cities, most of which had turned towards services by then, and in some traditional industrial regions. 1991 was a transitional time, though, towards a more logical territorial implantation. By 2008, industry as a dominant form of activity had largely deserted metropolitan space, while it had reinforced in select industrial areas, such as Eastern Switzerland, especially along the Rhine and the Thur valleys, and most notably in the Jura Mountains. Thus, it can be said that if industry retreated into outlying redoubts and holdouts, by 2008 it seemed to further its implantation there quite well, as the return of La Chaux-de-Fonds or Arbon towards industrial dominance seems to confirm.

5.8.3. Regional patterns: the ebb and flow of Switzerland's regions

As we have already surmised, most of the changes pertaining to the regional scale were linked one way or another to the global metropolitan processes which were experienced by Switzerland during our period of study. However, it remains that different regions underwent different histories, whether linked to metropolitan processes or not. It is interesting to review those regions and to look at their specific evolution.

5.8.3.1. Zurich and Aargau-Solothurn

The most central regions of all are situated in the lower Aare Valley and in the Zurich area. By 1939, this region sported the greatest density of centers of all sizes, especially of middle-sized and small ones. The whole region grew relentlessly during the 1939-1965 interval, in the wake of Zurich which showed the most growth, but with a series of midsized centers which boomed during these times, like Aarau, Baden, Winterthur, and the revelation of a great number of lesser centers – Lenzburg, Brugg, Wohlen, Wetzikon ZH… – throughout the area. The 1965-1991 period was marked by the explosive growth of the Zurich suburban belt with massive edge cities revealed in the Limmattal and Glattal, and by the boom experienced in farther-out areas like Upper Lake Zurich or the Gäu areas. The last period, up to 2008, was one of stabilization, as most of what could grow had already done so; growth subsided a bit, even in the edge cities complexes of western and northern Zurich. However, while not progressing at the same pace than before, the region didn't lose anything of its strength, and by the time it clearly constituted the core of metropolitan Switzerland, extending its influence further afield, notably in central Switzerland.

5.8.3.2. Eastern Switzerland

The structure of Eastern Switzerland in 1939 was indeed very close to that of Zurich and the lower Aare Valley, but its subsequent development was not. Up to 1965, Eastern Switzerland's growth was less than in Zurich, and furthermore it was rather patchy: relatively strong along the Rhine and Lake Constance, from Buchs to Schaffhausen, but rather inexistent in inner areas like Toggenburg or the Thur valley and lands. This difference in evolution was furthered up to 1991, as Eastern Switzerland saw very weak growth during the 1965-1991 period, and saw essentially no development of suburban centers – a very distinct propriety of the area. The last period under review was a copycat of the preceding one, with surprisingly few moves happening, as if Eastern Switzerland was a bit frozen out of time, keeping an urban structure quite peculiar for such a lowland region, so close to Zurich and its dynamics, and yet practically untouched by it. In particular, Eastern Switzerland showed no sign of undergoing metropolitan processes.

5.8.3.3. Basle

The Basle basin looked also very similar to the central regions – Aargau and Zurich – in 1939, and at first it looked like it was following the same evolutions, at least till 1965. However, the Basle region growth seemed already a bit muted then, and this certainly was confirmed afterwards, as the 1965 to 1991 period showed distinctly less growth in the Basle region than in neighboring Aargau and Zurich, most notably on the suburban center side: the Basel edge cities had grown first, and were already powerful by 1965, but they couldn't confirm afterwards and were largely overtaken by the Zurich edge cities. Likewise, the whole region looked amorphous in the period following 1991. In all, the evolution of Basle and its region showed two phases: a strong growth up until 1965, and atonement afterwards. To the contrary of Eastern Switzerland, Basle did metropolize. It did show the signs, notably the development of massive edge cities – in that respect it even metropolized before Zurich, as its edge cities developed on an industrial prior to the boom of Zurich ones. But it saw its growth interrupted as the economy turned towards services, as if the sheer domination of the pharmaceutical industry had neutralized the ability of the local economy to flourish in other sectors. In all, since 1965 the Basle region, albeit a metropolitan one, has taken the back seat.

5.8.3.4. Central Switzerland

The trajectory of Central Switzerland is very different. In 1939 a rural and economically backwards region, it counted only two meaningful centers, Lucerne and Zug, accompanied by a smattering of small local centers. As most rural regions of the country it grew clearly above average during the 1939-1965 period, such as making up for a great part of its lost ground on the central regions. After 1965, Central Switzerland followed the steps of nearby Zurich, with enhanced and general growth, a successful transition towards the service economy, the advent of massive edge cities. Furthermore, since 1991, as the metropolitan wave originating in Zurich hit the region in full, Central Switzerland continued to grow healthily, and to display more and more metropolitan traits – in 2008, the whole Zug-Lucerne corridor is an edge city ribbon, and the Ausserschwyz region exhibits about the same characteristics. In a way, Central Switzerland is an image in negative of the Basle region evolution.

5.8.3.5. The Jura arc

The last industrial region of the country straddles the Jura Mountains and part of the Aare Valley, between Biel and Solothurn. In 1939, this region was comparable to Eastern Switzerland, concentrating its considerable economic weight in a rather dense network of industrial cities and towns. In terms of orientation this was the most industry-dominated area of all, and up to 1965 none of its centers was oriented towards service activities. At first, its industrial orientation benefited the region, and its main centers – Biel, Neuchâtel, La Chaux-de-Fonds, Solothurn and Grenchen - grew strongly up until 1965. What came afterwards, though, is that the region was very hard hit by the economic crises that befell on Switzerland in the 1970s and the 1980s, as it was also by the transition towards a post-industrial economy. Between 1965 and 1991, the area as a whole, and in particular its major cities, actually shrank, and there was no sign of metropolitan processes at play. Likewise after 1991, when the deindustrialization processes actually reversed, still leaving the region with no significant growth but with a reinforced industrial presence. In that sense, the evolution of the Jura arc is really peculiar, unique in Switzerland, one of the last redoubts of industry, certainly the largest, but at the expense of the region's prosperity and prospects.

5.8.3.6. Berne

The Upper Aare Valley, covering the german-speaking part of the Western Mittelland, looked in 1939 like a protestant version of Central Switzerland, a region largely dominated by its rural function, a big center – Berne – devolved to administration, both of the confederation and the then biggest canton of the country, and a sprinkling of small-scale centers. The trajectory of this region is rather original. Its growth during the 1939 to 1965 period was one of the least impressive of all, and unlike other regions which shared this atonement, its center network wasn't developed at the time. Furthermore, it continued to grow at a slow pace during the period leading to 1991, Berne being then at the time the only major center of the country without a family of massive edge cities, despite having all the characteristics to get them – a nationally central position, and a fully developed highway network. However, the Berne region finally showed distinct metropolitan traits in the period that followed, with a late but explosive growth of its suburban centers. This trend affected only the Berne agglomeration and there were no spillover effects of any kind seen on the other centers of the region, like Thun, Burgdorf and Lyss. It is as if Berne would finally metropolize, but without a metropolitan region to speak of. In all, Berne showed about the same tendencies than other rural regions close to a major center, but with a major time lag of about a generation. In effect, Berne seems to be in 2008 where Lausanne was in 1991.

5.8.3.7. The Lake Geneva area

The larger Lake Geneva region, here encompassing the Geneva, Vaud and Fribourg cantons, shared many characteristics with the Bern region and Central Switzerland in 1939, i.e. it was then poorly industrialized, clearly dominated by a duopoly of rural activities in Vaud and Fribourg and sevices-oriented administrative centers – Fribourg, Lausanne and above all Geneva. Its central network was quite weak compared to those of the Zurich and Aargau regions, indeed also with all the industrial regions of the country. However, the region has known since 1939 major changes very much like those which marked Central Switzerland, based on the growth and economic weight of its two main centers of Geneva and Lausanne. By 1965, those two centers had grown relentlessly and had started to display typical metropolitan traits by developing large suburban centers. In the hinterland, growth was also significant with many smaller centers appearing in the network. The 1965 to 1991 period furthered those trends with a massive development of edge cities around Lausanne and Geneva and a spillover effect clearly seen in Fribourg, which at the time also showed a strong development of its suburban centers. The trend continued up to 2008, this time with a clear spillover effect seen around the whole Lake Geneva region pertaining to the sudden development of relay positions between Geneva and Lausanne, but also in the hinterland north and northeast of Lasuanne. By 2008, this former Swiss breadbasket and cellar had become the second metropolitan region of the country, behind the larger Zurich area, but clearly ahead of Basle and Berne.

5.8.3.8. The Alps

In 1939, the alpine regions were probably the least developed and poorest of all in the country, with a virtually non-existent central network and an economy based on subsistence agriculture and a sprinkling of small industrial centers. However, the alpine arc gained strategic importance during and after WWII and subsequently was at the receiving end of both political and economical attention of the rest of the country, benefiting of major infrastructure projects at the time its hydroelectric potential was tapped. The result was a general and explosive growth, with Sion and Chur becoming the first major dynamical centers of the country and the arc gaining at last a sizeable central network. The period leading to 1991 saw a furthering of those trends, with the continued growth of the major centers of the arc. However in Graubunden most of the growth was now concentrated on Chur, the rest of the canton receding a bit behind, a case not encountered in Valais where the whole urban string from Lake Geneva to the Simplon Pass grew strongly. The real turning point happened in 1991, with the progressive disengagement of the federal state from the region following the end of the cold war. The Alps receded as a whole in the years following 1991, falling again behind the rest of the country after 50 golden years. The future of the region is indeed problematic as its economy sputters out of sight of the metropolitan regions. Its structural problems – remoteness, difficulty of transportation, lack of workforce and mounting environmental concerns – remain and could even aggravate with global warming and the negative impact it could have on this sensible region.

5.8.3.9. Ticino

Last but not least, Ticino was in 1939 like the Alps: far removed from the main centers of the country, poor and underdeveloped. And at the beginning of the period under review it indeed behaved in fashion, experiencing massive growth of its center network. Then the paths diverged, as Lugano showed already in 1965, with massive city growth and already some spillover onto its burgeoning suburban belt. The suburban development generalized towards 1991 and furthered by 2008, which is a distinct feature of Ticino as compared to the rest of the alpine arc. Indeed, the urban form which developed in Ticino was distinctly metropolitan an its current structure shows large similarities with Aargau and Central Switzerland, with middle-sized centers adorned by massive – at least in relative terms – edge cities, found around all four meaningful centers of the region, and particularly west of Lugano and between Mendrisio and Chiasso in the extreme south of the country.

5.8.4. Mapping clusters and superclusters: edge cities and metropolises, again

5.8.4.1. At the cluster level: the generalization of suburban centers

Looking at the cluster maps at the same points in time than in the preceding section (*Maps 4-1, 4-10, 4-22 & 4-34*) allows us to follow specifically the evolution of essentially the suburban and exurban clusters, as for the rest the same conclusions would be made.

The first remark to be made is that at the cluster level is that in 1939 suburban centers were very few and very small, but by 1965 they had already appeared on the map. Most of the most massive complexes which exist in 2008 were already well developed in 1965. Two geographical patterns emerged as early as 1965. The first is that big cities were needed to spawn big suburban clusters; there was no big cluster located elsewhere than in the vicinity of a major center. Secondly, there was a clear preference for central industrial regions, which concentrate most of the suburban clusters. As we have said, 1991 was the age of edge cities, and correspondingly suburban clusters progressed massively throughout the country. More interestingly, they started to disseminate further away from their origins in the outskirts of major center – to this point, the emergence of a massive unit west of Zug, and the inflorescence of several clusters around Lugano: in those places, metropolitan processes were enough to generate impressive units around relatively modest parent urban centers. This is further confirmed in Aargau where several former exurban clusters began a new life as suburban ones.

By 2008, the overall growth had somewhat abated, but in several places it went on at the suburban level, most notably in the greater Lake Geneva area, where suburban clusters progressed notably around Geneva, Lausanne and Fribourg. In the greater Zurich area the growth was more muted, except in select places, the most spectacular of which is the Cham cluster west of Zug, the only suburban cluster of the country to be larger than its parent city. In all, the last period seem to indicate a generalization of job suburbanization processes out of the industrial heartland, as in most former rural areas of the country the progression of suburban clusters was the most spectacular. That being said, in the industrial heartland the transmutation of ancient exurban centers into edge cities continued – by 2008, there were no less than eight distinct suburban clusters in Aargau alone. The same phenomenon is seen in the Upper Lake Zurich area, along with the emergence of new urban centers, like Freienbach.

At the urban level, lastly, the passage at the cluster level showed the very strong emergence of Oensingen, and with it the Gäu complex. Inexistent in 1939, when it was a suburb of Balsthal and its metallurgy, the Oensingen cluster had become in 2008 one of the largest centers in the Berne-Basle-Zurich triangle, at parity with Aarau and Olten. Other cities have emerged, albeit less spectacularly, as Mendrisio which supplanted Chiasso as southern Ticino main center, Freienbach in Ausserschwyz already mentioned, Gossau, the closest unit Eastern Switzerland has to a massive edge city, or Nyon, with Gossau the biggest mixed center of the country.

5.8.4.2. At the supercluster level: regional and structural evolutions

There are rather few things that a look at the supercluster level reveals which have not been noted thus far (*Maps 4-3, 4-11, 4-23 & 4-35*). Finds are of two types.

Firstly, the evolution at the supercluster level shows again the very strong differences in structure and evolution by the different regions of the country. Most of the industrial regions, for instance, have had and still have a dense network of superclusters, north of a line running from the Jura piedmont to the Rheintal through the Aargau-Lucerne border, south of this line the supercluster network was, and still is notably scarcer. At the supercluster level, the old division between industrial northern Switzerland and rural southern Switzerland is still present.

In terms of dynamics, differences were also striking. In the southern half of the country, the superclusters routinely tripled their size – the cases in point being Central Switzerland, Ticino, the Alpine arc, all regions clearly lacking a strong network in 1939 and gaining one afterwards. Worthy of note is the fact that in the Alps and Ticino the progression happened above all early in our time span, whereas it was continue in Central Switzerland. Elsewhere in formerly rural Switzerland, the progression was less spectacular but still strong, as for instance in the Lake Geneva Region, where it concerned above all the biggest centers, leaving a still depleted hinterland. In that region, the lack of medium-sized superclusters is striking, unique in the country. In the Berne area, the center is accompanied by Fribourg and Thun, but there is nothing of the sort further west: the Lake Geneva is a duopoly of two cities.

This probably marks the biggest difference between the Lake Geneva metropolis and the Zurich one. In Zurich, the admittedly bigger center is accompanied by numerous important relays: Winterthur, Baden, and in a way now Zug, and a smattering of lesser level superclusters – Thalwil, Bülach, Wetzikon. The same can be seen of course in Aargau, and up to a point in the whole northern part of the country, with the exception of the Basle region where the center completely annihilates its hinterland – in this it looks distinctly like Lansanne and Geneva, only more so, with only Liestal playing the role of a very distant second to Basle.

Admittedly, supercluster growth in this part of the country, as a whole, was less impressive than in the former rural regions, with most of the superclusters doubled or less – an effect also of its earlier development and its far greater density. Inside the northern, dense, industrial part of the country, trajectories were also quite different between the center, i.e. the Zurich-Aargau, which progressed as a metropolitan region and thus showed general doublings of supercluster sizes, notably in Baden, Aarau, Olten and Zofingen. No such progressions were made in Eastern Switzerland, which grew quite modestly up to 1991, and not at all since then, except maybe in its western fringes with Frauenfeld and Wil, the closest to the Zurich metropolis. The evolution of the Jura arc is even worse, since it attained its optimum in 1965; by 2008, most of its centers were still catching up to the size and significance they had then, with the lone exception of Delémont, which had become cantonal center since.

One permanent feature of the supercluster level at the national level is that with time, the largest superclusters slowly enhanced their dominance on the whole of the network, notably by the fact that the smallest superclusters hardly progressed, if at all, during the period under review, leaving most of the growth to larger ones. Of course some superclusters experienced exponential growth, the case in point being Zug, but in any given area for one such emergence there was at least two other units showing less than average growth, so that, as a whole, the largest centers ended up dominating more and more the landscape.

5.8.5. Territorial conclusions: towards a metropolitan Switzerland

The review of the maps to search for longer term trends revealed four distinct territorial findings.

First of all, the sudden growth that Switzerland experienced after WWII had a very distinct spatial pattern. It originated squarely in urban centers, and especially in the largest ones. At first, mostly urban centers were concerned but as growth progressed, a spillover effect was noted towards the suburban belts of the growing centers, which developed spectacular edge cities during the period under review. A second spillover effect was then noted towards 2008 which concerned above all the larger influence zones of the burgeoning metropolises, which by the end of the period under review saw all their centers lifted up by the dynamics induced by their metropolitan cores. This growth pattern, while widespread, hasn't attained all areas as of 2008, though, so there is first still space for spillovers to spread further – whether this happened or not is left to be seen, but there are signs that metropolitan spaces are still extending in new areas – for instance the outermost areas of the Lake Geneva region like the Broye Valley, or the westernmost fringe of Eastern Switzerland.

A very spectacular functional redistribution has taken place since WWII, with a double phenomenon of transition from an industrial economy to a service-oriented one, which implied a strong spatial redistribution of functions. At first industry dominated thoroughly the economic landscape and the center network, with only the biggest cities with a service-dominated economy. However, as time went by, services started to develop more and more, even if by 1965 territorial changes had remained subtle, noticeable only in the major agglomeration with the apparition of massive industrial edge cities which signaled that industry was leaving urban space for suburbia. The epochal change occurred just afterwards with a massive transfer of centers from industrial to service-activities during the 1970s and the 1980s, and the concomitant tertiarization of most of the biggest edge-cities. By 1991, industry had vacated the central cities and was in the process of leaving also the metropolitan areas. By 2008, this process was nearly complete; however industry had regained importance in the areas it had retreated to, as to herald its new territorial role. As services could only dominate, in 1939, in the largest cities, industry has retreated to outlying areas where it can still assert, even reinforce, its domination.

One of the finds made here was the fact that at the supercluster level and despite all the changes which went under way during our period of study, perennial structures inherited from the 19th century have survived. Namely, the density of centers, regardless of their dynamics, is still clearly higher in the great industrial regions of the past: the Jura arc, the Aare Valley, the greater Zurich area and Eastern Switzerland. In all the other regions, at the supercluster level centers, while often more dynamic and larger, are clearly scarcer. This is valid for all territories south of a Yverdon – Biel – Langenthal – Wohlen - Freienbach – Sargans line, which include the Lake Geneva region, the Berne area, Central Switzerland, the alpine arc and Ticino. Thus, a very old spatial division between the northern part of the country, which industrialized early on, and the southern half which essentially never did, remains up to now in the form of the urban superstructure.

Finally, it has to be noted that with time a subtle but very real evolution happened in terms of relative size between superclusters throughout the country. In all, the largest units grew slightly faster than small ones, so that after almost 70 years their share was distinctly larger than the share of smaller centers: in time we had witnessed the passage of a dense and very structured network of centers to a network clearly dominated by fewer but eminently larger centers. In short, a transition from a Christallerian structure to a metropolitan one. At the local scale, this evolution started out in urban centers but for the major part of the period, what allowed the metropolitan centers to progress globally was the development of massive edge cities, which more than compensated the job losses endured by the urban centers since about the 1970s.

We therefore think that there is a very strong link between the metropolitan processes and the rise of suburban centers.

5.9. A discussion

5.9.1. Central forms

5.9.1.1. Cities: a graceful and subtle decline

At the beginning of the period under review, the classical Christallerian network of cities dominated the urban landscape of Switzerland, and a study of edgeless space would show that the Christallerian structure was replicated at lower levels. At the time it seems that a large portion of Switzerland would indeed function in a Christallerian way, with a well established hierarchy of centers dominating the urban landscape. At this time, cities accounted for close to a million jobs, most of which were occupied by urban residents. Classical cities at the time weren't very intense, although they were very dense. 1939 was a time where the urban system wasn't functioning as today: commuting wasn't widespread and thus the active population tended to live where it worked, or vice versa. Thus, job intensity wasn't very relevant as an index of urbanity, while job density was: at a time where daily movement was more difficult there was more incentive to build in a dense manner as to avoid unnecessary trips. Thus, Switzerland in 1939 looks very much like the Southern Germany in which Christaller wrote: an urban network composed of dense units which housed most, if not all, of its workforce, surrounded by rural villages.

At first sight 1955 wasn't very different from 1939. After the freeze due to WWII though, Switzerland experienced a period of relentless economic growth, of which the cities took the major part. The cities job numbers jumped, and represented 70% of all jobs created during this time. Accordingly, their job share rose to an historic level. At the same time, other trends started to manifest themselves. Firstly, job intensity started to rise, which resulted in a massive rise of the job-active imbalance, which more than doubles: classical cities were starting to specialize as job centers, and by 1955 one in six of its jobs were held by suburbanites.

In that respect, 1965 proved a turning point. Cities continued to grow strongly,; however, they lost some units and for the first time the part of new jobs apportioned to classical urban centers was less than their job share – in fact more jobs were created outside the classical network than inside. As a consequence, the cities job share dipped. Meanwhile, the cities continued to specialize into job centers, their intensity rising, and the job imbalance grew to new heights. Even if in relative terms cities were starting to lose ground, in absolute terms their impact on surrounding regions was actually growing at a very fast rate. In fact, every second job being created in cities went to an active that was residing outside it. It is difficult to know if residents were being pushed out of cities or if they jumped on the occasion to live in the countryside as soon as they could, but whatever the cause, residential suburbanization was in full swing and that the relations between job-specialized centers and residential suburbs were fast changing in nature.

While the 1965 turning point was rather muted, there was nothing subtle about the 1975 census results. They showed that the recession had hit the classical network very hard: it lost a quarter of its members. Correspondingly, the cities job share dropped. Meanwhile, amidst those strong losses the units that remained in the network continued to specialize, albeit at a reduced rate. The significance of the 1973 oil shock is that it furthered and greatly accelerated processes that were already seen in 1965. The processes that were already active since 1965 were in full swing by 1975. From this point of view, 1965 was the real turning point, the summit of the classical urban network.

From 1975 to 1991, a quadruple movement was at play. First, the job share losses initiated since 1965 went on, at a slow but steady rate and by 1991, the classical cities job share had passed under 50%. However, the loss was only relative. During the same time though, the job intensity jumped from 131 jobs per 100 active residents to more than 150. Likewise, the job imbalance also grew steadily during the late 1970s and the 1980s. Last, the classical Christallerian network regained some of the units it had lost in the 1970s. In all, the 1975-1991 period was fairly positive for the urban network, which saw its structures grow, intensify, specialize and add numbers. Weren't it for the nagging fact that despite all these positive points, its job share was nevertheless decreasing, we could have concluded that the 1975-1991 period was actually a period of great development of the classical network. The fact is, though, that its job share was sliding down, which could indicate either a structural weakness of the classical city network, the emergence of a competing network, or both, or the sign of another phenomenon altogether. As it is, we would strongly agree with the second and fourth explanations, as we will see afterwards.

The 1991 crisis marked a second phase in the post-summit evolution of the classical urban network. From 1991 onwards, the network's job share continued to decline. Furthermore, this relative decline was now marked by a very steep absolute loss of jobs, up to 2001: thus a long term trend, of absolute job decline in the classical urban network, established itself during the 1990s. During the same period cities not only lost jobs: they also lost a lot of active residents, such as despite this massive loss of jobs its job intensity managed to maintain itself. Thus, the classical urban network did not dilute during the crisis as much as it shrank.

But perhaps the greatest change the network experienced from 1991 on is the decline in cities numbers, in a very regular fashion. The classical urban network lost a third of its members from 1991 on, a figure far larger than the decline noted in other measures. It can be hypothesized that this prolonged and remarkable drop in cities numbers is the result of profound changes in the way the urban network is organized, corresponding to a general decline of the classical Christallerian network, the destruction of its lower levels and the incorporation of its remaining parts into new, bigger, far-reaching metropolitan areas, in which major and regional units of the former classical network insert as pivotal points while lesser units just lose their local central functions and get engulfed in metropolitan edgeless space. Certainly, our data shows a long term decline of the classical urban network, which, from 1965 on, lost one third of its job share, and which lost massively in absolute numbers since the early 1990s. Certainly, the fact that the classical network lost so many units while losing so much less substance indicates that mostly lower level units were lost while the upper part of the urban hierarchy remained. What it means is that mostly local centers lost their characteristics and reverted to insignificance, at least as job places but probably also as commercial centers. That also means that areas formerly served by those local centers didn't need them anymore and that probably they were now polarized at greater distances, by greater centers – or other urban forms. All those scenarios indicate a radical departure from the classical Christallerian world. As of 2005, the classical urban network had departed a long way from the Christallerian model and seems to mimic metropolitan assemblages seen elsewhere.

5.9.1.2. Industrial villages and towns: remnants from another age, eroded to oblivion

As we have said before, most of the urban network in 1939 was constituted by a fairly well developed Christallerian urban network. As Christaller himself recognized, his model was service-based and would not apply to industrial localization, which are determined by other factors than centrality – namely access to raw materials, power, work force and markets. In industrial countries, especially those benefiting from coal or ore resources, the industrial localization logics meant a superposition of industrial complexes on the classical Christallerian network. In Switzerland, devoid of mining resources, industrialization took hold especially in areas with abundant workforce, good railway accessibility, and accessibility to hydraulic power. Switzerland grew a very systematic railway network which meant that there were many places that would be suitable for industrial implantation and indeed, a first generation of non-Christallerian urban centers emerged during the late 19th century. By 1905, date of the first business census conducted in Switzerland, industrial villages, towns, burghs and cities were already well established in the urban landscape. Most of them were small enough not to be understood as bona fide members of the urban network, although some of them, like La Chaux-de-Fonds, or Olten, had grown to be considered major cities on their own. Here we will be interested only in those members of the urban network that weren't considered classical urban centers: the industrial villages and towns.

Even if the depression had probably wiped out a certain number of such industrial centers, the fact is that in 1939 they still played a sizeable role in the urban network. Industrial remnants were a small but substantial part of the urban network, its second component by importance behind bona fide cities. As units, they were relatively dense, and very intense for their time.

During the early second half of the 20th century, this class of objects was swept up by the relentless growth of the whole urban network, indeed of the whole country. However, their structure had changed sharply, with a strong decrease in job density and a parallel, albeit less marked, decrease in job intensity. While their absolute numbers looked good, in fact their internal structure told of a decaying situation, pointing to a degrading position on the job center market. More and more industrial towns were getting low-skill, low-wage, low-employment tasks that demanded space: hence the precipitous drop in density. They were also losing their edge as local polarizing center, attracting less and less workers from the outside, hence the drop in intensity. By looking at the figures though, everything looked bad for the exurban remnants even before 1975.

The 1973 economic crisis blew a very heavy blow to exurban remnants, which lost around two thirds of their numbers and jobs between 1965 and 1975, while their job share plunged to insignificance. They revived somewhat between 1975 and 1991, gaining a certain number of units and jobs, staying however very far from their 1965 optimum, and without strengthening any of its structures; exurban remnants were again brought forward by the general wave of job growth. Then the 1990s crisis essentially killed off whatever had subsisted thus far. In terms of significance, the exurban remnants show a long decline, which probably started during the 1930s and the depression, which touched first the structural integrity of these centers between 1945 and 1970, then their existence. Exurban remnants were exactly that: remnants that were left in the network, a large number of them succumbing to each economic crisis, until all had disappeared.

5.9.1.3. Ancient suburban centers: a peculiar lot

Besides exurban remnants, the urban network inherited another type of non-central centers. Those are the classical suburban centers, which are distinguished from exurban ones by the fact that they are set in suburban settings, i.e. in close proximity to a major center, at least in the early part of our time span. Structurally, those places are very distinctive, as they combine a rather high job density coupled with a low job intensity. Those structures separated them from exurban remnants, which showed exactly inverse features, but also from other suburban types, which in all would show far higher job intensities. Those suburban remnants are thus marked by high density and low intensity, which indicates that they are set in dense residential surroundings. They are thus very different from everything else.

A minor category, ancient suburban centers remained remarkably stable during the period under study. Up until 1965 they showed a slow evolution of their structural qualities as well as a striking stability in numbers. Their job density slowly climbed while their job intensity plunged, as if they were caught in a general densification process, which would see more and more residents come although jobs themselves were getting denser. As a result, those ancient suburban centers lost their job specialization and became more and more residential.

The 1973 oil shock and the resulting crisis dealt a severe blow to the ancient suburban centers, which lost half of their members and nearly half of their jobs. The transition was also marked by a big drop in job intensity, although job density resisted. However, the subsequent evolution of the ancient suburban centers allowed them to escape the extinction lived by exurban remnants. From 1975 to 1991, ancient suburban centers managed to regain their numbers and jobs, although this was done at the cost of their structural integrity, having lost in density and intensity. The 1990s crisis provoked steep losses for this category of places, halving their numbers and jobs. This time though, ancient suburban centers weren't able to rebound as they had done in the late 1970s and the 1980s, although they didn't die off as the exurban centers did. Instead, they lived through a very slow decline that seems to indicate that in the long run they are bound to disappear. From 1991 on they haven't shown any dynamic and their structure slowly degrades. However, their decline isn't nearly as rapid and brutal than the exurban remnants.

5.9.1.4. Tourist resorts: a world of their own

We practically haven't written about the evolution of tourist resorts. That's because tourist resorts have a life of their own, clearly disconnected from the rest of the urban network. During the period under review, they have remained, as a group, remarkably stable, remarkably removed from the rest of the urban network. Their total weight in the urban network has not evolved much, to a maximum of 1.8% in 1991, rather unimpressive numbers which contrasts with the regional importance and the world-class reputation of some of those places, and also with the absolute numbers: until 1991 the network had grown steadily and counted about 52'000 jobs, more than double the 1939 number, which underlines their significance for the remote regions they adorn. However, since 1991, the tourist resorts have lived through a major crisis, shedding a third of their jobs units.

Structurally, the tourist resorts are distinctive, sporting the lowest job density of all urban types, while having a quite high job intensity, always well above 100 jobs per 100 active residents, which may sound strange for such isolated places. The explanation for the low job density lies with the development of extensive development such as chalets and resort apartments, which supply very few jobs as compared with the space they occupy. The reason for the rather high job intensity lies with the massive recourse to seasonal workers, who did not live year-round in the station.

In terms of evolution, this network of its own shows that if, as a whole, the tourist resorts have remained stable, it lived a nearly continuous movement of renewal, with units exiting the network and other entering. When the distinction is made between dynamical resorts, the ones that showed a massive rise in employment at some point in time, and the other ones, one can see that the dynamical ones represented a tiny minority in 1955, and that they slowly gained importance in the network.

The 1991 census proved a turning point. The 1990s crisis coupled with a touristic crisis of its own, which hit tourist resorts extremely hard. In seven years tourist resort lost a third of its units and jobs. It is to be noted that the resorts suffered more at the tail end of the crisis, between 1995 and 1998, than during the height of it, which indicates a flexible relation with the economical situation at large and a stronger one to internal factors of the touristic economy. Tourist stations recovered somewhat afterwards. In those years of stagnating economic conditions, specialized tourist resorts took a brutal hit. It is not to say that the touristic sector as a whole took a similar hit, but more that tourism had evolved towards more integrated forms of leisure where cities as a whole are better equipped to respond to, while monoculture tourist resorts, especially winter sports ones, had a hard time to adapt at a time where climate reliability dwindled. In all, monoculture tourist resorts suffered far more than the tourist sector as a whole.

The crisis of the Swiss tourist resorts has hit above all non-dynamical, traditional tourist resorts. In fact, the resorts that had emerged as dynamical after the war, which grouped 11 units and one third of tourist resort jobs in 1991, gained 10 units by 2008, and by then they hosted three quarters of all tourist resort jobs. Meanwhile, traditional resorts have seen an impressive and rapid decline, an annihilation of the relevance of this center form.

The network of tourist resorts which covers Switzerland went through two very different phases from 1939 to 2008. From 1939 to 1991, the network underwent a growth period which allowed new resorts to emerge while preserving old ones from restructuration. The second period, starting in 1991, was one of brutal restructuration which all but eliminated outdated structures from a trimmed down and modernized resort network in which only big, multi-functional units are present.

Our study shows first that tourist resorts, when considered at a national level, are but a tiny part of the urban network and its economy, even at the best of times. Secondly, that tiny part of the urban network, while living a life of its own, wasn't totally unconnected to the rest of the world: the resort network showed two distinct evolutionary patterns separated by the early 1990s crisis, as for all other groups in the urban network.

5.9.2. Emerging urban forms

5.9.2.1. Edge cities: a powerful rise to prominence

We now turn on the parts of the network that appeared from 1939 on, the class of the dynamical objects.

We start with the biggest group of this class, the dynamical suburban centers. As per our definition dynamical units are first detected in 1955, for they have to show appropriate dynamics, which can only be attained by comparing two censuses. Dynamical suburban centers started out as a tiny, fringe-like category in 1955. They were then rather non-descript objects sporting average job intensity and low density. However, by 1955 they were already on par, in terms of numbers, with suburban remnants: by 1955, half of the jobs that were located in suburban centers were located in places that had emerged in the last ten years. The dynamical places were already taking the remnants over.

The first life phase of those centers extended until 1975 and was marked by huge growth. From 1955 to 1975, the dynamical suburban centers went from 2% to 9% of the total number of non-agricultural jobs in Switzerland. By then, of course, they had totally dwarfed the suburban remnants: more than 9 out of 10 suburban centers jobs were in dynamical centers and by 1965 the dynamical suburban centers already represented the second largest category in the urban network in terms of jobs, behind the classical cities. Meanwhile, their structure underwent surprising developments: job intensity went down to a point where it passed below par, while the surprisingly job density went strongly up. Seemingly, those primeval edge cities underwent massive development, more by internal growth than by addition, and densified markedly, while being swamped by the overwhelming residential suburbanization that had started to flood the country at about the same time. Therefore, by 1975 there was no job excess in dynamical suburban centers. Those could serve the equivalent of their active resident population, but not more, and this had remained basically true for the whole period extending to 1975.

Two further points merit mention here. Firstly, as for all dynamical categories, the 1973 economic recession did not stop the growth of suburban centers. Those were able to withstand the 1970s crisis apparently without much harm, registering just a notable slowing of the growth rate they experienced. The second thing worth mentioning is that it seems that edge city emergence started way earlier than expected and at least noticed. One can trace the emergence of edge city emergence in the literature in the late 1970s or early 1980s in the US, way later in Europe. But by 1975, a sizeable share of all jobs was already located in noticeable suburban centers that were non-existent in 1945. That it went essentially undetected is certainly very surprising.

The second life phase of the classical edge cities covers the 1975-1991 period, during which edge cities changed drastically in nature while still growing fast as a category. During the late 1970s and the early 1980s, edge cities grew at about the rhythm they had maintained during the preceding decade, before accelerating massively during the late 1980s. Then, edge cities were gaining about 30’000 jobs per year, a rhythm never seen before or since. Moreover, these impressive gains in absolute numbers were accompanied by a structural strengthening of edge cities. Job densities went up noticeably, as did job intensity. The growth rate sustained by edge cities during the late 1980s makes it logical that they started to attract attention at this time; however, in a sense they became a subject of interest after most of their growth had already happened.

As a consequence of this relentless growth, while in 1975 edge cities, as big as they were already, weren't net attractors of job seekers, by 1991 the job/active imbalance in edge cities had grown from nil to more than 50'000. This respectable figure is still very small when compared to the one the classical cities had at the, which may explain that they went unnoticed for so long.

The third phase of edge city life in Switzerland began in 1991 and extended through 2008. Unlike in the 1970s, the 1990s crisis impacted edge cities as well as other members of the urban network and for the first time in their admittedly short history, edge cities numbers stabilized. Edge cities, as a category, withstood the economic crisis without a hitch, but were also squarely stopped in their tracks. That being said, stability in a time of general retreat meant that the significance of edge cities in the urban network continued to grow. This resilience showed in full during the brief economic upturn of the 1998-2001 period, when edge cities regained growth rhythms akin to those of the late 1980s, gaining 62'000 jobs in just three years and strengthening their structures with significant rises in job densities as well as in job intensities. After a brief lull up to 2005, corresponding to the first economical downturn which primarily hit a suburban center – the Swissair downfall hitting primarily the Glattal complex, edge cities lived a period of most extreme growth between 2005 and 2008, with more than 36'000 jobs gained annually by edge cities, a figure never seen before.

Those sudden and massive growth periods shows that given the right economic conditions edge cities still prosper very well and that our third period only differs from the second one by the fact that edge cities were finally sensible to worsening economic conditions. In that sense, they had matured, having now less space to grow into than in the 1970s. However, this seems to be only half-true, for in favorable economic periods, the relentless growth restarts almost immediately. And again, in worsening conditions like those of 2001 to 2005, edge cities are strong enough to withstand duress. During this last period edge cities managed to maintain their numbers.

When considering the evolution of edge cities in the long run, though, our distinction in three phases doesn't seem clear cut. Phases one and two really differ from one another, in that before 1975 growth is obtained at the cost of structural strength while after both grow together. But the distinction between the two latter phases – 1975-1991 and from 1991 on, seems to be conditioned more by differing economic conditions than by intrinsic differences. And moreover, the whole period under study has been one of regular, relentless growth for edge cities. In 2008, they host 676'000 jobs, 20% of the total, and are very firmly in second position behind the 42% of the classical urban network.

5.9.2.2. Dynamical cities: a very significant find

One surprising find of our study is that it revealed the existence and dynamism of an unsuspected class of objects of the urban network: the dynamical urban centers, bona-fide regional or local centers that show edge city-like growth for at least one intercensal period.

By 1955, five urban centers counting 18'000 jobs were detected as having undergone growth powerful enough to match the detection criteria for edge cities. Those cities had characteristics that separated neatly from edge cities of the time, namely a very high job intensity as well as a high job density. Those figures show them to be structurally distinct from the suburban centers, being at the same time a bit denser and much more intense than edge cities. Those structural differences, while they tended to diminish with time, remained sensible throughout the period under study. Furthermore, the evolution of dynamical cities differs greatly than that of the edge cities. At the same time, they are quite distinct also from the classical cities, having a far lower density than them as well as a far higher intensity. Thus, dynamical cities grew in jobs more than in population, creating a sizeable job-active imbalance that only commuters from nearby residential communes can fill. In other words, dynamical cities were products of the suburbanization process; in that sense they are clearly related to edge cities.

For a long period of time dynamical cities grew in the shadow of the bigger and more successful edge cities, maintaining their characteristics of relatively dense places with strong job intensity, and adding numbers. By 1975, dynamical cities were showing the same intensity evolution than suburban centers: they were maintaining their density but residential population was catching up with jobs, the small size of those centers allowing for in-situ rather than suburban residential growth, as it happened at the same times for larger centers.

At that time, jobs in dynamical cities represented about a third of those present in edge cities. However, the dynamical city category ranked now third in the urban network components, behind classical centers and edge cities. Between 1975 and 1991 dynamical cities were swept up as the rest of the network, gaining above all in job numbers: dynamical cities were growing internally. This made them bigger and allowed for suburbanization to develop around them. As a consequence, job intensity shot up, and the job-active imbalance skyrocketed. Basically, while before 1975 dynamical city evolution showed signs of convergence towards edge cities, from 1975 on it reverted back towards classical cities, of which they seemed to be a lower density version. In 1991, they hosted 4% of all non-agricultural jobs in Switzerland, still about a third of the figure sported by edge cities.

The really interesting part about dynamical cities started in 1991. To the contrary of the classical centers and the edge cities, dynamical cities resisted very well to the crisis, adding new units and jobs, suffering only structurally, by losing job density and job intensity. Then, since 1998, dynamical cities have shown exceptional growth, going from 32 to 49 units and gaining more than 100’000 jobs, almost as much as the edge cities.

During the same time densities and intensities moved according to the economical climate, up from 1998 to 2001, then down again; however in absolute numbers, by 2008 dynamical cities were hosting a quarter million jobs, 8 % of all non-agricultural jobs in the country, and more than a third of the numbers now held by edge cities. In addition, their job-active imbalance rose impressively since 1998, to an excess job number of 75’000, very significant when compared to the 130’000 strong imbalance of the edge cities themselves.

In terms of imbalance, the very high job intensity of dynamical cities has always made them big providers of job imbalances as compared to edge cities – in fact, edge cities overtook dynamical cities in job imbalances in 1985 only. In that sense, dynamical cities were always quite significant. During the final years of the period under study though, dynamical cities had become a very significant part of the urban network, gaining prominence along the better known edge city category in absolute numbers. Most dynamical cities are former classical network members that happened to undergo massive growth for a period of time, more than brand new additions to the network. But in any case, they make the two periods of massive growth of dynamical centers look very different. In the late 1980s, the essential part of the growth was happening in classical edge cities, which took three quarters of the new jobs; during the 2000s, new jobs were almost equally apportioned between the two categories. Those are very significant developments: the urban boom of the late 1980s was essentially an edge city boom. By the late 2000s, dynamical centers were as significant for center dynamics as edge cities.

This last fact arouses two remarks. First, the much lauded "return to the city" happens not so much in largest centers, which dynamics remains lackluster, than in select smaller but very dynamic towns. While dynamic cities appeared in the 1950s and 1960s essentially in the Alpine regions, by 2000 they were predominantly situated in the outskirts of major metropolitan areas, from Yverdon to Frauenfeld, through Bulle, Lyss, Oensingen, Sursee, Baden, Freienbach or Wetzikon. Secondly, and in relation to this specific location pattern, the fact that metropolitan processes now engulfed local and regional centers as well as edge cities, which wasn't the case in the 1980s.

5.9.2.3. Mixed centers: in-between interlopers

The minor category of mixed, urban-suburban centers shows dynamical properties which seem to relate them to cities, while their structures are clearly edge city like. As a class they remain minor, and they appear late in our time span: they appear in 1975 only. At this time they were a very minor part of the urban network, sporting weak structures: mixed centers were thus just emerging from a residential stage.

From then on, their evolution has been very similar to that of the dynamical cities, showing progress throughout the 1985 to 2008 period, regardless of the economic conditions. By 2008 they counted 16 units and about 68'000 jobs, small numbers. During this period they grew more and more intense, which shows that while they were structurally weak when they first popped on stage, they gradually reinforced themselves during the last two decades.

While they remain a very small category, covering about 2% of the total job numbers, the major reason for this is that there is only so much former cities and district seats that had turned residential between the 1940s and the 1970s which could then revert back to some form of centrality. With 16 members, in fact a majority of potential mixed centers had actually turned so, and many of its units are definitely significant, at least regionally, as the examples of Nyon, Wädenswil, Bülach, Gossau and Uzwil show.

In fact, the late emergence of those mixed objects confirms what was already remarked in the preceding section: in the last decade of the period under study, all kinds of centers were swept up by general growth, as if lately growth was returning to established centers instead of creating ones ex nihilo, as it was the case in the 1980s.

5.9.2.4. New exurban centers: still in the shadows

In a way the rise to prominence of dynamical cities overshadowed the new exurban centers. There is anecdotal evidence that those had been appearing in the last twenty-five years and thus they were expected to be found by this research. We were also expecting to find them relatively late as it seemed to us that exurban forms would only develop in particular conditions, notably in developed metropolitan settings where most suburban spaces had been already occupied. But our study shows that in fact, exurban centers had emerged before. Way before, in fact, under the guise of exurban remnants of the industrial age, and again around 1955 and 1965. There have been at least two waves of exurban center creation, of which at least one took place before 1939. Exurban centers are not so new after all.

The second wave of exurban centers emergence started about 1955. The first significant numbers are for 1965 though, with 45 units grouping about 50'000 jobs. This wave of exurban centers showed a very small size, very low job density, and rather high job intensity. This new group was still composed of small units, which were quite sprawling, probably specializing in land-hungry occupations like warehousing and logistics. Up until 1991 this category went on to grow, essentially by putting up new units so that by this time there were now 67 new exurban centers for 78'000 jobs. Exurban centers had remained small and sprawling, but they had also specialized in jobs: their density was very low, but intensity was now quite high, which confirms the specialization into low-density, land-hungry, unglamorous specialized places.

The 1990s marked the moment when the new exurban centers took over the exurban remnants, which were essentially dead by then. It also marked a pause in the growth rhythm that the exurban centers knew especially between 1985 and 1991. Since 1998, dynamical exurban centers have followed about the same evolutionary patterns than dynamical cities and mixed centers, albeit in a more muted fashion. In 2008, there were 86 such centers with 113'000 jobs, by a wide margin their best ever result. At the same time, a far cry from the 675'000 edge cities jobs, or the 260'000 ones in dynamical cities; a far cry, also, from the heights, more than 145'000 jobs, attained as recently as 1965 by the exurban remnants.

In essence, exurban centers are no match for classical edge cities, which is a surprise as anecdotal evidence would point to such examples emerging in metropolitan areas. Those examples are indeed spectacular, but they are few, far between and tend to remain small. True, metropolitan areas could sport one or two very visible exurban emerging centers, like the Reiden-Dagmersellen corridor in rural Lucerne, the Stein chemical complex along the Rhine upstream of Basle, or the Beznau nuclear plant complex in the extreme lower Aare Valley; but as we pointed out they are few and far between, and their parent metropolitan areas will sport numerous edge-cities, each of which would dwarf the exurban centers.

Reasons can be put forth to explain this relatively poor showing of exurban centers. Firstly, they were supposed to emerge strongly at a late time, when urban agglomerations were already quite large. Thus, there was a greater probability that a center would emerge in a spatially large agglomeration rather than outside of it. In other words, the stringent criteria chosen to define the exurban centers plays a damping role on their emergence, much the same effect than for mixed centers: there are few locations where such centers can emerge, most suitable locations being already included in urban agglomerations and thus deemed suburban. This wasn't a problem for the remnant generation – indeed, during the late 19th and early 20th centuries, the problem was reversed: suburban areas were scarce, if existing at all, and most emergences were happening outside of them, hence the dominance of exurban over suburban forms then, and the reverse dominance of suburban over exurban forms now.

5.9.3. Edgeless space: an inert filler

Last, the great emptiness that edgeless space seems to be. Edgeless space groups all communities that fail to register as one of the categories we described above: everything that register less than 1'000 jobs, or fail to meet minimal density or intensity criteria is considered edgeless space.

It could be said then that edgeless space is constituted by everything which does not primarily revolve around jobs or more generally central functions.

The first find of our study about edgeless space as completely distinct from central space is that it is fairly recent. In 1939, in terms of intensity, there wasn't any major difference between the urban network on one hand and the rest of the country on the other hand. This prompts us to advance the hypothesis that in 1939 the urban network structure, which was strongly Christallerian, replicated itself all the way down to the hamlets and settlements. That would explain nicely the relatively feeble differences accounted for in 1939 between the urban network on one side and the rest of the country on the other side. In terms of density however, edgeless space has always been very sparse in jobs. In 1939 job density was at half of the minimal value to be detected as center; centers in general, for their part, sported a value more than twice this threshold. Therefore, there was indeed a strong quality difference between central and edgeless space in 1939, not so much in terms of function than in terms of form: central places were dense, whereas edgeless space wasn't. Centers were spatially efficient whereas edgeless space was already sprawling, or at least not devolving its built space to jobs.

During the seventy years of our study, the history of edgeless space has been one of continuous dilution. While in 1939 edgeless space had a job intensity relatively close to the one in cities, intensity in edgeless space sank without respite since then, indicating the specialization of edgeless space towards residential functions. The job intensity decrease has been continuous such as in 2008, only 51 jobs were to be found for 100 active residents in those areas. Meanwhile, job density, which was already very low in 1939, decreased regularly to about 5 jobs per built ha in 2005. In terms of structure, it can be said that edgeless space specialized at being purely residential.

In terms of absolute numbers, edgeless city showed growth commensurate with that of the country at large. There were about 451'000 non-agricultural jobs in edgeless locations in 1939, or 29% of the total. Between 1939 and 1965 absolute numbers grew modestly to 546'000 jobs, expressing in fact a big decline in job share, at 20%. However, edgeless space saw its number soar with the 1973 oil shock, such as in 1975, 25% of the total jobs were again to be found in edgeless space. From 1975 to 1991 edgeless space experienced a new drop in job shares, to less than 21%. The 1990s crisis marked a new jump in numbers for edgeless space, to a 24% job share. Then, the job share dropped again at less than 21% in 2008.

Another way to look at the significance of edgeless space as a differentiating unit is to look at the evolution of its job/active imbalance. In 1939, there was an excess of actives over jobs of just over 110'000, showing that in fact edgeless space was rather undifferentiated. However, starting in 1955, the imbalance grew spectacularly, to 201'000 in 1955 and 284'000 in 1965. During this first phase, job growth in edgeless space had remained relatively tame, while the number of active residents grew by 60%. But to the contrary of practically every index in our study, edgeless job/active imbalance growth wasn't affected the least by the oil shock. By 1975, it reached an excess of 498'000 actives over jobs. From then to 1991 this job imbalance remained stable, showing that a first "optimum" had been reached in the way edgeless space had developed as a reservoir of actives, i.e. a primarily residential area. However, the stabilization process lasted only till the next crisis, that of the 1990s. By 1998, the job/active imbalance had climbed to 672'000 excess residents, a figure that stood at 682'000 by 2008, with about 718'000 jobs for 1'401'000 active residents. Clearly, edgeless space is now deeply residential. Its emergence as a strongly specialized space expresses the massive residential changes that occurred in Switzerland since 1939, with the gradual replacement of a rather undifferentiated, fractal Christallerian urban network by a space structured by specialized job centers surrounded by specialized residential territories.

Evidently, edgeless space prospers during economic crises: it did very well between 1965 and 1975, and again between 1991 and 1998, i.e. during the two major economic crises of our time span. In turn, it performs weakly during periods of economic growth, with absolute numbers remaining stable but relative numbers plunging. Times of economic highs are when the edgeless job share is lowest, at 21% in 1965, 1991 and 2008. Edgeless space seems to grow when the economy shrinks, and decline or stagnate when the economy grows – a strange behavior, though explained the following way. The urban network reacts to economic stimuli, growing more than the country as a whole during periods of economic growth and losing more than its share during economic crises. Edgeless space does simply reflect, in negative, those evolutions. At no point in time does edgeless space show anything like a proper dynamic. During the whole period under review we can conclusively exclude the possibility of a movement of job deconcentration that would allow significant job relocations in a patchy or sprawling fashion in edgeless space. Figures seem to show that whatever developed during favorable economic periods in edgeless space took significance early enough to be included as a central place in one or another of our categories. In Switzerland between 1939 and 2008, there was no significant sprawling job development in edgeless space.

As such, edgeless space, as significant as it may be with over 20% of all jobs, serves either as a reservoir on which a growing urban network feeds when the economy is going strongly, or, in times of duress, as a trash-can in which a stagnating or shrinking urban network dumps its excess units or workers. In both cases, edgeless space plays an important but totally passive role, remaining inert, as is the yolk, which feeds the embryo and collects its waste: essential to life, but not alive itself.

5.9.4. A general view or two of the urban network evolution

Two conclusions can now be reached about the evolution of the urban network.

Firstly, data shows beyond any doubt that there is a strong correlation between the economic situation and the dynamics of the urban system as a whole. In particular, the two major economic crises of our period of study, the 1973 oil shock and the 1990s crisis, correspond to major turning points in the evolution of the urban network, and even more with regard to their growth rate. Basically said, the urban network grows when the economy is good, and stagnates or shrinks when the times are bad. But it isn't only a matter of growth: it's also a matter of structural strength. Although, during the years, strengthening the urban network took different disguises, the fact remains that as a whole, during times of economic growth, the urban network not only grew but strengthened, having higher growth than the country as a whole and having its structural indices generally showing densification and intensification of job centers. Conversely, during economic crises, the urban network stagnated or shrunk, losing jobs and units at a higher rate than the country as a whole, and also losing in density or intensity.

That being said the economic evolution has above all a role of accelerator or brake on the urban network, which underwent changes that overlies the economic pattern of booms and crises and seem unaffected by them, at least in terms of change direction. Economic conditions affected the changes speed, but couldn't reverse of derail any of those changes. Several phases can be detected in the evolution of the urban network. They will be described here from a historical point of view.

The first phase, going from WWII to the early 1960s, is one of strengthening of the traditional urban network, a reinforcement of the network already in place. During this period, classical centers were rose to an even more prominent role than already theirs before the war, profiting first from the agricultural revolution that emptied the countryside and probably also of the rampant tertiarization of the economy, at a time when tertiary economic functions were almost all concentrated in classical centers. The link to the transportation infrastructure of the time is also tempting, with an economy already based on accessibility, where centers were performing well in the absence of urban congestion, motorways and bypass roads. The urban network was at this time flanked by ancient exurban centers, above all industrial towns and boroughs that were strung along rivers and railways, and thus deemed accessible by train.

From the mid-1960s on to the late 1980s, a second phase took place. First, classical centers, while still growing in terms of size, started to slowly lose job shares. Those shares went in their majority into new suburban centers which suddenly burst onto the stage, at a time where another type of center was going rapidly down, the ancient exurban centers. At first, these developments were relatively tame, but they took more and more speed and gained their full speed during the second half of the 1980s. This period saw a definite drop in classical center preeminence, a strong reduction of the numbers and importance of ancient exurban centers and the strong and quasi-exclusive rise of suburban centers as new central forms integrated in the urban network. As before, it is tempting to link those developments with contemporary events happening in Switzerland at the time, such as the advent and generalization of the private automobile as a means of transportation, the massive residential suburbanization happening at the time, the building of the national highway network. As compared to the preceding period, the 1960s to 1990s phase was profoundly different, superficially showing an reversal from more centralization to less centralization, an undoing of the Christallerian network with less powerful centers challenged by bigger and bigger subcenters.

The third phase started in the early 1990s and is still running. This third phase doesn't represent a rupture with the immediate past, but more of an inflexion. The classical city network continued to shrink, this time also by losing a fair number of units – which it hadn't done in the second phase – as well as in relative importance in the urban network. This seems to indicate a strong movement of dissolution of the Christallerian network, particularly of its lesser levels, probably concomitant with a metropolization process that favor bigger centers over smaller ones. In parallel, dynamical suburban centers – edge cities – continued to grow in importance, albeit at a reduced rhythm than before and far more oriented towards internal growth than before, when this category grew by adding new units. The inflexion in direction is above all rendered visible by the upsurge in two hitherto marginal categories of places, the dynamical cities and the mixed urban-suburban centers. Those two categories are related in that they are former bona-fide classical centers which emerge or reemerge as dynamical centers. Together with the fact that edge cities were growing internally rather than sprouting new units here and there, and with the fact that dynamical exurban center growth remained rather muted, all indicates that while the second period was one of sheer dispersal towards new suburban centers, the most recent period was – and probably still is – a period of containment of growth on existing or potential centers, be they former classical centers, refurbished mixed centers having been through a residential specialization, or just bona fide edge cities.

There is ample anecdotal evidence to link those three phases with spatial developments happening during the same periods. The first period is one where widespread commuting wasn't happening, where highways were non-existent, where roads and railways linked the urban network from center to center and where urban congestion wasn't general. Thus, until the early 1960s, centers were still the most accessible points of the territory, the places where it was easiest for most people to meet. Consequently, they rose to greater prominence during this period, which goes pretty well with our hypothesis that accessibility is the main factor in the development of job centers.

The second period underlined here shows a general trend towards dispersal, and the sprouting with time of more and more suburban centers. Again, it is tempting to link this evolution to changing accessibility conditions across the space under review. Firstly, between the 1960s and the 1990s, following the generalization of the personal car as a means of transportation, suburbanization and commuting took a firm hold around most classical centers. An ever growing part of the population located farther away from classical centers, and contributed to urban congestion which appeared and then aggravated during this time. In parallel, the highway network was built essentially during this period. At first, highways were meant to link greater cities center to center, but with time the network conception evolved towards bypassing the centers with highway belts. This meant that the gains in accessibility provided by highways ended up not benefiting classical centers, but some selected points in their suburban belts. This, in turn, meant a major shift in accessibility patterns across the territory, with losers being clearly the classical centers and winners being suburban centers, well located within an ample supply of workers and customers and within reach of those new points of accessibility which highway junctions are. That, of course, fits very well with our fundamental hypothesis, at least if we can show that most of our edge cities do indeed sit at or close to those points of greatest accessibility.

The third period started at a time when the highway network was nearing completion and when massive suburbanization started to subside – if only because it had already conquered Switzerland. From then on changes in accessibility in major centers in Switzerland could not be attained by major modifications of the road network, but only by relocation of people and jobs, which effects are supposed to be far more subtle, since suburbanization processes had already happened by then. Factoring in the economical context, in fact we could expect, from the 1990s on, a strong stabilization of the accessibility pattern across Switzerland, with changes being of lesser importance than those that were happening beforehand. However, why this "glaciations" should benefit established centers (be it for 10 or 1'000 years) over new locations is not self-evident. While we built our hypothesis on the basis of the largely known phenomena we just described under phases one and two, we were not really expecting the pattern we discovered in phase three. It will be very interesting to see if those patterns can be reconciled with our main hypothesis of strong link between accessibility and job centrality, or if we'll have to reject it, at least from 1990 on.

5.9.5. Transverse looks at the urban system

5.9.5.1. The density-intensity dichotomy: which one comes first?

Up to now, many of the indices we have put forward have been put in combination to describe urban forms, or taken one by one, to check for their evolution in time. At this point, too, there are some angles with which it is interesting to delve into. We start first by checking the varying effects of density versus intensity.

First, given the thresholds we have taken it is important to note that the majority of detected centers register on both scales. If a center is dense enough to be detected, chances are good that it will also be intense enough, and vice versa. This effect is particularly true of non-dynamical urban forms, i.e. classical centers and ancient exurban and suburban centers. This is less the case of dynamical centers. Currently, a majority of dynamical centers register only on the intensity scale. In a general way, centers that register on both scales are likely to be strong on at least one of them. If a center registers as both dense and intense, there is a great probability that it will be either very dense, or very intense, or both. This is true of both the classical network and the dynamical one.

Turning our attention now on centers that do register on only one of both scales, a very general trend shows that there are far more such centers that are intense only than centers that are dense only. Generally said, anything dense enough to register as a center is very likely to be intense enough to do so, but the reverse is not true; this means that density is a far more restrictive way to qualify centers than intensity is. Conversely, if intensity is used as a way to detect centers, one could almost dispense with the density criterion, which will basically select a subset of what will be detected by the intensity method. Therefore, intensity is a far more inclusive criterion than job density. In turn it means that as far as job centers are concerned, commuter patterns are far more indicative of their development than building density. In fact, what this all means is that we have, on one hand, a population of classical centers that are both dense and intense, and a population of centers that are just intense but sprawling or at least relaxed, while a population of centers that are dense but not intense, i.e. dense centers without a commuter shed, is not existing anymore.

There seems to be no evidence found to argue for a historic variation of these finds, bar for the period leading to 1965 which saw the inception of intense-only suburban centers – before that, in effect, centers were dense only. The results show that the finds we discussed, once they did establish, are quite robust through time. Some differences arise when we consider different urban forms, as defined in this work. Those differences are essentially expressed in terms of a gradient in intensity, as density seems to play no big part in the differentiation of the urban space – that is, it does play an important part, especially to discriminate between types, but it does not play a structural role in the definition of the urban network. However, while in terms of units found along the gradient we just mentioned this dichotomy is well illustrated, in all cases jobs are predominantly located towards very dense and very intense units, a rule that is valid for all urban groups. This shows that the city network is clearly hierarchical against both density and intensity: the bigger centers are, the denser and more intense they tend to be.

5.9.5.2. The imbalances between jobs and actives

As we have seen, commuter patterns are critical to appraise centers and more generally the dynamics of a territory. However, historically commuting is a recent phenomenon and in Switzerland, its development is certainly coincident with the time span of this study. It is of interest to resume here how commuting patterns evolved between our centers categories. While commuting existed in 1939, it only played a minor role in the territorial organization of the country. Its post-war development started to play an important structural role in the way the territory was organized, with the concomitant advent of the residential suburb and the work center. In this view, work centers started to grow an excess number of jobs as compared to active residents, while in residential suburbia the inverse was true. The goal of this part is to study those imbalances and see how they can inform us about the way space reacted to the advent of mass commuting.

A first period of imbalances evolutions seems to take place between 1945 and 1973. During this time, both the job-leaning imbalance in urban centers and the residential-leaning imbalance in edgeless space exploded. By then, commuters were filling more than a quarter of all urban jobs, while a third of edgeless space active residents were finding jobs in central places. Meanwhile, all other central types were representing a very small job-leaning imbalance. This first period was one of polarization between centers and periphery, or suburban edgeless space: exchanges increased fivefold but the territorial structure didn't evolve much and remained Christallerian in essence, organized in a dichotomy of urban centers and rural peripheries.

The 1973 crisis had a double impact on the evolution of imbalances. For the first time, active residents largely exceeded jobs. Most of them were seemingly located in edgeless space, whose residential imbalance grew to an excess of residents over jobs that wasn't matched, by far, in urban centers. Secondly, the period was also one of residential flight from urban centers: between 1965 and 1975, they lost more active residents than jobs. Thus, in 1975 up to a third of urban jobs were held by commuters. Meanwhile, more than a third of edgeless residents were going elsewhere to work. But more to the point, for the first time a significant number of actives residing in edgeless space, close to 150'000 of them, could not find jobs in urban centers.

The second phase covers the 1975-1991 period. Then, a renewed segregation phase took place, with job-leaning imbalances growing in urban centers and while remaining stable in edgeless space. By 1991, one out of three urban jobs was held by commuters from edgeless space. However, the period saw the gradual emergence of new central classes as job centers: dynamical suburban centers had grown a job-leaning imbalance, as had dynamical exurban centers. Lastly, Switzerland now sported a job-leaning imbalance of more than 165'000, fuelling a fully-employed workers pool, and a growing cross-boundary job market.

From 1991 to 1998, the economical crisis wrecked the model we just described; urban centers reverted to an excess of just 435'000 jobs, losing twice more jobs than actives. Meanwhile, edgeless resident-leaning imbalance grew close to 680'000, gaining far more residents than jobs. Even counting in the dynamical urban centers which numbers were steadily growing, now 235'000 edgeless residents couldn't count on cities to provide them with a job. A large number of those ended up unemployed – globally, the resident-leaning imbalance of the country as a whole in 1998 was around 175'000, close to the actual number of unemployed. Dynamical centers also suffered during these times, although far less than classical urban centers, and their imbalance remained fairly stable, just below 1991 figures.

During the next period, which was of economic recovery, all imbalances grew concomitantly. Job-leaning imbalances grew strongly in cities, past their 1991 level with a 606'000 imbalance by 2008, a reopening gap due above all to job gains in urban centers. By 2008, more than one third of all urban jobs were held by commuters. At the same time, job-leaning imbalances also grew explosively in dynamical suburban and exurban centers, from a bit less than 60'000 in 1998 to 150'000 in 2008. While the majority of workers in suburban and exurban places came from such surroundings, it is to note that at least 150'000 edgeless residents found their jobs there, or close to a fourth of all out-commuting edgeless residents, a significant departure of the center-periphery dichotomy.

But what's really new about this period is that while the economy was growing and thus cities were reasserting their primacy as job centers, residential-leaning imbalance also grew in edgeless space, to 682'000, and here essentially by residential gain. Such a concomitant growth was a first and showed that space was now specializing whatever the economic conditions are: cities are more and more specializing in jobs, while losing inhabitants, and edgeless space growing ever more residential as time goes. Alongside those two categories specialization starts to be evident in dynamical suburban centers, which grew significant imbalances in the last thirty years. However, those imbalances remained relatively small as compared to the massive ones incurred in urban centers and in edgeless space. Of all workers in edgeless space that need to find work elsewhere, only one in seven will find it in dynamical suburban or exurban centers. Not a negligible number, but still not structurally dominant as compared to cities.

5.9.5.3. The role of dynamics as a relevant discriminator towards location

One of the main divide splitting our categories concerns the role dynamics plays in our definition. Originally, the use of explicit dynamics follows Garreau 1991 in the axiomatic idea that suburban centers are new, emerging places. At first, our intent was to exclude from the suburban center group all units that wouldn't register as dynamic from our study as it wouldn't pass the axiom of emergence. However, there is no prior reason to believe that suburban centers couldn't be detected on the basis of other criteria of minimal size, density and intensity. For one, there is no law against suburban centers having emerged before 1955; or their growth rate could have been sufficiently small to go undetected by our method. In any case, the inclusion of dynamics as an additional, but non-exclusive, condition to detect urban units allows us to discriminate between those centers that go with the flow, and those that are currently emerging in the sense of this study, that is since 1955. Therefore, we have traditional and dynamical subspecies of each of our urban unit types, urban, mixed urban-suburban, suburban, exurban and touristic.

The results between the categories are extremely interesting. The dynamical constraint was meant to discriminate above all in the suburban realm. The application of our definition in suburban areas showed first that, dynamics put aside, such centers were existing in 1939, and probably before. We deemed them "suburban remnants" or "ancient suburban centers". Up until the early 1960s they remained an important part of the suburban center network. They were subsequently marginalized by the rise of bona fide dynamical centers, and by 2008 they represented less than 1 in 10 jobs in suburban centers. There has been, here, a real change of guards between ancient forms of suburban centers and the advent of a new generation of them. This is further seen in the major structural differences those spaces had besides their dynamical discrepancy, the remnants being far less intense than the dynamical centers, as well as clearly denser, at least at the beginning of our period of study.

It took far longer than that for dynamical exurban centers to override exurban remnants. As we have already shown, exurban remnants were very present in 1939, being the second most important urban type at the time, with around 4% of all jobs, at a time of absolute Christallerian dominance by classical centers. During the first half of our period of study, ancient exurban centers dominated clearly the newly emerging ones. Between the two major economical crises (1973, 1992), both categories were roughly on par with each other, and only since 1992 has the dynamical group taken over the remnant one – which had essentially disappeared. As we can see, the transition between the two groups happened later and lasted longer in exurbia than it did in suburbia. In fact, it is as if the dynamical wave started in suburban space and spilled over slowly to exurban locations. However, if dynamics by themselves did not discriminate very clearly between the groups, it correlated strongly with other structural measures. In terms of density, both groups evolved similarly, from relatively high densities up until 1965 to frankly low ones afterwards. However, intensities diverged completely between the two groups, being very close to unity and thus showing autarky for remnants, while showing very high values, and thus an elevated level of integration into a larger functional unit in dynamical ones. Clearly, their origin and their integration into the economic system wasn't the same for both categories. Hence, they stand as relevant.

It wasn't expected that the network of classical urban centers would be discriminated by our method but indeed it is. Rather logically, non-dynamical urban centers far outnumber dynamical ones, but in later years, dynamical cities rose to prominence and currently, more than one in three cities are dynamical, and about one sixth of all urban jobs are located in such cities. We can certainly note that structurally, dynamical cities appear to be quite different than established urban centers, the latter category being far denser and somewhat more intense than the former. However, this may be just a size effect, dynamical cities being on the whole three times smaller than established ones. It is entirely possible that given an equal size, dynamical and established centers would show similar characteristics.

Like classical urban centers, tourist resorts do react to the dynamical criterion, albeit very late in our history: job dynamics seem to matter from 1991 on, which we linked to a structural change in the resort group with older or mono-cultural stations exiting and newer, bigger and multi-modal resorts replacing them. Up until 1990 there was no difference between dynamical and established resorts, nor, in terms of structure, was there afterwards between the two groups. However, the dynamical factor is still significant as a discriminator between two resort generations.

Is the explicit use of dynamics in our study justified? First, it bears repetition that dynamics differences between cases go generally hand in hand with structural discrepancies. This is particularly true of two of our groups, the suburban and the exurban centers, where dynamics differentiate between two very different kinds of units. In those two groups, plus in the case of tourist resorts, the discrimination has proved to be generational in nature, dynamic members replacing established ones in the urban network. Both those facts taken together seem to us a powerful argument towards the acceptance of dynamics as a relevant character to discriminate: the use of dynamics splits our cases in structurally different groups, which then evolve in vastly different ways.

That being said, dynamics doesn't work so clearly for classical urban centers. Here, dynamics select a fair number of units, but those do not supersede the classical members of the group. Furthermore, while there is a structural difference between the established centers and the dynamical ones, it could just be the result of a size effect. Up until now we haven't taken into account differences in size inside each of our groups. We will now turn our attention towards this question as it is required to answer firmly about the alleged structural difference between established and dynamical urban centers.

5.9.5.4. The evolution of the suburban job share in superclusters: a strong size effect

Up to now we have considered units, clusters and superclusters separately – but by construction, clusters are made of units, and superclusters of clusters. In particular, clusters can still be qualified by their location: clusters can be urban, mixed, suburban and so on. Therefore, it is interesting to look at the composition of superclusters by location of their constituting clusters. The literature shows in effect that it is expected that the greater the supercluster, the greater the share of suburban clusters and jobs (Huriot & Bourdeau-Lepage 2009, for instance). Thus, we built a database of all our superclusters by adjoining them the number of jobs held in urban clusters, then computed the ratios of urban jobs against the total for each period and studied the general results by splitting the superclusters into the same size classes we used throughout this work.

Looking at the list of individual superclusters ordained by size for 2008, a quadruple trend is immediately visible. First, as a general rule the share of non-urban jobs in a supercluster dopes indeed decreases in step with the supercluster size and as a first rule, the share of suburban jobs is indeed higher in larger superclusters than in smaller ones. Secondly, this rule is not valid up until the very top – it seems that the largest urban centers have some quality which allows them to keep a larger share of their jobs in the urban center. Thus, the highest suburban shares are not to be found at the very top, but just under the very top. For instance, in 2008 suburban, mixed and exurban jobs represented 29.3% of all supercluster jobs. The Zurich supercluster had 36.1% of suburban jobs, Geneva 44.4%, Basle 33.2%, Berne just 28.5%, under the national mean, Lausanne 45.9%. But several lesser centers had crossed the 50% mark, meaning that they hosted more jobs in their suburban belts than in their centers: those were the cases of Zug with 58.4% of its jobs in suburban settings in 2008, Olten with 57.0%, Wil with 56.1%, Zofingen with 52.2%, Lugano and Heerbrugg with 50.7%. Thirdly, as a rule those figures were growing with time, very much in line with the trebling of those figures at the national level, from 10.3% in 1939 to 29.3% in 2008, although this was not a exclusive trend. Lastly, there is much variation from one case to another. We have already mentioned the dominant suburban shares of half a dozen superclusters, but to be exact we should also mention very weak suburban shares in St-Gallen (24.5%), Winterthur (just 1.5%, or essentially nil), Biel (15.1%), Chur and Neuchâtel (both under 10%), and Sion (nil). While generalizations about size are rich in insights, as we will shortly see, local circumstances are paramount for individual cases.

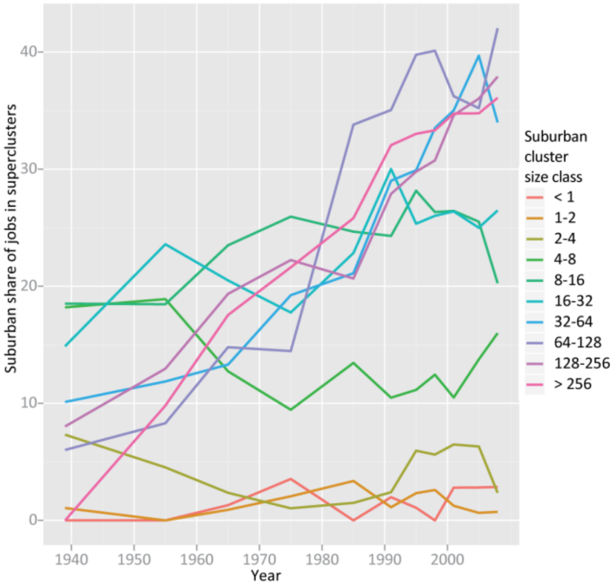


Chart 5-42: Suburban job share by supercluster size class, 1939-2008

As we have said, the general trend has been one of rising share of suburban employment in the central network from 1939 to 2008 (*Chart 5-42*). In 1939, about one central job in ten was held outside the urban center. By 1965 this figure had progressed to about 16% of all jobs, the boom happening squarely between 1975 and 1991. At the latter date, the share had jumped to 25.1%, or every fourth job now held outside the urban umbrella. By 2008, this figure had progressed to about 30%. However, the patterns seen by size class were very different.

In 1939, the relationship between supercluster size and suburban job share was less evident than today, the midsized superclusters from 4'000 to 32'000 jobs, as a class, sporting a far higher job share in their suburban fringes at between 15% and 18% than either small or big superclusters, at respectively nil and a bit under 10%. However, the smallest of those midsized superclusters, those under 8'000 jobs, never took off from this position and even saw their suburban job share decrease such as by 1965 it was clearly lower than the suburban job shares of all bigger superclusters. Meanwhile, the big superclusters, those above 32'000 jobs, saw a continuous growth of their suburban job share. By 1965, the stratification between small and big superclusters was essentially into place, with centers under 4'000 jobs sporting no non-urban jobs, while all greater classes sporting suburban shares between 13% and 23%. The following years showed the decoupling of the 4'000 to 8'000 jobs superclusters from the bigger ones and the steady progress made by larger units. While in 1975 the greatest share, at about 26%, was found in relatively small centers – the 8'000 to 16'000 jobs class, by 1985 this maximal class, at 34%, was the much larger supercluster class from 64'000 to 128'000 jobs. By 1991 the supercluster network was clearly split in three categories. The superclusters with more than 8'000 jobs sported suburban job shares of between 25% and 35%, the superclusters under 4'000 jobs were seeing suburban job shares between nil and 4%, while in-between, the superclusters sporting 4'000 to 8'000 jobs had a suburban job share of about 10%.

Since 1991, the evolution has shown a selection effect tearing smaller centers off bigger ones. Centers with 8'000 to 32'000 jobs, which were having the same suburban job share than greater superclusters in 1991, were clearly behind by 2008, with shares about 20% to 25%, while superclusters over 32'000 jobs sported suburban job shares of 35% to 43%. As in 1991, by 2008 the superclusters were separated in three groups, but with different limits: now the group of largest centers was formed of centers above 32'000 jobs, instead of 8'000 in 1991. In all, the period under review showed a continuous trend which favored suburban job growth in ever larger superclusters, from a start in medium-sized centers to a finish with a very large part of the largest supercluster jobs held in suburban space. It is as if as time progressed, suburban jobs could only develop and flourish in ever larger clusters – a fine confirmation, by the way, of the metropolitan processes at play.

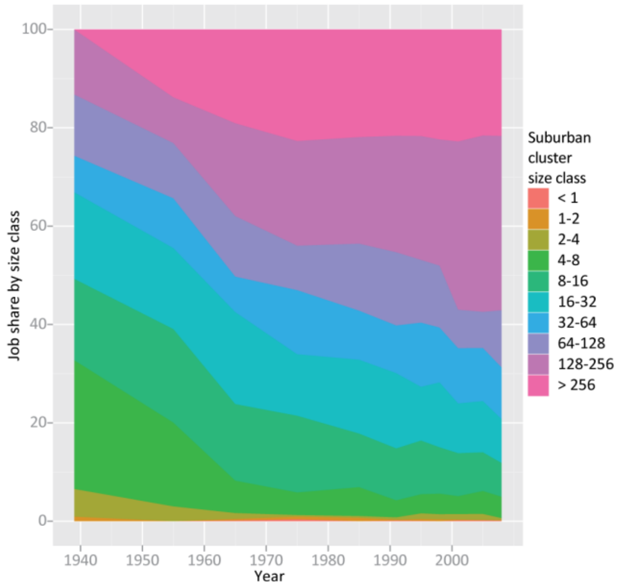


Chart 5-43: Suburban job share by supercluster size class (stacked), 1939-2008

The study of the suburban jobs controlling for the size of the superclusters they are in confirms what we found earlier (*Chart 5-43*). In 1939, a majority of suburban jobs were held in superclusters with less than 16'000 jobs, a group which hosted by 2008 just 12% of all suburban jobs. At the same time, suburban jobs held in superclusters of 128'000 jobs or more passed from 13% in 1939 to close to 60% by 2008. In 1939, most of the suburban jobs were held by mid-sized superclusters – by 2008, most of them are held in one of the big five superclusters. Between the two dates there has been a continuous transition from one distribution to the next. The share of suburban jobs in the smallest superclusters, those with less than 8'000 jobs went from 35% in 1939 to less than 10% in 1965, while conversely the same figure for superclusters with more than 128'000 jobs went from about 15% to close to 40%. After 1965, the medium size classes saw their very big share – more than 50% in 1965 for the 4'000 to 128'000 jobs superclusters – shrink regularly, if not as spectacularly than the share drop of the smaller centers before 1965, to about 35% in 2008. This shrinkage benefited exclusively the largest superclusters, which share grew regularly from a bit under 40% in 1965 to close to 60% by 2008. More interestingly, unlike for many phenomena in the period under review 1991 does not mark a transition from one period to the next. And in all, what it shows is that as time pass, suburban jobs tended to prefer larger and larger agglomerations, a confirmation of the metropolitan processes in progress at the time, and of the furthering domination of the largest conurbations on the rest of the territory.

The momentous change we just mentioned should also be regarded in absolute numbers, as this view shows that the changes mentioned happened only by sheer growth (*Chart 5-44*). The job numbers of the smallest size classes remained stable throughout the period under study, while absolute numbers rose in midsized and larger size classes. This means that the changes happened by addition of newer jobs in suburban space rather than by replacement and decommissioning of older edge cities by newer ones. As time went by, new suburban jobs located preferentially in larger superclusters, and again that showed that metropolitan processes dominated more and more, with the advent of very large metropolitan superclusters.

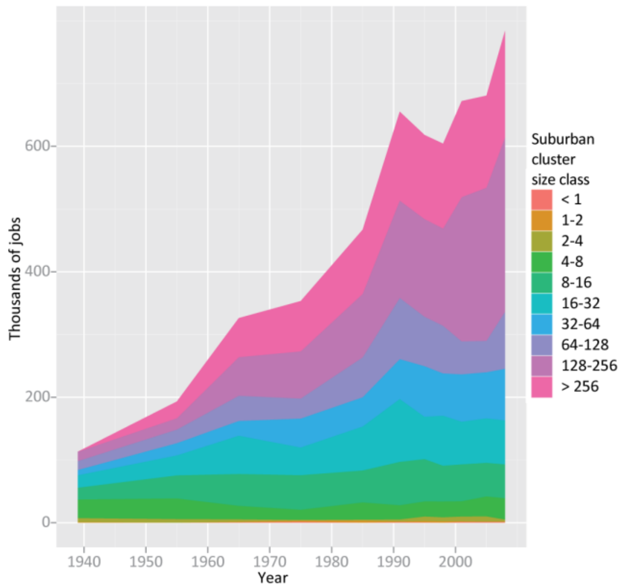


Chart 5-44: Suburban job numbers by supercluster size class (stacked), 1939-2008

5.9.6. Christaller unraveled?

5.9.6.1. 1939

In 1939, the central network closely followed a Christallerian distribution. True, there was no center at more than 200'000 jobs at the time, where Christaller postulated one, and conversely the medium-sized city classes were a bit overrepresented. This could be attributed to the federal structure of Switzerland, which hindered the emergence of an undisputed overgrown center like Paris for France or London for the UK, while promoting a certain number of mid-sized centers to a level they wouldn't have gotten under a central form of administration, which is postulated at least implicitly by Christaller in Germany. The real turnoff, though, was reached below 2'000 jobs: there, we find only a quarter of this number Christaller postulated if we limit ourselves to the urban network. Those figures got somewhat corrected when the exurban centers are taken into account, although the correction effects were far from complete. The fact remains that under 2'000 jobs, in 1939 the Swiss network showed a strong dearth of centers, with only half the units expected.

However, there is a way to explain the major difference between Christallerian theory and observed number of centers: Switzerland was a lot denser than the idealized Christallerian landscape. In 1939, Switzerland packed most of its 4 million people on roughly 15'000 sq km. According to Christaller, the A-centers need about 130 sq km of market area, corresponding to a circle with radius of about 7 km. In 1939, there were 114 A-Centers (including higher categories) in Switzerland, which covered a territory of 15'000 sq km, which gives a mean A-center market area of 130 sq km, exactly the Christallerian value. Thus we could firstly conclude that at the local level, A-centers were vastly deficient in Switzerland as compared to southern Germany because a lot less of them were needed to adequately cover the Swiss territory in terms of accessibility.

However if this was to be taken literally, the whole network should have been deficient of centers, and not only its lowest levels. According to Christallerian theory, a B-center should have a market area of about 1'200 sq km, and an effective influence radius of about 20 km. In 1939 Switzerland, the mean market area of a B-center was only 500 sq km, the corresponding radius of influence being about 12.5 km. About the same contraction was seen for all upper levels of the Christallerian hierarchy: in all, upper and mid-level cities of the Swiss urban network thrived on territories basically 2.5 times smaller in area than the classical Christallerian network, where the population density was about 2.5 times higher than postulated. Thus, those centers served a population market of the size required by Christallerian theory, which in turn means that a market principle was at work for those cities: the urban network looked noticeably denser than in theory because the market, being itself denser, allowed it. The fact that the proportions between density excess and market area shrinkage are so similar is in fact a resounding confirmation of the Christallerian form of the Swiss urban network.

Further down, though, the network abandoned its dependence on market and reverted to a dependence on accessibility. The number of A-Centers closely matched the one we would expect of a Christallerian network on 15'000 sq km. It means that at this level, accessibility, or the 7 km radius rule, worked. When taking into account all centers in the network, the A-centers areas translated to a 85 sq km territory, and a 5 km radius, not quite what it would be if the market area shrinkage had been similar to what it was in higher levels of the urban hierarchy. This means that even by taking into account units that we think are not part of a classical Christallerian network, at the A-level we can't find a density which was similar to the ones exhibited by higher-up centers, which means that the market principle was not fully at hand, and that it was superseded by an access principle.

The conclusion is then twofold. First, the Christaller theory matched beautifully the Swiss urban network: from about 2'000 jobs up, the Swiss urban network was clearly market-oriented Christallerian. When considering a strictly classical Christallerian network and comparing it only with central places, or in our case urban places, however, there was a definite deficit under 2'000 jobs. Three reasons can be advanced to explain for this lack of units below 2'000 jobs as early as 1939. Either the urban network gets cut at this level – the greater density of lowland Switzerland as compared to southern Germany could explain a dearth of low level centers, their functions being covered by upper-level centers, whose density is high enough to get them close enough from one another to serve also as a basic level center, and thus to get rid of one Christallerian level. This is largely confirmed by the fact that the Swiss urban hierarchy above the A-centers is one step up from the classical Christallerian hierarchy: in 1939 Switzerland, the B-centers had a market area and a range that are vested in Christallerian theory to the K-centers, one level lower. If this view is right – and it certainly looks like it – a higher density in Switzerland allows the Christallerian network to move most of its centers one ladder up in the urban hierarchy. That would explain both the overrepresentation of upper and mid-level cities in the network, as well as the dearth of smallest centers: many of those having been promoted to the next higher level, while accessibility to the services of those pumped-up local centers hindering the apparition of purely local centers in the 4 to 7 km range.

A second possibility is that we have defined our categories too tightly, as exurban centers show a size distribution which complements nicely the urban network. However, that would mean introducing in the network places that weren't considered central in the Christallerian sense, that is, that do not provide services for a hinterland. An industrial village does not provide services for other than itself; its integration in the global economic picture is not dependent on services but on industrial output. That being said this argument would hold if all of our defined exurban centers are genuinely industrial towns; it is a distinct possibility that at least some of them exhibit true central qualities. But even taking those into account there was still a dearth of small scale centers as defined by Christaller; whether this deficit is about half or three quarters isn't of primary importance as compared to the fact that there was an important deficit. Conversely, it could be that most centers in the 1'000 to 2'000 job category aren't detected because of insufficient density or intensity; that is, our other requirements for inclusion as a center do conflict with Christallerian criteria. That would also say that the lowest Christallerian would be very difficult to detect as centers by any other means: they would structurally look like villages.

Further study should help us to determinate which of our three scenarios explains best the dearth of small scale centers. If the reason lies in a structural deficit of small scale centers with regard to our criteria, we could expect their later emergence as their structures, essentially job intensity, become more urban-like. If, on the contrary, the density and accessibility theory holds, then further development should show continued depletion of small-scale urban centers. On the face of it for the 1939 situation, it very much looks like the effect is a density – accessibility one, and we would thus expect the dearth of lower-level centers to remain during further developments.

5.9.6.2. After 1939

Data for 1955 showed a strong reinforcement of the urban network, which overshot the Christallerian distribution for all size classes, in a very big way in the 4'000 to 16'000 jobs class, and a catching-up effect in the 2'000 to 4'000 jobs class. However, the smallest centers class stayed as depleted as in 1939, with about a quarter of the theoretical value. Adding all members of the urban network has an impact essentially in the two lowest classes, but in all, it doesn't change the big picture much: there was now an excess of medium-sized centers alongside a dearth of smallest centers. This seems to indicate that the density-accessibility theory held for the smallest center classes, while the structural reinforcement theory was holding for bigger center classes. The result is an evolved Christallerian network with a higher density of medium-sized centers, and a dearth of smallest centers attributable to higher density.

The data for 1965 showed a definite furthering of this trend with ever more overrepresentation in the 4'000 to 16'000 jobs classes, a contamination of this trend towards upper levels, with a strong overshoot in the 16'000 to 64'000 jobs class. Conversely, numbers stagnated in the 2'000 to 4'000 jobs class and dropped significantly in the 1'000 to 2'000 jobs class. Meanwhile, the exurban centers made up for the big deficit in smaller units: in 1965 there was about twice as many exurban centers than urban centers in the 1'000 to 2'000 jobs class, and about as much in the 2'000 to 5'000 jobs class. It is as if traditional cities had started to vacate those size classes to occupy upper levels of the hierarchy.

1975 confirmed the trend aforementioned, by decimating the ranks of the smallest cities, while counts in upper classes remained essentially the same. Moreover, the decline was also sharp when the whole network was taken into account. By 1975, non-central centers were starting to have an impact. In all, the Christallerian network started to look distinctly un-Christallerian. By 1991, those tendencies had exacerbated to the point where the network didn't seem to respond to a Christallerian scheme anymore, with major overshoots first in the 16'000 to 64'000 jobs bracket, then in the 4'000 to 8'000 jobs bracket, while there was a severe undershoot in the 1'000 to 2'000 bracket. More interestingly, the curve looks the same when adding the non central members of the urban network at least down to the 5'000 jobs level; underneath it remained true that non-central units contribute a lot to the lowest levels of the urban hierarchy. However, while they contribute a lot to those lowest levels, they didn't fully compensate. A strong deficit still subsisted for the 1'000 to 2'000 jobs class.

Recent evolution has confirmed the trends mentioned above: in the classical urban network of 2008, there is a strong overrepresentation of centers in the 4'000 to 64'000 jobs bracket, where the numbers of centers are approximately double those we would expect from a Christallerian network, and marked underrepresentation of centers below the 4'000 jobs threshold, where numbers, averaged, are about one quarter of what should be expected by Christallerian theory. Adding the non-central members of the networks pads the curve from 64'000 jobs down: non-central units represent between a third and a half of the members in the 4'000 to 64'000 jobs bracket, and a clear majority under 4'000 jobs, a conclusion already reached in the preceding part. Even with those, the deficit under 2'000 jobs, already noticeable in 1939, remained throughout history. Furthermore, it is remarkable to recall from a previous part that during the latter half of our period of study, such small centers showed long-term structural deficiencies, with low densities and intensities. Not only are those cities largely absent from the Christallerian network, but the ones that are here are structurally weak.

When considering only the central units of our urban network, the evolution has been one of reinforcing of the upper and mid-level scales of the network, parallel to a destruction of its lower levels. In a Christallerian way, we could interpret this by emphasizing the accessibility parameter: when accessibility rose, it made local centers obsolete. Rise in accessibility meant that higher-order centers were now equally accessible to all while providing more goods and services. Thus, lower level centers withered while higher up centers could prosper by getting their market areas extended and getting rid of the local competition.

However, such a view is restricted to the classical urban network of genuinely, traditional central places that we devised. What to make, then, of the suburban and exurban centers which invaded the network since 1939 and which represent a sizeable fraction, about a half, of all centers beneath 64'000 jobs? Do they conform to a Christallerian spatial logic? Either they do, occupying "empty" spaces and interstices in the classical network, and that will mean that the Christallerian, hierarchical arrangement of places held throughout the century, or they don't, arranging themselves along other localization criteria, and that will mean that new spatial logics took over, at some point in time, from the Christallerian central place logic.

More generally, the discussion about size effects and the corresponding digressions about a Christallerian vision of the center networks show convincingly that the network was quite close to a Christallerian network in 1939, and that it evolved away from it since then. First, even if we lump into the network all exurban centers for good measure, there is still a historical deficit in numbers of small units, which was never corrected. This suggests to us that in fact the Christallerian network lowest levels are grouping something between 2'000 and 4'000 jobs, a conclusion that we could have reached also by asking for more stringent requirements in terms of density. It is a fact that the two lowest size classes of our urban network are below our density threshold and are included in the network only because of their intensity, which furthermore is barely special in its own right. Thus we have two different indications that seem to converge to place the limit of the classical urban network at somewhere between 2'000 and 4'000 jobs.

In any case, all questions that remain at this point are clearly spatial: are dynamical units truly new, or are they former classical units which morphed into dynamical ones? Does the spatial distribution of non-central urban units complement the initially strongly Christallerian network of urban centers, or do they locate along other lines? In particular, can they be assimilated to a lower level of the Christallerian network that seems to be in place in 1939? Having studied the theoretical locations of our centers as object classes, which allowed us a number of findings and which brought us where we are, it is now time to turn to the maps and study the actual spatial distribution of the urban network members.

5.9.6.3. A last look at Christaller

When looking at the maps, it is quite interesting to note that Christallerian structures seem to have survived in peripheral, non metropolitan areas of Switzerland. However, this observation needs to be qualified. When looking at the big picture, there is clearly no return to a Christallerian network. The classical urban network has seen an impressive reduction of the number of its units, and what remains of it are very much skewed towards big cities. As a whole, there are far less urban centers than in 1939, never mind 1965, but they are far bigger. Most of the smaller units have been dropped from the network, and in the vicinity of major urban centers, even fair sized ones have disappeared, Uster being a case in point. Meanwhile, edge cities have started to appear around major centers, to the importance of which they contribute at a regional, metropolitan level as well as compete for job places at the local level. The biggest of those units dwarf most regional centers: Kloten has as many jobs as Winterthur; in Western Switzerland, three edge cities appear at the ranks 3 to 5, behind Geneva and Lausanne but way before Neuchâtel and even Biel; in the Basle area, Schweizerhalle is well before the second city of the area, Liestal. The rise of the edge city can't be explained in a Christallerian way and is indeed an attack on the Christallerian system, making areas, instead of points, central. Christallerian central place theory can be reconciled with a view which considers whole areas - agglomerations, metropolitan areas, and so on, as centers, and up to a point, when considered this way, things might hold. However, Christaller is of no use to describe what is happening inside the areas, the relationships between the urban center and the edge cities, and to what extent they are engaged in competition. Moreover, there are now entire areas where a Christallerian network seems to be completely out of sorts with reality. In the Aare Valley, there seems to be no definite recognizable hierarchy between classical centers, edge cities and exurban centers. As a whole the classical centers of the area seem to have lost prominence during these times, as edge cities and even exurban centers started to successfully compete with classical centers of the area, while reinforcing it as a whole against other regions of the country. In Central Switzerland, meanwhile, classical centers are on the verge of being overrun by a ribbon-like corridor of edge cities which does not correspond to anything in the Christallerian book, while exurban centers are on the rise everywhere. True, pseudo-Christallerian systems still hold in more peripheral areas, at least when looking at the map. This, however, would be forgetting that the network lost almost all its smaller units. In fact, they may represent an intermediate stage towards a new territorial organization of urban units which is represented, in more complete forms, by what's happening in core metropolitan areas on one hand, and in outlying metro areas on the other hand. In a way all Swiss regions evolved from a basically sound Christallerian system, albeit one with specificities, as we have surmised earlier, to something wholly different; but it can be seen that one of the earlier stages of this evolution was the dropping of the smallest urban units, especially in the vicinity of larger centers, which was followed, in regions dominated by large centers, by the emergence of rapidly growing suburban centers, then by the morphing of former local centers into mixed urban-suburban centers in their vicinity. In the outskirts of the metro areas, urban hierarchies seems to experience continued dilution, and with the weakening of the urban structure and the concomitant rise of suburban and exurban centers, those areas seem to become a sort of giant jigsaw where urban units pepper the landscape with no apparent logic. Last, in those areas any of the urban category can take precedence, as is shown by the Lucerne-Zug corridor which has now as much importance as have the main centers of the area.

Thus a case can be made which states that the urban network organization has evolved from the hierarchical, proximity based, point-like structure of the Christallerian logic, to a more regional logic of greater urban regions, which function and count as one at the national or global scale, but which are composed of many urban structures, all of which participate to the dynamic of the region while competing against each other for prominence within the metro area. Furthermore, the spatial distribution pattern inside those areas do not match a distance-based network; it is our hypothesis that instead of a dominance on an hinterland, centers rely instead on their accessibility and more generally ease of access from the outside, most probably by car.

5.9.7. Job growth and highway development: the anecdotal evidence

The literature shows that there is ample anecdotal evidence of a link between the development of highway networks, especially in and around larger cities, agglomerations and metropolises, and the way jobs and economic activities relocated. As it is one of the goals of this work to establish this firmly and statistically, we won't delve much time on the anecdotal evidence we find of a link at this stage. However, we will conclude out trip into the spatial economical landscape of Switzerland between 1939 and 2008 by stating the obvious and not so obvious relations that link edge cities and highway exits in Switzerland.

The first remark we can make is that there is proximity indeed between highway exits and edge cities. Of the 25 largest suburban units of 2008, only one, Carouge-Praille in Geneva, is not situated on a highway exit, or at least developed way before the commissioning of the highway in its vicinity. When taking the 50 largest suburban units, 43 of them are situated on highway exits. In parallel, in 2008, all Geneva highway exits, all but one Lausanne exits, all Berne exits not situated on the Berne commune territory, most of the Basle exits in the same situation and most of the Zurich exits give access to at least one edge city. In terms of geography, then, the link between the two seems very strong.

In terms of temporality, the things are more blurred. True, many of the 25 first edge cities emerged after the commissioning of their highway exits, although by no means all of them. For instance, the two largest ones , Kloten and Cointrin, show growth temporalities linked more with the development of their airports than with their highways, which came decades later; Likewise, the Schweizerhalle complex came before the A2-A3 corridor and may be linked more to the development of a fluvial port there than to the motorway. But other cases are less explainable, like Emmen or Schlieren-Limmattal, which boomed during the building of their highways and not so much after. In those cases we may be in presence of an anticipation effect, although this would prove very hard to demonstrate. Anyway, on the other hand many of these units boomed way after the advent of a highway in their vicinity. Cases in point are the whole roster of edge cities in the Berne area, which boomed very late although they were served with a competent highway network very early, as well as several other ones. But that being said, it remains that a good proportion – indeed half of them – of the 25 major units of our roster did show their strongest dynamics at or just after the opening of a highway nearby – namely, this was the case for Wallisellen-Middle Glattal, Dietikon-Lower Limmattal, Baar-Sihlbrugg, Volketswil-Upper Glattal, Ecublens-Hautes Ecoles, Reinach-Upper Birstal, Crissier-Westside, Plan-les-Ouates-ZIPLO, Münchenstein-Lower Birstal, Cham-Blegi, Risch-Rotkreuz, Moosseedorf-Schönbühl, with many more showing indeed a stronger time lag, like the Berne cases or the Lugano ones.

On the face of it the argument seems strong to declare a link between the presence of a highway exit and the presence of a job center, especially in suburban areas. Indeed the listing we just made would qualify as evidence in many cases found in the relevant literature. However this is anecdotal evidence, and furthermore the relation of causality is far from being evident, with the temporalities not matching in more than just one or two outlying cases. Likewise, not all highway exits sported a job center in 2008 – conversely not all job centers developed around a highway exit. The only way to assess the extent of what are up to this point mere coincidences is to try and statistically demonstrate the presence of a real link between the two.

5.10. Management summary

All along this very long chapter, we have studied empirically the evolution of the urban network in the larger sense for a period of time of close to 70 years, across 11 business censuses from 1939 to 2008. We have delved deep into the thick results we could garner from this study. Here, as a conclusion, we aim to resume in several bullet points what are the major finds made during this journey that can enlighten us on what remains to be undertaken. Here is the list:

The center network in 1939 was a denser variation of the theoretical network postulated by Walter Christaller in his central place theory.

During the 70 years under review, the central network has evolved away from a Christallerian network towards what we could call a metropolitan model. As compared to the Christaller model, the metropolitan model is characterized by an overabundance of large centers, a dearth of small centers, the constitution of metropolitan regions centered on a massive center, constituted of a network of centers small and large which share a common destiny, especially in terms of evolution. Metropolitan areas are also marked by numerous and large suburban centers. At the national scale, then it can be said that the centers have concentrated on a handful of metropolitan areas which dominate, now more than ever, the economic landscape.

At the local scale, however, centers have decentralized. Where once most of the economic functions of a region were concentrated in its center, now a sizeable share of those functions are localized in suburban settings. The larger the center, the larger the share the suburban centers take.

Whereas in the Christallerian model, size didn't have a major impact on unit structures, meaning that in short, a large center looked like the addition of several smaller ones, in the metropolitan model size is a very strong structural determinant. The larger a unit, cluster or supercluster, the denser, more intense it is likely to be. This means that the central network evolved from a very territorial, fractal network which replicated itself at different scales – at least in terms of structures, to a very differentiated space, where centers are apportioned density, intensity and functions largely according to their size – with highly productive functions in dense, intense and large centers, while functions requiring space are relegated in the outskirts of metropolitan space – or beyond.

Three major evolutionary phases can be found in the way the network evolved from 1939 and 2008, although patterns pertaining to the three different processes we will identify can be found at all epochs.

The first period, up to 1965 – and in fact probably to 1972, was a phase of urbanization. It corresponds to a strong growth period, both demographically and economically, which befell above all on urban centers – this period saw a strong reinforcement of the urban network, and the first modest departures from the Christaller paradigm, all in a context of domination of the industry on the economy.

The second period, from the early 1970s to the early 1990s, was an epoch of suburbanization, with the end of job growth in urban centers, the massive development of suburban job centers, especially around the largest centers of the country, all in a period of strong tertiarization of the economic functions.

Lastly, the period leading to 2008 has been one of metropolization, with the incremental reinforcement of the largest urban areas to the detriment of local centers and the compartmentalizing of the Swiss territory into metropolitan areas on the one hand, and outlying peripheries on the other hand. While this process had started before 1991, it has not yet reached fulfillment – it is still, in 2008, a work in progress, but we think the processes at play have been thorough enough to confidently conclude that they are going to succeed in a near future.

In the sense of the preceding point, the swing between the central place world and the metropolitan world happened when jobs started to massively suburbanize, therefore getting the Christallerian model out of date to contrinute to create large areolar central areas that we called metropolises. This, in Switzerland, happened essentially between 1970 and 1990. This is also the period of massive development of the Swiss highway network, largely inexistent before 1964, and which general armature was complete by 1991. We think this is too much of a coincidence to be relegated as just that – an aim of this work is to show an association between the two phenomenons, and more largely, a link between accessibility changes and changes in spatial job patterns.

From here, several questions need to be answered. The next two chapters aim at detailing the economic specialties of centers given their location and their size, and then the dependency relationships that we can infer between urban and suburban activities, as to demonstrate or disprove the general assessment of the European literature that as a whole suburban centers are subservient places to urban centers, with less productive and subordinate functions. Then, the two chapters after those aim at studying the veracity of an indisputable link between accessibility and job locations.

6. Spatial division of activities amidst old and new job centers: a summary, 1975-2008

6.1. Introduction

Apart from the distinction between industrial and service activities, up to now we haven't delved into spatial division of labor and activities. It is however highly likely that the activity structures differ markedly according to units, clusters and superclusters, and also along the different categories we have used so far, such as location and centrality, dynamics, orientation, form or size, as well as according to its general environment, whether it is located in a great cluster or supercluster or not. The goal of this chapter is to study activities according to their job numbers across the country and in particular across the categories we just mentioned. It is also of interest to try to summarize the data along discriminating axes. The activity classifications we will use in this chapter discriminate the economy into up to 85 categories – however it may well be that broader categories could be used to explain the spatial differences we expect to find. In particular, broader activity classifications can be used; activities can also be grouped with regard to the qualification level of its workers, their productivity, the area they occupy, the productivity per area, whether physical interaction with clients – and thus proximity, is important or not, whether, at last, the workers belong to the "creative class". According to most urban theories we would expect some or all of these factors to be heavily discriminated along some or all the categories we used.

Many of the concepts we just mentioned have been treated in the literature, as has more generally the subject of spatial division of labor. We will then make a concise literature review about the concepts we will be using in this work, before giving precise definitions of the categories we intend to use in this chapter. Then, we will embark into the actual findings we have made when studying this subject, which will lead us to dissert about the justification of the notion of spatial division of labor.

6.2. Literature review and data considerations

6.2.1. A small literature review about the distribution of activities within urban space

The idea that economic activities are not located randomly and arrange themselves according to various parameters dates back all the way to Von Thünen 1842, which described how diverse agricultural specialties were located with respect to their market, represented by a city – however, Von Thünen 1842 applied his model only to agricultural production and assumed that artisanal, industrial and service activities were all located indistinctly in the city. That the city was largely undifferentiated up until the industrial revolution wasn't entirely true as most activities were clustered together so as to form specialized streets and boroughs, but besides this rather anarchic juxtaposition of specialized streets and places, there was no evident inner-urban structuring of economical activities, not as much in any case than political and religious ones.

The differentiation of activities inside the urban domain came essentially with the industrial revolution (Vance 1990). Initially, industrial activity was heavily dependent on water power. However, with the diffusion of the steam engine, industrial activities were freed from any link to particular places and could locate about anywhere. In parallel, the advent of railway transportation made it clear that the best locations for industrial activities were situated along and around railways and stations. However, in most cities stations weren't located right at the heart of the medieval city but near its limits, this location provoked a first wave of spatial division of the economy at the urban scale, with industries and warehouses situated in preferential places, on the outskirts of the medieval core. This is for instance exemplified in the Chicago school model of the city (Burgess 1925). In this work, most economic activities are concentrated in the loop, or downtown; however, between the downtown and the extensive residential suburbs which are at the heart of the Chicago School research, one finds a zone of warehouses and industrial locations which are linked to the innermost railway lines. Further in, major technological advances, most notably the availability of electric power and advances in building techniques allowed for the concentration of offices and shops in massive skyscrapers which were staffed and visited by suburbanites coming in downtowns by streetcars or metropolitan undergrounds, and which had to a large extent deserted downtown as a residential place.

At about the same time the generalization of automobile superimposed a new transportation network on top of the existing railway one. This had similar impacts on urban morphogenesis and activity divisions than the advent of the railway city before. As there are countless more roads than railways, the advent of mass transportation of people and goods by road allowed for a massive wave of dissemination, first of people, then of activities – in particular, the downtown role as a wholesaling place for the entire agglomeration was challenged by the apparition of the shopping mall, the first of which opened in 1923 in Kansas City (Vance 1990, p. 491). Even though residential suburbanization remained the overriding phenomenon since the advent of the automobile, by the 1950s urban geographers had recognized the ongoing dissemination of economic activities, first at the interurban level with the emergence of the metropolis or as Gottmann 1957 named it, megalopolis, but also, at least indirectly, at the urban scale, as for instance in Schnore 1956, which identified a vast array of economically specialized suburbs, both industrial and service-oriented, noting, though, that service-oriented ones were above all of local interest: while the industries were integrated in national and international economies, the services served above all the immediate surroundings, the vast expanses or residential suburbs nearby. Murphy & Vance 1954 saw that the initial wholesale and industrial area situated at the outer limits of the traditional downtowns were already in disuse by then, because they had migrated outwards. In the same article, they tried to define downtown chiefly based on the land value of the place, thus mimicking one of the great schools of thought about land apportionment in cities, that which makes it a function of land rent and which gave rise to the bid rent curve and the monocentric city models (Alonso 1964, Muth 1969). As early as 1964 the existence of suburban job centers was recognized as “urban realms” by Vance (Vance 1964).

All those authors pointed out that the activities in the centers were different than those of the suburbs – in particular, suburbs were the realm of land-consuming, lower added value activities such as manufacture, warehousing, wholesale and retail trade, as opposed to the high-intensity, high-value of the office activities of the downtown. The monocentric city model would attribute this to the cost of land, each activity locating as close to downtown as possible given what they can pay for rent, thus explaining the dispersal of activities to an essentially repulsive mechanism: all activities and people unable to pay for higher rent are pushed outwards. This was for instance shown by Murphy et al 1955, which also show territorial shifts in CBD location, away from industries and warehouses, and into former residential areas. In the 1970s, the functional differences between centers and suburbs were evident, with the suburban centers growing much more than their urban counterparts, those, however, keeping the most noble functions. These finds reasserted the prominence of the urban center even as it was decreasing in total job numbers and size as it was supposed to do so by shedding the lower functions towards its suburbs while retaining the most productive functions: professional services, finance, public Administration and communications (Guest 1977). Hall 1999 and Halbert 2005 very much convey the same impression, however both pointed out the specialization processes which were affecting the cities towards a duopoly of high end functions and select personal services. The numerous works Allen J. Scott consecrated to the subject by the early 1980s (Scott 1982, 1983, 1986) confirmed this, and concentrated on the disintegration of the fordist company into formally independent units which were then dispersed according to their core business – in Scott's sense, territorial dissemination was paralleled by institutional disintegration of firms and concerns. One of the merits of Garreau 1991, then, was to point out that professional services, highly productive jobs and flagship buildings were locating in the suburbs in what he dubbed edge cities, countering the general impression that suburban employment centers were subservient to the traditional downtowns and reserved to lower-end activities. Gong & Wheeler 2002 essentially arrived at the same results when studying Atlanta. Even then, it is still largely assumed that office jobs in edge cities are less glamorous and less productive than those of the urban centers. It is also assumed that back-office jobs are more likely to be relocated in suburban centers than front-office ones, which suggests that there is an intrinsic quality about urban centers in terms of human interaction. At the same time, some studies show a dispersion of high end functions from classical downtowns towards suburban centers, however those have to be structured, which indicates that agglomeration and interaction functions remain important for these activities (Coffey & Shearmur 2002).

In all, if intraurban activity dissemination had been recognized, it was seen as a process where desirable activities were still clustered in the central business district while less desirable activities were located farther away. But what determines the desirability of a given activity? Several contributions try to answer that question. Browning & Singelmann 1978 put forward a typology of service activities which is funded on five different criteria of desirability: added value per job, qualification level, whether the client is a person or a business, whether the activity is a public service, and finally whether the services are intermediate or final. Cunha 1984 applied this typology on Swiss services and enlarged it on industries, which were qualified with regard to their position on the international market, in three categories. Enlarged to agriculture and construction, the Cunha typology counts 9 classes: agriculture, weak industry (uncompetitive former industrial specialties), middle industry, strong industry (strongly competitive specialties), construction, distribution services (trade, transport and logistics), business services (including finance), social services and personal services, with business services and in a way strong industry being the most desirable, and weak industry being least desirable.

The Cunha typology of activities had seen wide use in Switzerland and remains one of the major ways to study activities in the country. However, given the strong theoretical emphasis given to job intensity and the capacity to pay a high rent in order to remain in the city center, other considerations can be used to assess the desirability of jobs. In particular, the added value per job, and the added value per floor area unit, seems to be relevant indicators of desirability and competition ability for prime location, as demonstrated for instance, in Zurich, Basle and Lugano by Güller et al 1980.

Apart for the measures of usage intensity: added value per job, added value per floor area, jobs per floor area, as just discussed, measures of job qualification and more generally of worker desirability can be used. In particular, the spatial distribution of jobs held by the creative class (Florida 2004) could be a good measure of job desirability. Florida 2004 acknowledges the idea that what matter most to companies hiring creative people is where they should locate with regard to their intended workforce instead of their markets, as their products are generally with so much added value that the cost to ship them everywhere is negligible. This idea was also present in Kotkin 2000 and the creation of what he called Valhallas, job centers geared towards getting creative people happy. In another way, and as stated before, the need for direct interaction seems to be a relevant quality which may be able to explain for differences between center types. Nuisances could also play a major role in the way centers specialize – we could expect dangerous, smelly, noisy, traffic inducing functions to be relegated to the "periphery".

The goal of this chapter is to test whether there are genuine differences between job centers when discriminated by location and position, dynamics, orientation, form and size, when compared to the different classifications we just summarily described. The next point describes in more detail how those classifications were built.

6.2.2. Data considerations

As specified in chapter 2, the data at hand does not allow us to study in detail the spatial division of activities for the whole period under review – the first census for which precise data about activities is available is the 1975 edition, with jobs dispatched in 51 activity classes. From 1985 on, we use a classification scheme in 85 classes corresponding to the NOGA 2008 activity classification scheme used by the Federal Statistical Office for its 2008 business census (SFSO 2008). The NOGA 2008 is a rather precise definition, which was provided with a passage key to the previous NOGA classification schemes which were issued in 2002 and 1995. We also recuperated an old passage key allowing for translation between the NOGA 1995 classification and the WART classification which was in use beforehand. By using all those schemes we were able to retrofit without much loss of information the NOGA 2008 classification scheme all the way to the 1985 business census, as far at the 2-digit level classification is concerned.

As we have said, the classification scheme used in this chapter is highly consistent for the 1985 to 2008 period. However, between the 51 activity classes of the 1975 classification scheme, and the 85 classes of the NOGA 2008 classification scheme, there are of course many differences. Fortunately, there is no instance where a NOGA 2008 class spans more than one 1975 class. In most cases, a 1975 class is formed of two or many 2008 classes. In most cases, the 1975 grouping does not affect too much the general classifications we will describe shortly, but in some cases, there are intractable 1975 groupings which members are grouped in widely different groups in the NOGA 2008 classification. The following 1975 groups are concerned: energy and water supply; postal activities and telecommunications; and finally business services, which included professional and menial activities as well as an important part of what would become the high tech sector. We can readily see that those groups were making sense at the time, as public services were in charge of water and energy supplies, and as telecommunications deregulation had not happened yet. However, this means that some of the categories we will be creating will lack some precision for the 1975 census; whet we'll be discovering when comparing the 1975 results with later censuses results should not be taken at face value – they are more of a broad indication.

With this reservation marked, we can now describe the classifications we have put into place for this chapter are described fully in a separate table, made available for the NOGA 2008 scheme as well as for the WART 75 scheme. The main remarks to be made as for those classifications are given here.

The first grouping we have made is simply the economic divisions as identified by the NOGA 2008 classification scheme (SFSO 2008), which groups the primary sector in one division, the secondary sector in five and the vast tertiary sector in 15 divisions, 13 of which are censed – extraterritorial activities and domestic services are generally not. In the retrofitting into the 1975 census it was found that there was no possibility to distinguish between two of the five industrial divisions, as energy supply and water supply were grouped. Thus, the 1975 division entitled “industrial services” groups what is referred as “energy supply” and “industrial services” in later censuses. Likewise, there are significant differences between the contents of the following classes between 1975 and later censuses: transportation, information & communication, professional services, and support services. Information & communication is the most affected division of all in 1975 counted only postal and telecom activities, whereas afterwards it lost postal activities to transportation but gained computing, IT services publishing and broadcasting activities from miscellaneous other divisions – respectively professional services, manufacturing, and public services. Professional services and support services are also strongly affected as the former included, in 1975, most of the latter as well as of information and communication services, which were then discriminated afterwards. As we’ve seen, some other divisions were also affected but less so than the four we mentioned.

We also applied strictly the Cunha classification scheme (Cunha 1988), which is composed of one class for the primary sector, four for the secondary sector and four for the tertiary sector for a total of nine classes. The only class attribution we made which was different from the original Cunha scheme concerned watch making, classed as weak industry by Cunha and as strong industry by us – of course, with hindsight, it appears that watch making operated a remarkable recovery during the last two decades and its importance on the world market allows us to make that decision. A second reason of this classification change is that the scheme we use does not allow for separate reporting of watch making, which is grouped with other high-precision industrial specialties such as electronics and optical equipment.

As we said, we have adapted the Cunha classification to our needs. This classification creates in industry three manufacturing classes which differ from Cunha’s ones as they regard more their territorial imprint and morphology that the destination of its products like Cunha. Thus are defined a light industry which groups industrial specialties from machines to watches, a heavy industry which includes metallurgy, chemical and pharmaceutical industries, and a base industry which is composed of the production of base products like food, clothes or wood products. In the service sector, the Dessemontet classification is essentially a more precise version of the Cunha classification, dividing the distribution services in trade and transportation, and splitting the business services in four: high tech, financial, professional and menial services.

The three categorizations of economical activities were completed by more classifications, aimed at discriminating economic activities according to a series of particular themes. Those particular themes are whether an activity is linked to particular places or not, the nuisances they produce, the qualification level of their jobs, the added value per job, the added value per floor area unit they occupy, their floor area per job, the interaction level with the outside world they need, and finally the creative status of their workers.

Our first categorization is whether the activity is linked to the geography and the nature of a particular location or if it can theoretically be located anywhere. Most current activities are free to locate everywhere, with agriculture, mining, water supply, air and fluvial transportation the sole exceptions, the first three because they depend on underlying earth resources, the two latter because obviously need an airport or a fluvial port, of which there are indeed few in Switzerland. In theory, everything else can pretty much be located just about anywhere.

The nuisance classification was made entirely on our own and split the economic activities in three classes given the amount of danger, pollution, traffic, noise or visual pollution they provoke. Mining, most heavy industries, water sewerage, and most transportation activities are classified in the worst section, agriculture, most of the rest of the industry, trade, accommodation and personal services awarded the middle classification while office jobs are deemed activities which are less harmful on their direct environment.

Likewise, the qualification level of the workforce was evaluated by branch, in five classes. The topmost class includes extremely qualified occupations such as law, accounting, management services as well as engineering, architecture, technical analysts, and scientists. All those occupations normally require a university degree and often some sort of graduate studies. Directly behind this topmost class come the activities with a large number of college graduates or high responsibility occupations, from the pharmaceutical industry, IT occupations, most financial services, education, and health activities. The third category include mid-level qualifications which require usually some professional schooling, from the most qualified industrial occupations in the chemical, machine and precision mechanical industries to marketing, public administration, social work and personal services. The fourth category, occupying skilled workers, include most of the industry and construction, as well as trade, transportation and logistics, many support and personal services. The lowermost class, that of unskilled labor, covers agriculture, mining, waste management, general construction, accommodation and catering, and the most menial services.

The added value per job was inferred using productivity statistics by economic branch from the Federal Statistical office (SFSO 2010b). However, those data concern only the market-oriented part of the economy, and does not provide for the productivity of non-market activities, such as most of the public services and administration. Therefore a second data source was used, that of the medium wages per economic branch (SFSO 2010c). Those data cover in good detail the 2-digit level of the NOGA 2002 classification (SFSO 2002), which was not very precise with respect to business services, which were lumped in one class then. To discriminate those activities, we used, in conjunction with the wages by economical branch, the wages by economic activity (SFSO 2010d), which allows to distinguish along what people actually do in the job instead of the branch in which their company is primarily active. A broad comparison shows that generally, productivity goes along with mean wage level, which authorized us to put a rough estimate on economic productivity for branches for which only wage data was available. When productivity data was available it was used as a base for the classification we put into place, which counts five levels corresponding to more than double, more than 1.2, around the mean, less than 0.85 and finally less than half the mean productivity per job in the country. For branches where those data were missing mean wage level was used as a proxy, however with narrower brackets such as the most extreme classes correspond to less than 0.8, respectively more than 1.25 times the national mean wage.

Güller et al 1980 gave a very precise description of the mean area used by job for a wide array of economical activities, based on unpublished results of the 1975 business census. To our knowledge the data displayed there hasn't been superseded by more recent ones. Thus, those data were used to form a 5-class categorization of the mean area per job and per economic activity, splitting the areas at 50%, 85%, 120% and 200% the mean area per job across all categories.

Having categorizations for both added value per job and area per job allowed us to create a compound 5-classes categorization expressing the added value per floor area unit, a measure of spatial density of added value.

The two last categorizations we created concerned the interaction need on the one hand and the creative class on the other hand. For the first we had to estimate to what degree a given activity had to be located with respect to the intended interaction with people and entities outside the establishment, be it customers, consultants, specialists, or competitors. As we didn't find much literature linked to this subject, we pretty much created our own, 5-classes categorization. The class with the highest need for such interactions groups, in our classification, financial services as a whole, management services, law and accounting services, and design activities. Those activities are those for which the status of the establishment is most important, hence their strong dominance in prestigious streets and location, while their need for interaction provokes their focus on transportation nodes and all places with exceptional people flows. Behind them, a vast array of activities do not need the prestige of central locations but need to be close to their intended customer base with which they need to have contact on a daily basis. This second category includes retail, accommodation, most personal services, the most public-oriented part of the public services, and some support activities. In the third category, the need for contact with the outside is not so stringent, or is kept in check by other needs, most notably for space. This third category includes car sales and repair, warehousing, an array of back-office activities and of qualified technical jobs such as most of IT, high tech, telecom and computing industries, an important part of social services, and the part of personal services most in need of space, such as sport and leisure activities. The fourth category is formed by activities which can be conducted without contact with the outside world but where there is still some link to it in the delivery of the goods or services – we put agriculture, wholesale trade, ground transportation and business support services in this category. The last category includes most of manufacturing and the most land-consuming service activities, notably air and fluvial transportation; most of the workers in those domains never need to face a customer in their daily activities, and only need interaction with people from inside the company, while they routinely need ample space to develop.

Finally, we rigorously implemented the domains deemed creative in Florida 2004 and thus reproduced in detail his classification. This resulted in a 5-class classification in terms of creativity. The creative core includes the publishing and medias, the whole computer and IT industry, engineering, architectural, analytical activities, research and development, market research, design, artistic and cultural activities and sports and leisure domains. Education as a whole is considered creative core by Florida but kept separated from the rest in our analysis. Around his creative core, Florida describes a second circle of professional creative people, in which he lumps all financial, legal, accounting and management activities along with health professionals, which we have kept separated from the rest of the creative professional class. All the rest of the economy is considered in the non-creative economy, either as production or services, the two other economic classes which Florida 2004 recognizes.

While it is delving on economical specialization, this chapter and the next one include agriculture as an economic activity, to the contrary of chapters 3 to 5.

6.2.3. Some useful measures

Data has been cross-tabulated for censuses from 1975 on using the classifications used in chapters 3 to 5 against the classifications we just described, with full-time equivalent jobs as our unit of measure. These tabulations gave job counts for each combination of categories. Our main goal is to study whether different places are structurally different, and how those differences evolved with time. Absolute numbers aren't of great direct use to respond to those questions.

Thus, in the following studies we made wide use of relative measures. The first measure used is the share of any category in total employment, which is useful to measure trends across the period under review, more so than absolute evolutions which are notably affected by economic conjuncture. Using percentages can however be deceptive – in cases on economic classes varying widely in size, chances are that relatively minor moves made by populous economic classes could be seen as more relevant than major moves in rare economic classes. As we are here interested in economic structure and diversity, changes in economic classes with few jobs could be very significant if those jobs are strategic. One way to equalize between all economic branches regardless of their job numbers is to use the location quotient. The location quotient of a branch b in a given area i is computed as follows:

$$LQ_{b_i} = \frac{b_i/E_i}{b_{tot}/E_{tot}}$$

Where LQ_{b_i} is the location quotient of the branch b in the area i, b_i is the job number (or any other quantifiable value) of the branch b in the area i, E_i is the total number of jobs in the area i, b_{tot} is the national total of jobs in the branch b, and E_{tot} the national total of jobs. In essence, the location quotient is obtained by dividing the local share of a given branch by its national mean. A location quotient of 1 signifies that the given branch has the same importance in the area under consideration than at the national level. A location quotient under 1 signals that the branch is under represented in the area under review, while a location quotient over 1 means that the branch is over represented in the area. We have made wide use of this indicator to check for local and structural imbalances in the economic structure of job centers.

While the diversity of a place can be accessed using location quotients for a variety of activities and making a profile analysis, we could revert to the Christallerian hypothesis that higher-order centers have a more diverse economy than lower-order ones. Following this hypothesis, we would expect to find in the most central city all activities present in all other centers, plus some activities which are only present in the top center. Regional centers would lack national center activities while grouping all activities present further down in the network, plus some others specific to the regional level, and so on. It is then possible to work on a centrality index which would take into account the rarity of some branches and their concentration. Davies 1971 proposes such a synthetic centrality index. The centrality of a place i is computed as follows:

$$C_i = \frac{1}{n}\sum_j \frac{N_{ij}}{N_j}$$

Where C_i is the centrality of place i, n is the number of branches considered, N_{ij} the numbers of jobs in the branch j located in place i, and N_j the national total of jobs of branch j. Essentially, this index sums the local share in the national total of a given branch across all branches; as such it emphasized both a center's size and diversity. A location accounting for 25% of the workers in each economic branch would then be attributed a centrality index of 25%, meaning that a quarter of all central functions in the area of reference is concentrated in that place. The centrality index certainly derives from the Christallerian paradigm, as it emphasizes rare and concentrated functions over populous and widespread ones. As it stands it is a better measure of tertiary sector diversity than of overall economic diversity, especially in a country replete with industrial specialties. Nevertheless, we have used this index both on the whole economy and on the tertiary sector wherever it was fit to do so, that is for the classifications in economic divisions and following Cunha and Dessemontet's schemes.

6.3. Structural changes at the national level

6.3.1. Economic branches

In chapters 3 and following we have seen that as a whole Switzerland's economy and job numbers have steadily grown during the 1939-2008 time interval, albeit with interruptions (*Chart 6-1*). Such interruptions occurred most notably in the mid 1970s, most of the 1990s and in the early to mid 2000s. Thus, the profile of total employment figures shows marked variations, alternating growth periods, for instance from 1975 to 1991, from 1998 to 2001 and from 2005 to 2008, with stagnant or declining ones, essentially 1991-1998 and 2001-2005. Those moves make the visibility of individual branches aor group of branches moves more difficult to read. The general impression is one of vast ebbs and flows linked to economic cycles in which structural change is difficult to point out.

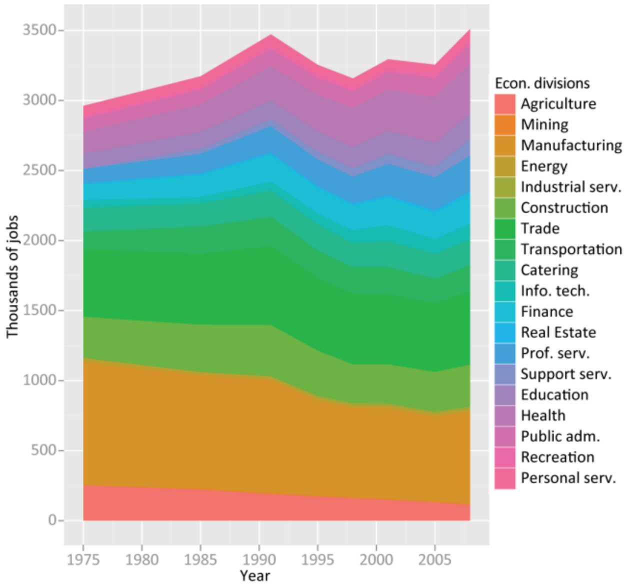


Chart 6-1: Job numbers by economic division, 1975-2008

By looking at the evolution of the branches share in the economy during the same period instead of at its gross numbers, we find that economic cycles do not seem to have much of an effect in terms of structural changes (*Chart 6-2*). All looks as if structurally, the economy smoothly transitioned from one state to another in a very regular and linear way. Looking at the Cunha classification, the coarsest of our lot, we can see that the economy can be broadly divided in

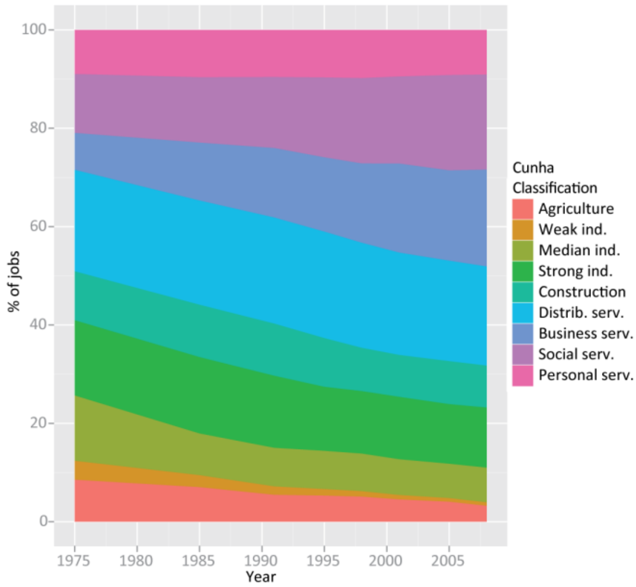


Chart 6-2: Job share by Cunha's classification, 1975-2008

three categories: declining, stagnating and expanding branches. Declining branches include agriculture (from 8.6% in 1975 to 3.3% in 2008), weak industry, which essentially disappeared from 3.8% to 0.7%, median industry, which suffered a near-halving of its importance from 13.3% to 7.1%, and to a point even the strongest industrial branches, which went from 15.3% in 1975 to 12.2% in 2008. Stagnating branches include construction, which is stable at around 9% of all jobs, the distribution services at around 20%, and the personal services at close to 10%. Finally, two groups expanded: the business services, from 7.5% in 1975 to 19.7% in 2008, and the social services from 12.0% to 19.3%.

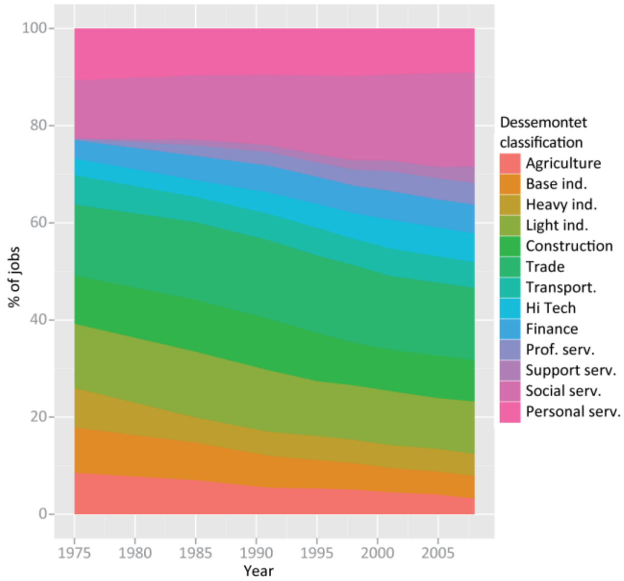


Chart 6-3: Job share according to Dessemontet's classification, 1975-2008

Looking at the Dessemontet categorization allows to see that the general industrial decline is above all due to basic and heavy industries, both halving their job shares from a combined 17.5% in 1975 to 9.3% in 2008 while the industrial specialties limited the losses to 2.5 percentage points (from 13.3% to 10.7%), while in the tertiary sector all business services groups grew: High-Tech from 3.4% to 5.9%, finance from 3.7& to 5.9%, professional services from virtually naught to 4.5% and menial services from nothing to 3.4%. Looking even further, at the division level, we find that in the public services all divisions grew, albeit not at the same rate: public administration, health and education grew moderately (respectively from 3.3% to 3.9%, 5.0% to 5.8% and 3.8% to 5.1%), while social services and residential care grew more spectacularly, from 1.2% to 4.4% combined.

This allows us to make the following findings, which we will use further down. First, economic cycles do not play a massive role in the way the economy evolves structurally. A declining branch is hit harder than an expanding one during recessions, and grows less in economic expansion phases – but in the end the transitions, in terms of job shares, are smooth. On the period under review there is no meaningful economic turnaround: declining branches decline, expanding ones expand, stagnating ones stagnate. At this time scale no significant reversal of fortune has been noted, at least when looking at economic divisions. This means that at the national level, the structural evolution of the economy is smooth and regular. The fact that these evolutions are so smooth is in fact remarkable – it is as if economic cycles were only happening at the surface of things, as a short term signal superimposed on vastly stronger undercurrents of structural changes.

This evolution is essentially part of the deindustrialization process which are common in Europe for this period, and of the affirmation of the service economy. Agriculture and large parts of the industry declined sharply between 1975 and 2008, and even the most successful branches of the industry suffered job losses during these times. For their part, services developed above all in two directions. The first is that of business services, which progressed vastly during the period under review, with the most spectacular advances made in professional and support services.

This seems to mirror the industrial decline and is certainly a consequence of the economical transition from a fordist model of production, where all services needed by the industrial and service conglomerates are internalized, resulting in giant companies actives in a bewildering array of specialties, to a post fordist organization model in which companies focus on their core business and contracts their non-core activities to independent specialized companies, most of which registered as professional services. The 11 percentage points lost by the industry between 1975 and 2008 are mirrored by the 12 percentage point gains posted by the business services in general, of which 8 gained by professional and support services alone. Apart from this shift, a second long-term trend seems to concern public services, with the slow but steady expansion of social care in general, which is to be put in relation with the slow but steady ageing of the population at large and the needs which come with it.

In all, the picture depicted by the economic branches is one of smooth transition from a modern, productivist, stable and integrated economy towards a post-modern, service-oriented, flexible and disintegrated economy.

6.3.2. Other classifications

Smooth evolutions were also found in most of our classification schemes, whether looking to levels of qualification and creativity required by the various branches, or their added value. The first classification we tested was the one discriminating the economy in two groups according to the link they have with special geographical conditions: terrain or land based economy: agriculture, mining… versus the rest. By 1975, the Swiss economy was already overwhelmingly free from geographical constraints, as only 9.9% of its jobs were linked to the land or physical geography conditions. However, the economy continued to evolve away from physical constraints and by 2008 the percentage of land-based jobs had declined to 3.9%, most of them in agriculture. In the same vein, jobs in nuisance-inducing branches of the economy retreated during the period under review. Jobs in branches which elicit few of no nuisance saw their share soar from 23.9% in 1975 to 42.1% of all jobs in 2008. This 18 percentage points gain was realized above all on branches generating moderate nuisance, which combined job share went down from 61.8% in 1975 to 48.8% in 2008, a loss of 13 percentage points. Jobs in branches producing lots of nuisances went also down but are not disappearing yet, from 14.4% to 9.1%. This seems to illustrate the shift from factory, hard-working, sweat jobs to more menial, less physically taxing jobs in offices and more generally in smaller, less visible places – in all, a transition from noisy, visible occupations to invisible ones.

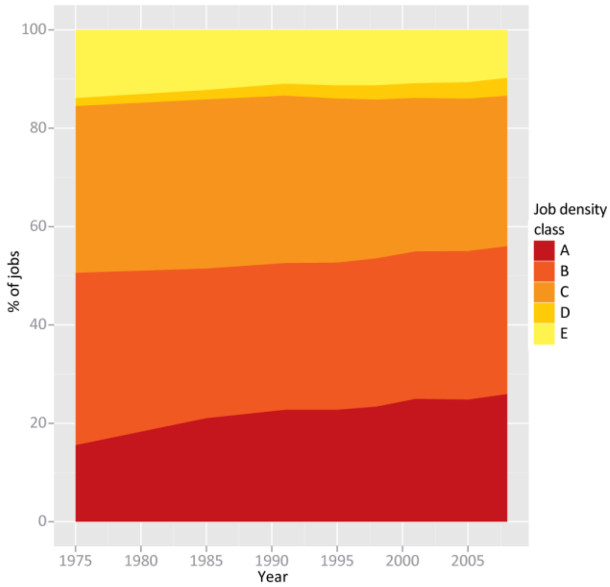


Chart 6-4: Job share by job density class, 1975-2008

In terms of people per built area, the trend is similar, if less evident (*Chart 6-4*). Branches with the densest settings in terms of jobs, i.e. branches with lots of office jobs, progressed quite strongly, from 15.6% of the total in 1975 to 26.0% in 2008 but a part of this progression was made at the expense of branches with higher than average job density, which went from 35.1% in 1975 to 30.1% in 1985. At the other end of the spectrum, jobs in the least dense settings, i.e. in fields, warehouses and complex industrial plants, went significantly down from 13.8% in 1975 to 9.7% in 2008, albeit some of this loss was offset by the gains made by the next category, those jobs in less than average density settings, which went up 2 percentage points from 1.6% to 3.6%. In the end, moves at this stage were rather subtle, above all due to the retreat of agricultural activities, and to marginal transfers from close categories.

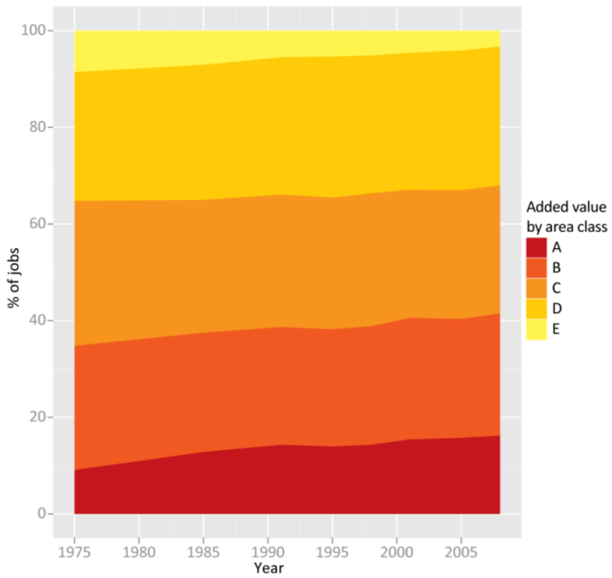


Chart 6-5: Job share by added value by area class, 1975-2008

The picture is clearer when studying branches in relation with their productivity or added value per area unit (*Chart 6-5*). Here, activities which generate the most added value per area unit, which are those which need the least space to prosper, did progress strongly from 9.1% in 1975 to 16.2% in 2008, gaining 7 percentage points almost doubling its job share. At the other end of the category, jobs in branches which need the most space to prosper (i.e. agriculture) lost more than 5 percentage points, from 8.6% to 3.3%. Between them moves were more subtle and given the importance of those medium classes, not very significant. The same could be said of branches classified according to their added value per workers (*Chart 6-6*). Branches with the most productive workers expanded greatly, from 6.2% of all jobs in 1975 to 14.6% in 2009, and correspondingly, branches with the least productive workers retreated, from 14.3% to 10.5%. All this indicates a long-term evolution of the economy towards branches with higher productivity, by area and by job, but this evolution is slow, in all rather unspectacular, and plenty of less productive jobs remain.

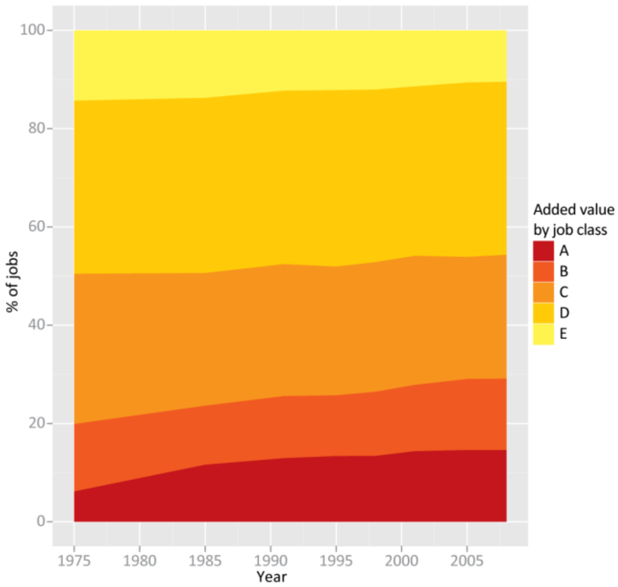


Chart 6-6: Job share by added value by job class, 1975-2008

Changes have been more marked in the way people interact at work. The transition from an economy dominated by the rigid organization of the fordist paradigm, where most workers had only their direct superiors or subordinates to talk with has been progressively replaced by a more flexible post fordist approach where smaller outfits maintain daily contacts with the external world of colleagues, partners, competitors, clients, consultants and contractors through a larger array of workers. We should expect then that the interaction part of any job should have risen during the period under review. This is effectively the case (*Chart 6-7*). The job share of the branches where intense contacts with the external world are the norm have strongly risen from 4.1% in 1975 to 10.4% in 2008. More spectacularly, branches in the two categories which workers are the least prone to have contacts with the external represented 57.4% of all workers in 1975, but only 41.8% in 2008. Most of this 16 percentage point loss is compensated by an 11 percentage point gain by the median category, which passed from 8.3% in 1975 to 19.8% in 2008. In all, while a large part of the workforce is still occupied in positions which require few contacts, if any, with the external world, the share of those job places where daily contacts with it are the norm have risen – this seems to confirm the post fordist hypothesis, but could also mean that more and more Switzerland is specializing towards highly interactive service activities.

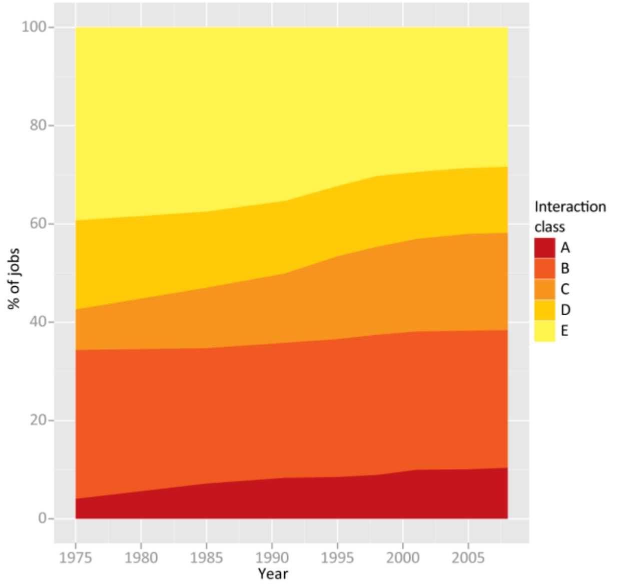


Chart 6-7: Job share by interaction class, 1975-2008

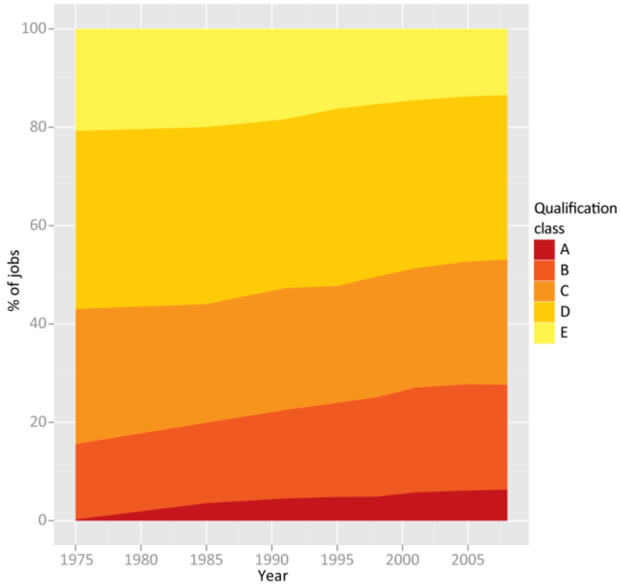


Chart 6-8: Job share by qualification class, 1975-2008

In line with the previous findings, education seems to play an ever bigger role in the Swiss economy. In 1975, branches which relied on highly qualified workers represented 15.6% of all jobs (*Chart 6-8*); in 2008, this proportion had jumped to 27.7%, a near doubling of the importance of these jobs in the economy. This 12 percentage point gain was mirrored by a 10 percentage point loss in the branches employing unskilled or low qualified workers, which sank from 57.0% in 1975 to 46.9% in 2008. Two conclusions can then be reached. The first is that Switzerland's economy is evolving towards a knowledge based economy and by 2008 more than a quarter of its jobs were high skills ones. Then again, almost half of the workforce still works in occupations which require few skills if any. A mildy alarming sign is that most of the loss has been in unskilled labor, which went from 20.7% to 13.5% between 1975 and 2008, which shows that jobs are becoming scarce for the most unskilled members of the society, a potentially damageable situation.

In complete agreement with the previous results, we find that creative jobs have become more important with time, almost with the same figures than those of the qualified at work (*Chart 6-9*). Creative jobs according to Florida 2004 were representing 15.9% of all jobs in 1975, but 27.4% in 2008. Interestingly, the progression has been more marked in what Florida calls the "professional creative", which proportion doubled from 8.0% to 15.1%, than in the "super-creative core" of developers and artists, which progressed more modestly from 7.9% to 12.3%. This may well reflect an innate carefulness of Switzerland which will always prefer developing

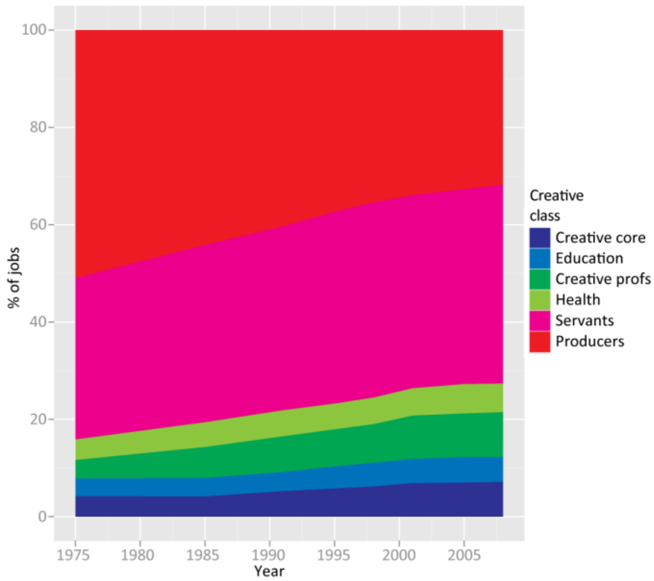


Chart 6-9: Job share by creative class, 1975-2008

qualities perceived as directly useful, than ones perceived as having no evident short-term value. However, the big story about the creative class may be outside it. Florida classified workers in three new classes: the creative workers, the service workers and the producers. In 1975, the producers, all jobs included either in agriculture or industry, represented 50.9% of the total jobs, while in 2008 they represented only 31.8%; conversely, the services, i.e. all tertiary activities not included in the creative jobs, went from 33.2% to 40.9% at the same time, thus progressing a little, and confirming Florida's hunch that the service economy represents the infrastructure on which the creative class can flourish. The result is quite telling: every two members of the creative class have three "servants" at their disposal to silently help them do their jobs without having to care for small things. Meanwhile, the production function was severely restructured, going from half of all workers in 1975 to less than a third in 2008.

6.3.3. A gentle move towards a knowledge-based economy?

In all, the picture drawn by the national evolution of the economy across a large series of classifications is quite consistent. It aptly describes an economy in transition from an industrial base, still very much present in 1975, towards a service-oriented economy, which dominates the picture in 2008. Looking at the various curves representing the evolution of the economy, we can't conclude that this transition is over yet and that we have reached a new equilibrium state – if such a concept is of any help. On the basis of our results, the economy is still changing, its structure evolving, some branches declining while others expand.

The evolution in which our period of study is embedded shows a transition from a production-based economy towards a knowledge-based one. The most significant moves we have found in all our classifications concern first the strong retreat of the agriculture and the secondary sector, what Florida groups into his production sector. Agriculture retreated by more than half in terms of job share, and such decline was common in many manufacturing branches. The only industrial branches which resisted somewhat were the industrial specialties: the chemical domain in general, the pharmaceutical in particular, the metallic products, the high-precision instruments industries resisted, as did more or less the whole construction sector. Everything else in the production sector suffered a lot, especially in the base industries and the ones not active on the international markets.

As a whole, the services progressed during the period under review, although in widely variable patterns across the branches. The distribution services (trade and transportation) stagnated as a whole, with a lone exception seen in the relentless progress of warehousing – yet another sign of post fordist disintegration as warehouses were typically internalized in the fordist model. As a whole, personal services also stagnated although this was more due to conflicting internal changes than to a general stagnation: the domestic reparation branch plunged, which emphasizes a change in the consumption mode, from one where object were repaired to one where they are replaced. It was compensated by the strong rise of leisure activities, which includes sports, theme parks and gambling – here, also, a testimony to the changes in the way people spend their time off. Public services as a whole went definitely up between 1975 and 2008, which can be linked to several societal evolutions, most notably ageing and the end of the extended family, both of which triggered a massive rise in social and residential care during the period under review, as well as significant growth in health activities. On the other hand, education also rose, and did so most significantly in college-level education, a welcome move for a society which transition from a productivist to a knowledge-based economy. The sector which gained the most during the 1975-2008 interval was undoubtedly the business services as a whole, and for two concomitant reasons: first because the whole of the economy was transitioning towards knowledge and creativity-based sectors, and secondly because of the functional disintegration of the economy which allowed subcontractors and consultants to flourish.

Those general branch trends are confirmed when looking at other classifications. The most significant moves seen through these classifications show the rise of the qualified, knowledge and creative-based economy, and the concomitant rise of menial occupations which serve this new ruling class, while producer activities floundered. This was confirmed by looking at the activities according to their place in the creative-service-producer trichotomy invented by Florida, by the intensity of their interactions with the outside world, or more simply by the qualification level of their workers – all these point at an economy slowly but surely on its way towards a knowledge-based economical structure. In a way but less evidently, those trends are also seen when looking at the productivity associated with jobs and floor areas, which all show a steady rise of occupations with high productivity per worker and a corresponding dwindling of low productivity occupations, whether by job or by area.

All trends seem then to point out to a gradual shift in the economy, from a productivist industrial economy towards a more and more service-oriented, knowledge-based, creative economy. This transition is very probably still in progress and at this time the Swiss economy is still restructuring and in transition. However, before delving into the main subject of this chapter, which is the differential localization of those branches and categories, we reflect here on the strengths and the weaknesses of the new Swiss economy. Since the industrial revolution, Switzerland has turned some of its inherent weaknesses – a near-complete lack of natural resources, and a difficult terrain to name just two – into strengths. The lack of resources meant a lack of mining and heavy industries, which were finally beneficial to the country which hadn't to deal with a massive industrial restructuration. In comparative terms, the Swiss industry was and still is highly competitive, based as it is on its specialties. With its famous universities and colleges, Switzerland was probably readier than most countries to embark on the knowledge economy revolution and it is a fact that even today, Switzerland weathers economical crises far better, with lower unemployment and better public finances than most. In this Switzerland probably profits from the international division of labor where low productivity occupations are subcontracted to lower wage countries, in Eastern Europe and in the developing world, while Switzerland can specialize in higher productivity occupations.

This has some important consequences. The main consequence is that for all their progress, creative jobs still represent just over a quarter of all jobs in 2008's Switzerland. On the other hand, production jobs have strongly retreated, in areas where jobs were taxing, but relatively protected by general agreements between unions and companies or the federal state. Menial service jobs, however, have maintained their numbers and even progressed a bit. Whatever happens to the strictly productive jobs in Switzerland, a large part of which could still disappear in the future, it seems likely that the menial service jobs will to form a major part of the economy tomorrow as of today. Those jobs, however, are clearly less protected than those of the productive economy. Wages are lower, hours are longer and more flexible, possibilities of promotion and social capillarity less evident in these domains than in productive domains. In that sense, a somewhat egalitarian society where jobs in less glamorous areas of the economy were cared for by powerful unions and nanny states seems to give way to a more discriminate society which mixes highly paid knowledge workers at the top of the economy with lower paid, flexible, less protected menial "small hands" for which union protection has all but disappeared. As the economy as a whole has become more flexible, flexibility pervaded all domains, all occupations, at all levels of the economical hierarchy – however for members of the ruling, educated and knowledgeable classes, this has probably not the impact it has on lower social classes. As we can envision it when looking at the allure of the curves we just discussed, the menial service class is likely to represent the majority of tomorrow's jobs in Switzerland, providing, as Florida 2004 puts it, the infrastructure and framework on which the creative minds of the ruling class will flourish.

6.4. The spatial division of labor, 1975

6.4.1. The economical structure

6.4.1.1. Location

In the sense of this subchapter, we understand location as being the classification of places in locations as used in chapter 3, that is the discrimination of job centers into one of the six following categories: urban, mixed urban-suburban, suburban, exurban, touristic and edgeless. Precise definitions of those categories and how they were built can be found in chapter 3. The main tool for this study is the location quotient, which will be used in conjunction with the total job numbers of the classes and the locations under review.

As a brief reminder, the 1975 spatial structure of the economy was dominated by urban centers, which accounted for 54.3% of all jobs, while edgeless space accounted for 30.7% of all jobs, a higher figure than in chapter 3 as we include here agricultural jobs. Other center types were of less importance. Suburban centers grouped 8.6% of all jobs, exurban centers 4.6%, touristic centers 1.6% and mixed urban-suburban centers only 0.3% - in practice they were inexistent.

Urban centers were then the main focal points of the economy, even when including agriculture (*Chart 6-10*). Their economical structure showed a very strong deficiency in agricultural jobs, which had a location quotient of 0.16. Likewise, by 1975, as a whole industry was already underrepresented in Switzerland's cities, with the exception of the industrial specialties, which maintained a location quotient above 1 in cities. In contrast, all tertiary categories were overrepresented in cities. This overrepresentation was particularly sensible in the financial services (location quotient 1.69, cities concentrating nearly 90% of all financial jobs), but very noticeable in the high tech (l.q. 1.38) and business services (l.q. 1.37) sectors. The urban specialization of transportation and social services is also clear albeit less so than the preceding sectors; in trade and personal services, the urban share is close to the national mean. In all, 1975 cities seemed to be specialized in several occupations. They held a monopoly on financial services and a very strong position in business services and in the high technologies, which was also seen in the rather good position held by the industrial specialties, decidedly the most urban domain of the service sector.

The suburban centers showed a very different economical structure. Agriculture was already as absent from them than from urban centers, however the industry as a whole was overrepresented in suburban centers, particularly the industrial specialties (l.q. 1.52) and the heavy industry (l.q. 1.44). Base industries and construction, by contrast, did not concentrate particularly in suburban settings. As a whole, the tertiary sector was deficient in suburban centers by 1975, however this masks very different realities according to the domains. Trade (l.q. 1.24) and above all transportation activities (l.q. 1.49) were overrepresented in suburban centers, while other tertiary specialties were largely absent like financial activities, or strongly underrepresented like high technologies and social services.

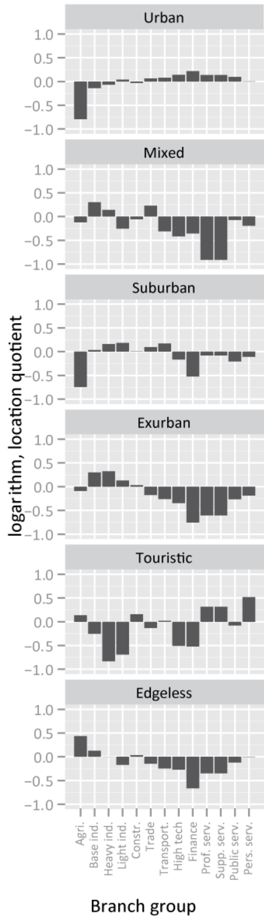


Chart 6-10: Lq by branch group and location, 1975

Even more pronounced was the specificity of exurban centers. Agriculture was as present there than in national mean, which expressed the transitional nature of exurban centers between urban and rural worlds in 1975. All industrial activities were overrepresented in exurban centers in 1975, some very much so: basic industrial activities had a location quotient at 1.99, heavy industries at 2.10. Industrial specialties were also overrepresented, while construction was present as it was everywhere else, close to the national mean. Services were universally underrepresented, with the most high-end services – finance, high tech and business services – essentially absent from the picture. Worthy of note, though, is the fact that even in the most overrepresented sectors of exurban cities, the exurban centers job share did not exceed 10% of the national total. Touristic centers were above all noticeable for the very strong overrepresentation of personal services, with a location quotient of 3.29, which is understandable as these places specialize in hosting and catering tourists – even so, personal services jobs in touristic stations represented just 5% of all such jobs in Switzerland.

Edgeless space, in job numbers, was second only to urban centers in 1975. Its economical structure was also very different, complementary to the urban one. Agriculture was very present there, with a location quotient of 2.73, represented one job in four at the time, and edgeless space grouped about 85% of all agriculture jobs of the country. Besides agriculture, the only domains overrepresented in edgeless space were the basic industries and construction. Everything else is underrepresented in edgeless space, either lightly, like heavy industry and personal services, or largely, like most everything else. In particular, most tertiary functions are largely absent from edgeless space, which represents 30.7% of all jobs but less than 7% of financial service jobs, less than 15% of business services, or just 16% of high technology.

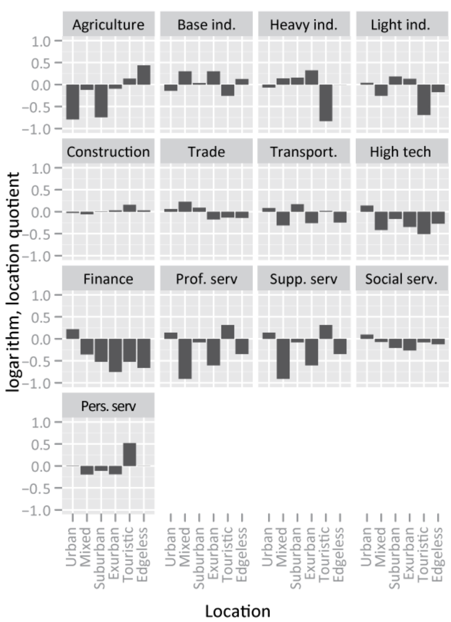


Chart 6-11: Location quotient by location and branch groups, 1975

It is equally interesting to look at these data the other way, by looking at the branch preferences (*Chart 6-11*). Economic activities seem to be spatially distributed along several very distinct types. Some sectors showed a strong preference for urban settings – this was above all the case for financial activities, which were strongly overrepresented in cities and underrepresented everywhere else, and also of social services, decidedly urban in their location preferences. Some branches showed a preference for suburban settings. This was the case in the industrial sector, especially light industry, and in trade activities. Basic and heavy industries showed a preference for exurban and suburban settings above all else, personal services and to some degree construction were strongly present in touristic areas, agriculture in edgeless space. Moreover, some activities were very strongly discriminant in their location choice – finance, agriculture, high tech activities, while others were rather ubiquitous, like construction and to a lesser degree trade.

All taken together, the economic structure of Switzerland by 1975 was strongly differentiated. Over the fact that cities were dominating the economic landscape, they were also specialized in two domains: first, the high end activities: finance, high tech, business services all showed strong concentrations in cities. This was also the case of the state power and its public and social services. On the other hand, cities were starting to show a dislike of industries, especially base and heavy ones. In all, cities concentrated power, both economically and politically, but weren't economically complete anymore, having started to lose its industries. Furthermore, their function as marketplace was already challenged by the place slowly taken by suburban centers. While rather feeble with only 8.6% of all jobs at the time, suburban centers had begun by specializing in land hungry activities and without surprise, all industrial domains as well as transportation and warehousing were overrepresented in them; but this was also the case of trade activities. Worthy of note is also the fact that the industrial preference of suburban centers went above all towards industrial specialties and heavy industry, i.e. towards quality industrial output. By 1975, suburban centers were not mere "industrial zones" anymore – they had started to diversify into the service sector and by seeing the most productive bits of industry starting to develop there. In contrast, less productive land hungry activities, like base industry and construction, weren't particularly present there. Exurban centers were the most specialized places of all with their very high industrial concentrations and the very low presence of everything else. In a way, touristic places were mirroring this intense specialization by showing the same overwhelming preference for hotels and catering, construction and some business services linked to construction. Edgeless space was indeed the inert matrix we alluded to in preceding chapters with a strong presence of agriculture and of essentially nothing else.

6.4.1.2. Size effects

Up to now we haven't introduced the notion of center size into the equation – but as we've seen in preceding chapters, size can have a major impact on how the economic structure varies with center size.

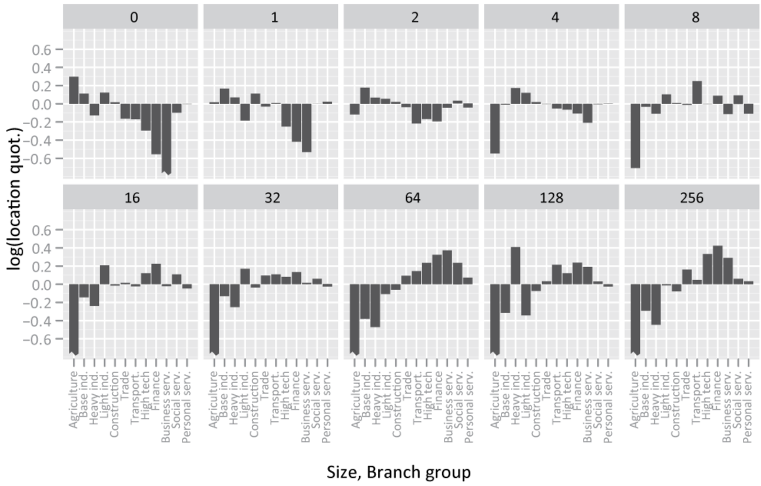


Chart 6-12: Location quotient by branch group and urban center size class, 1975

It appears that urban center size has a major effect on economic distribution in 1975, small centers having a decidedly different economic structure than medium and large ones (*Chart 6-12*). Very small urban centers, up to 2'000 jobs, sported an overrepresentation of industry and even agriculture, the overrepresentation in base and heavy industries surviving into urban centers up to 8'000 jobs. Correspondingly, those urban centers were service-deficient. A medium-sized class appeared which concerned urban centers between 8'000 and 64'000 jobs, in which base and heavy industries were somewhat depleted and services normally over their national mean, in particular in the high tech, financial and social branches. The last center category is represented by the big five, each of them with more than 64'000 jobs, and where industry was as a rule very depleted while most service activities were very much overrepresented, most notably the business services, overrepresented in those five centers only.

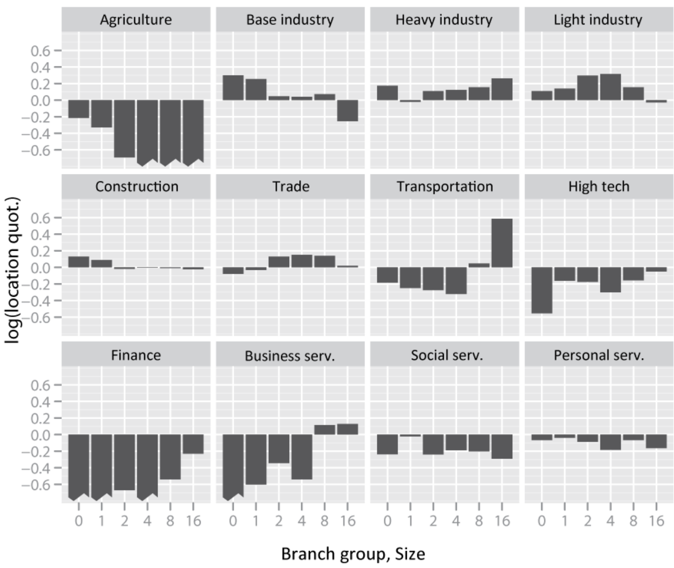


Chart 6-13: Location quotient by suburban center size class and branch group, 1975

Suburban centers had a distinctly different economy than the urban centers by 1975, and it appears that the economical structure of suburban enters was also governed in part by their size (*Chart 6-13*). A clear size effect is seen in the location quotients displayed by agriculture, confirming that smaller units looked more peripheral than larger ones, which is confirmed by the clear preference shown by base industry, which include food and leather industries, for smaller suburban centers over larger ones. The reverse effect was seen for heavy industry, which favors larger suburban units. In general, service activities, while deficient most of the time, were more deficient in smaller units than in larger ones. This was especially the case in transportation and more importantly in business services, overrepresented in suburban centers over 8'000 jobs, but the same trend was seen in financial and high tech activities. Industrial specialties and trade followed a somewhat different trend which saw them favor midsized units. In turn, there seemed to be a three tier specialization of economic activities according to the suburban center size: a lower tier where industrial activities dominated, especially base and heavy industries, a middle section, between 2'000 and 8'000 jobs, where industries, especially the specialty ones, cohabitated with trade activities, and an upper tier over 8'000 jobs where higher end service activities started to be important and supplanted the traditional industrial and trade activities. The very important position of transportation activities in these larger suburban centers was due to the fact that airport activities played a big role in two of them.

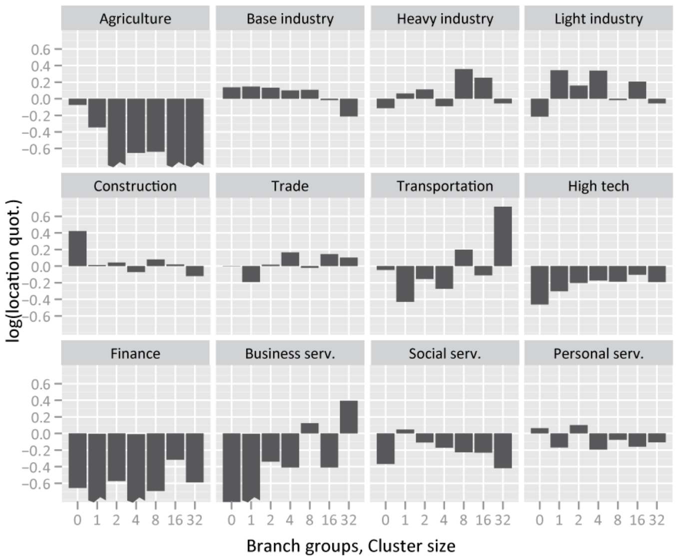


Chart 6-14: Location quotient by suburban cluster size class and branch group, 1975

It may be that unit size wasn't the best way to look at suburban centers. As we've seen in preceding chapters, suburban units, in the right conditions, can coalesce to form larger suburban clusters. It may be that looking at the size of those clusters may yield more meaningful results that to look at the mere unit size. However, this seems not to be the case in 1975 (*Chart 6-14*). Likewise, it seems that the size of the parent urban center didn't play as important a role in the economic structure of suburban centers than their size. In 1975, unit size was most discriminant for the economic structure of a suburban center.

6.4.2. Classifications according to added value, qualification and creativity

6.4.2.1. Location

As we already pointed out, cities in 1975 seemed to hold power, even if some of its functions were nibbled away by the rise of suburban centers. It may be, though, that cities were just pushing lowly activities out while concentrating high end jobs in their core. In that sense, the observation of what was going on when looking at the added value, qualification and creativity may be of value.

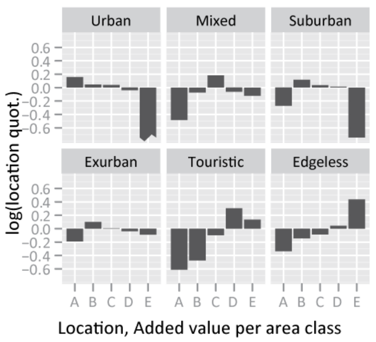


Chart 6-15: Location quotient by added value per area class and location, 1975

In our calculations, productivity is measured along two different ways. The first is to measure added value per floor area units, which should be relevant as it is an index of how much a company can pay for its rent. In a bid-rent curve, monocentric urban model, one would expect the most productive activities per floor area to concentrate in the best locations possible. And in fact that's what was seen in 1975 (*Chart 6-15*): in urban centers, there was a systemic gradient between the most productive activities by area, which were overrepresented, and the least productive ones, which were underrepresented. Conversely, in touristic and edgeless locations, the exact reverse was true with land-hungry occupations overrepresented and intense ones underrepresented – those areas relied on their vast expenses of real estate to generate their economic activity. In between, suburban and exurban centers displayed a mixed image. Both were clearly lacking the most productive activities, which seemed to be uniquely concentrated in urban centers. However, in all other activities, the same gradient was found than in cities. Bar the activities with the most added value per area, suburban and exurban centers behaved like cities: they had an overrepresentation of relatively high added value per area activities, and an underrepresentation of low added value per area ones. In that sense, they were already central, albeit lacking in the most productive activities and in that sense, subservient still to the urban centers. Nevertheless, they were already discriminate in their economic structure: by 1975 not every activity could occupy suburban center space: to be there, an activity had to be able to compete for rent.

A rapid examination shows that broadly the same held true for added value by worker – however the trends are clearly less legible than for added value per area, which was expected: what was really at stake was land use and not so much acreage per worker (*Chart 6-16*). The same general trends are seen, putting urban centers at the center, and touristic and edgeless space at the peripheries. Suburban and exurban centers, again rather similarly to one another, seemed to show a clear preference for middle class productivity occupations.

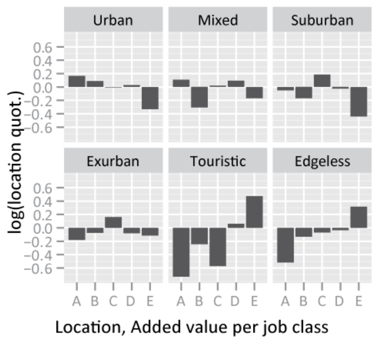


Chart 6-16: Location quotient by added value per job class and location, 1975

Another possible explanation could lie with the interaction level of various economic branches. The rationale behind it would be that branches in constant need of interaction with the external world would not have the same location requirements than activities which have no such needs. In particular, cities could be expected to host a disproportionate amount of interaction intensive activities as they would here find the contacts and the intercourse they need and in fact cross-communicate (*Chart 6-17*). In essence, that's what was found in 1975: cities concentrated more than their share of the two topmost interaction classes, while they were depleted in the three lowermost classes. The situation was reversed in suburban and exurban centers, which were lacking activities which needed interaction most – in fact the topmost class was uniquely urban and strongly deficient everywhere else. On the contrary, activities which weren't in need of interaction were strongly overrepresented in suburban and exurban settings, the same being true of edgeless space. Intermediate interaction classes were less discriminated, and in all there was a strong discrimination between activities with a strong interaction need, which were nearly all situated in urban centers (88.9% of such jobs were urban in 1975), and the interaction-less occupations, which were mostly situated out of

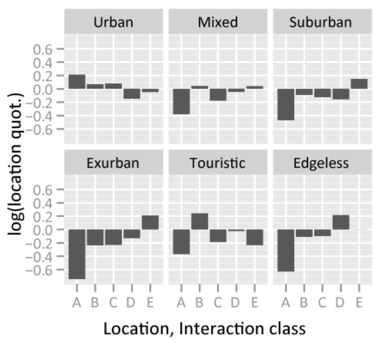


Chart 6-17: Location quotient by interaction class and location, 1975

town. In that sense, interaction played as big a role as added value per floor area to differentiate between town, outskirts and country.

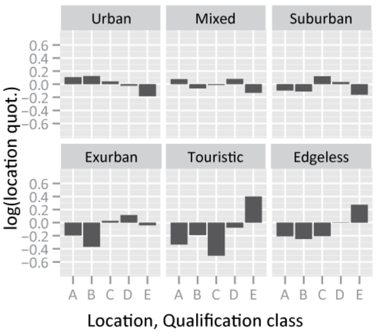


Chart 6-18: Location quotient by qualification class and location, 1985

The qualification data could not be reliably reconstructed for 1975, and instead we used data from the 1985 business census to look for the distribution of qualifications into the urban system (*Chart 6-18*). Data for qualification classes split by location type showed similar patterns with added value and a more subtle picture than interaction. True, urban centers were favored by highly skilled occupation, to a point where the two topmost qualification classes were overrepresented only in urban centers. Conversely, the two lesser qualification classes were underrepresented in cities. At the other end of the center-periphery dichotomy, edgeless space and touristic stations favor low-skilled labor and are deficient in medium and highly qualified occupations. Between the two, suburban and exurban space concentrated the medium skills, especially present in suburban centers, while lower to median skills were in use in exurban centers. Thus, the partition in three distinct qualification regions: urban, suburban, rural, seemed to hold well in 1985 Switzerland.

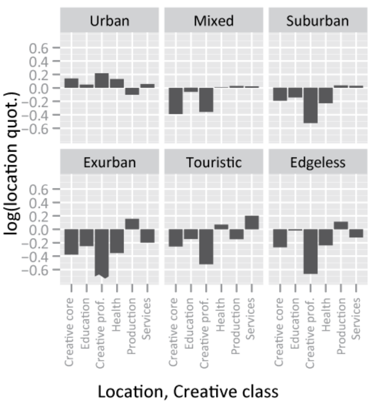


Chart 6-19: Location quotient by creative class and location, 1975

Lastly, the picture drawn by the territorial distribution of the creative class was decidedly cruder. The creative people, which encompassed the creative core, the creative professionals and education and health activities were all overrepresented in urban centers, and in urban centers alone; in all other settings, creative people were very strongly lacking, especially when not linked to universities or hospitals. The two other classes, the producers and the servants, were apportioned differently. Producers were overrepresented in exurban and edgeless settings, and well present in suburban ones. Servants were overrepresented in cities and in touristic settings and well present in suburban space.

6.4.2.2. Size effects

As we've seen in a preceding section, there was a clear structural effect of the urban center size and the suburban unit size. It is then legitimate to ponder whether center size played a role in the way the different categories of workers were apportioned in urban and suburban centers.

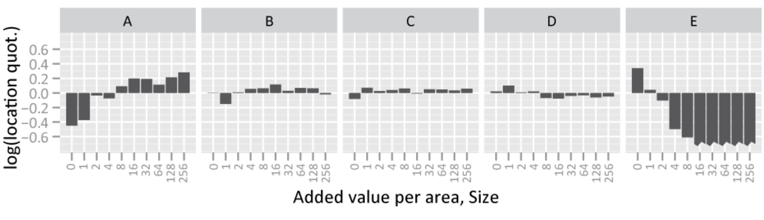


Chart 6-20: Location quotient by urban center size class and added value per area class, 1975

In terms of added value per floor area, the size effect was above all visible in the two extreme categories (*Chart 6-20*). The most productive activities per floor area, those most able to pay dear rents, are concentrated in larger cities, those over 8'000 jobs, while they are lacking in smaller centers. The effect is not very spectacular, but it is present. Activities directly behind the most productive activities show the same trend but in even smoother fashion and tend to be overrepresented in more centers, from 4'000 jobs on. Conversely, while the least productive activities per area of all, agriculture, was very strongly underrepresented in medium and large urban centers, the effect seemed to be rather feeble on all other categories of activities with regard to their added value per area.

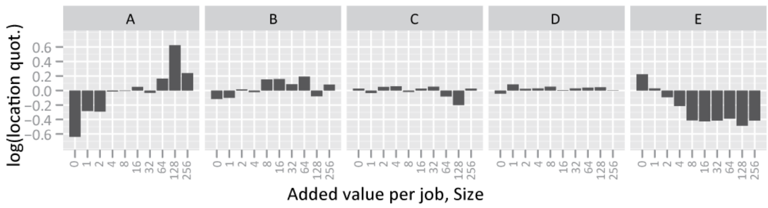


Chart 6-21: Location quotient by urban center size class and added value per job class, 1975

Essentially, the same conclusions were reached when looking at the added value per worker, although the relationship between productivity per worker and urban size was far more acute for the most productive activities, which were overrepresented only in the urban centers above 64'000 jobs – that is the big five – while clearly lacking in urban centers under 8'000 jobs (*Chart 6-21*). It seems, then, that the link between productivity and urban center size was more important when reported to jobs than to floor area. Interestingly enough, those considerations were only valid for the topmost classes of productivity. For all other classes, urban center size had no impact on the way they were apportioned.

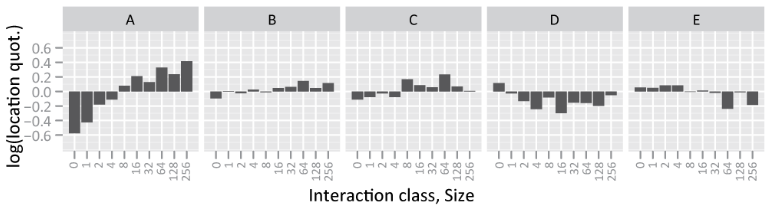


Chart 6-22: Location quotient by urban center size class and interaction class, 1975

The need for interaction showed a strong correlation with city size: the bigger the urban center, the more interaction-intensive activities were found, the turning point being situated at 8'000 jobs (*Chart 6-22*). Clearly, urban centers above this size were having special qualities to accommodate for interaction-hungry activities which were lacking elsewhere. As for added value, this size effect is above all noticeable for activities most in need of interaction, while there is a clear trend legible across all classes, with the three topmost classes showing an inclination for big centers, and the two bottom classes for smaller centers.

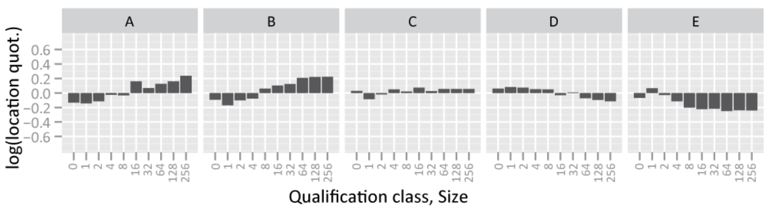


Chart 6-23: Location quotient by urban center size class and qualification class, 1985

The dependence on size showed more markedly when looking at qualification levels, with the two topmost qualification classes showing a similar inclination towards bigger centers, the two lowermost classes displaying the inverse tendency and the middle class showing no trend (*Chart 6-23*). In 1985, there was a very strong stratification of qualification levels in the cities, according to their size: larger urban centers concentrated qualified workers way more than smaller ones, and in larger cities, the largest concentrated the most qualified. In

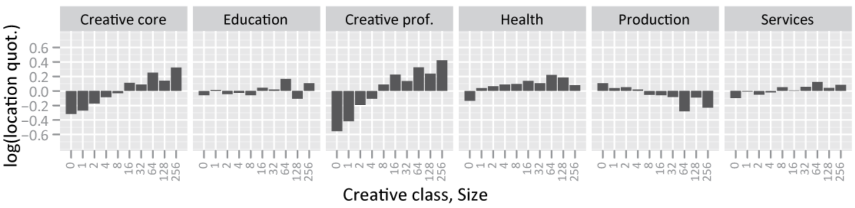


Chart 6-24: Location quotient by urban center size class and creative class, 1975

that sense, big was definitely beautiful. This was further confirmed by the pattern showed by the diverse creative classes (*Chart 6-24*). Here, the size dependency was even stronger for the creative core, the health professionals and above all the creative professionals, while it was more or less absent, save for some of the largest centers, in education. Production was slightly underrepresented in larger cities, servants slightly overrepresented.

There were several patterns of concomitant differentiation for the most productive, interactive, creative and qualified people in 1975's Switzerland: these elites were very clearly working primarily in cities, and in particular in large urban centers, above 8'000 jobs, with a preference for still larger centers. Interestingly, in most cases those differences affected only the most extreme workers: cities were far less differentiated by size when looking at other workers. It was as if in most domains size had only a slight effect on the way different classes of jobs and activities were spread, except for the topmost class, of which the largest cities had clearly a disproportionate amount. By extension, it seemed then that the command functions of the economy were primarily residing in the larger urban centers of the country.

Suburban unit size played a far less spectacular role in the way activities were distributed. In terms of added value per floor area or per job, there was no definite trend which linked unit size with area or worker productivity. Suburban center size started to play a small role when looking at interaction classes, with activities in most need of interaction showing a less definite dislike of suburban centers if those were rather large, above 8'000 jobs. The same trend was seen in less brutal form when looking at the creative classes, which showed less aversion for the largest suburban centers of the time. Finally, the qualification classes showed that the largest suburban centers of the time, those above 16'000 jobs, had stated to accumulate highly qualified workers, which they had close to the national mean (*Chart 6-25*). Size was also discriminating in lower qualification jobs, where mid-qualified workers were more present in large edge cities to the detriment of low skilled work. In all, suburban centers in 1975 appeared far less discriminated by their size, and for the most part, except for the largest ones, large edge cities were nothing much more than overblown smaller ones.

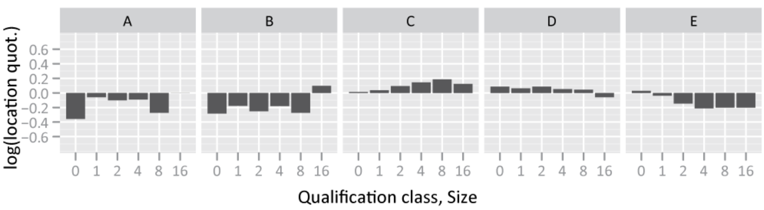


Chart 6-25: Location quotient by suburban center size class and qualification class, 1975

6.4.3. The 1975 urban network: cities ruling the roost

The picture drawn by the economic structure and the distribution of the different worker classes in 1975 was, in definitive, rather straightforward. By and large, cities, especially larger ones, ruled. They concentrated the political and economic power and its infrastructure, with an exclusive hold on finance and a stronghold on high technologies, business and public services. Their economic specialization towards the most rewarding activities made them a workplace of choice for the most qualified and creative workers, those which produced the most. In particular, some of the activities which could afford the highest rents concentrated in cities, and especially in larger ones, which meant that competition for land was probably fierce. Thus, lower-yielding activities had a propensity to vacate cities, at least large ones. And in fact, some of those activities were found elsewhere, most notably in suburban and exurban centers, and to a point in smaller urban centers, which were the repositories of industry at large, especially the heavy sort and the specialties, but also, more and more, of some service activities, such as trade, transportation, warehousing. Other locations were very specific: exurban centers were above all industrial, touristic resorts, well, touristic, and edgeless space largely undifferentiated, save for the still very strong presence of agriculture which probably still dominated its economy.

Thus, a three tier economic structure of the country was in place in 1975. A first tier, formed by the urban centers of a respectable size or more, concentrated the most productive economical and political functions and controlled, economically and politically, the country. Below this first tier of the economy, the second tier grouped small towns, suburban and exurban centers which specialized in land-hungry, relatively productive branches in the industry, trade and transportation. The lower tier of places in terms of economy was formed by edgeless space, dominated by agriculture. Worthy of not is the fact that not all economic specialties were preferentially located – in particular, construction and personal services seemed to be rather well spread across cities, suburbs and peripheries. More generally, the strong discriminations were above all seen in extreme classes. Only very discriminate activities were strongly discriminated: finance and highest skilled labor on one hand, agriculture on the other hand. For most other activities, including, for instance, land-hungry ones, discriminations were far less significant. Thus, it appears that spatial discrimination started with the most productive areas of the economy. It's not so much that land-hungry activities were pushed out of the centers – in 1975 they weren't. It's that the top activities, employing the top workers, themselves in need of daily contacts between them, needed the central city space.

6.5. The spatial division of labor, 2008

6.5.1. The economical structure

6.5.1.1. Location

As a brief reminder, the 2008 spatial structure of the economy is still dominated by urban centers, which accounts for 48.7% of all jobs, a slight 4.5 points decrease since 1975. Edgeless space has massively retreated since 1975, down 10.5 points to 20.2% of all jobs, a decrease above all due to the slow disappearance of agriculture. The main beneficiaries of these retreats are the suburban centers, which have nearly trebled their relative job share, up 14 points to 22.6% of all jobs in the country. Mixed urban-suburban centers are also strongly on the rise and had decupled their importance to 2.2% of the whole economy. Exurban and touristic centers have more or less maintained their relative shares, at respectively 5.0% and 1.3%.

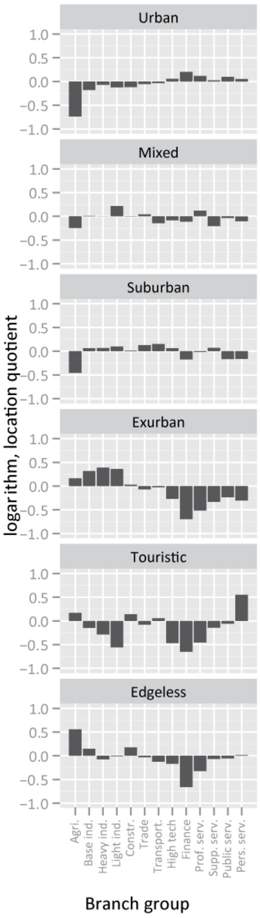


Chart 6-26: Location quotient by branch group and location, 2008

Urban centers are in 2008 as in 1975 the focal point of the economy (*Chart 6-26*). As compared to 1975, several subtle but real trends were seen. Agriculture, now as then, remains very deficient in cities – not a surprise. More interestingly, industry has retreated, especially the industrial specialties which have now vacated the urban centers (location quotient 0.75). More tellingly, some service domains are now underrepresented in urban centers: this is the case of trade activities (l.q. 0.88) and of transportation (l.q. 0.93). While still somewhat overrepresented in cities, support services (l.q. 1.06) and more importantly high technology (l.q. 1.13) have also been clearly disseminating. In all, urban centers in 2008 appear more specialized than in 1975. They are now strongly specialized in three key domains: the financial services (l.q. 1.59), the business services (l.q. 1.31), and the public services at large (l.q. 1.25). In all those domains, it maintained its dominance – however, this was acquired at the cost of losing its grip on other domains, the most meaningful of which are probably the light industry and of course the high technologies.

Suburban centers haven't only grown very strongly since 1975; they have seen their economic structure evolving. They are very much less industrial than before, having lost both in location quotient and in relative job share. These declining positions weren't taken by classical suburban occupations: trade and transportation maintained their positions but did not progress. Instead, suburban centers gained high technologies (l.q. 1.16) and support services (l.q. 1.18. Furthermore, suburban centers have seen a relative progression of professional services (l.q. 0.96) and even of financial services (l.q. 0.67, against 0.30 in 1975). In all, even while they were growing explosively, suburban centers were also gaining quality and diversity in their occupation, compensating a clear deindustrialization trend with the arrival of service and even some highly qualified functions, in the high tech most notably. Between the two, the mixed centers, which have appeared in the wake of the urban network metropolization, seem to have specialized in light industry and professional services while they seem depleted in trade, transportation and high technologies; in all their profile, albeit anecdotic, is special.

Exurban centers are even more specialized in industrial occupations now than in 1975; in particular, with a location quotient of 2.30, light industries are now as strongly overrepresented in exurban centers as the other industrial domains. At the same time, exurban centers have not seen their service activities develop, except in the most land-hungry of them, trade and transportation, which are now close to unity in terms of location quotient. As industry retreated across the country, it tended to relocate or to settle in exurban centers. At the same time one should not forget that industrial occupations have strongly retreated, so that the industrial job share has passed from 53.5% in 1975 to 45.7% in 2008. The overriding change is that light industry represents one quarter of all exurban jobs, against one sixth in 1975.

Edgeless space, which lost many of its locations to suburban space between 1975 and 2008, has nevertheless seen its economy diversify. Agriculture is still important in edgeless space with a location quotient of 3.60, but its job share has been halved, to 11.7%. Construction is now more overrepresented in edgeless space (l.q. 1.50) than before. More to the point, edgeless space has a more diversified economy than in 1975. In particular, while most tertiary domains are still underrepresented in edgeless space, many have progressed quite a bit since 1975, the cases in point being trade, transportation and support services. Arguably, those are low added value activities, and while those progressed in edgeless space, finance and professional services didn't at all, which alludes to the fact that edgeless space was still an area where the least interesting economic domains, also those with the most space requirements and the least skilled workers. An interesting half-exception in high technology, which has progressed much in edgeless space since 1975, as it has in other non-urban settings.

Looking at the economy through the territorial distribution of branches shows that for the most part, the economy is spatially less discriminated than it was in 1975 (*Chart 6-27*). Several branches have seen a reduction of their spatial disparities, like trade and transportation, which are, if anything, a bit more suburban and exurban than before. Public and support services have also grown more distributed, although the urban dominance of the first remained. Some domains, which were exclusively urban in 1975, have spilled on other locations. This is clearly the case of the high tech sector, now as well present in mixed and suburban space than in urban settings, of business services also, although they remain urban. In a way, even financial services are concerned by dissemination, with large progresses made by mixed and suburban centers to this respect. For its part, industry has become distinctly suburban and exurban, as even the industrial specialties have left the urban centers in which they were still overrepresented in 1975. Construction, already quite peripheral in 1975, disseminated further and is now with agriculture the only economical sector which displays a constant gradient towards peripheral locations. Meanwhile, personal services underwent the opposite way by concentrating on urban centers and displaying a stronger central gradient.

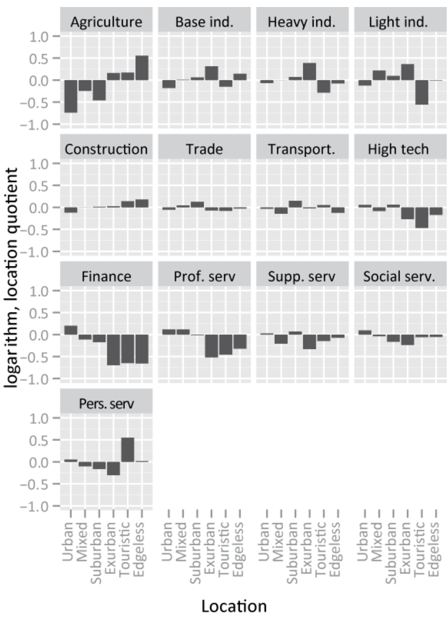


Chart 6-27: Location quotient by location and branch groups, 2008

In all, even if evolutions and profiles are quite diverse, the general trend is one of partial dissemination. Exclusive preference for urban centers concerns only finance and public services, and in those two domains the urban dominance has decreased. The disseminating trend has favored above all suburban space, which has seen its economy diversify and enriched by the arrival of high-end activities, high technology first, but also business and to a point financial services. These new suburban sectors supplemented more than replaced the traditional suburban sectors which are industry, trade, transportation and warehousing, as present as ever in suburban settings. Thus, suburban centers have grown in two ways: not only are they far larger in 2008 than in 1975, but in the meantime they diversified, so that their economic importance has grown even more than their size. This growth had more or less eclipsed other members of the center family. Exurban centers have turned more industrial, especially with regard to the rest of the economy, and even if they are now dwarfed by the massive rise of suburban centers – now holding four times more jobs than them. Mixed centers are certainly interesting places but they remain relatively sparse. Their economy seems to be transitional between urban and suburban centers. They are clearly less oriented towards land-hungry activities than their suburban counterparts, except for industrial specialties. They seem to complement their economy by a strong proportion of professional and financial services, as if the urban feel in suburban settings that they represent was fashionable to them. Conversely, touristic centers are still dominated by personal services, but if construction activities are still present there, the business services which were accompanying construction and development have left them, presumably for cities. In a sense, touristic stations are now more dependent, from an economic monoculture and from the outside world than they were in 1975. Edgeless space, to close, has lost much of its clout during recent times, which is due both by agricultural decline than by the nibbling of suburban centers at its expense. Nevertheless, what remains of it in 2008 is economically more diversified than it was in 1975, which confirms the general deconcentration trend we noted at the start of this paragraph.

6.5.1.2. Size effects

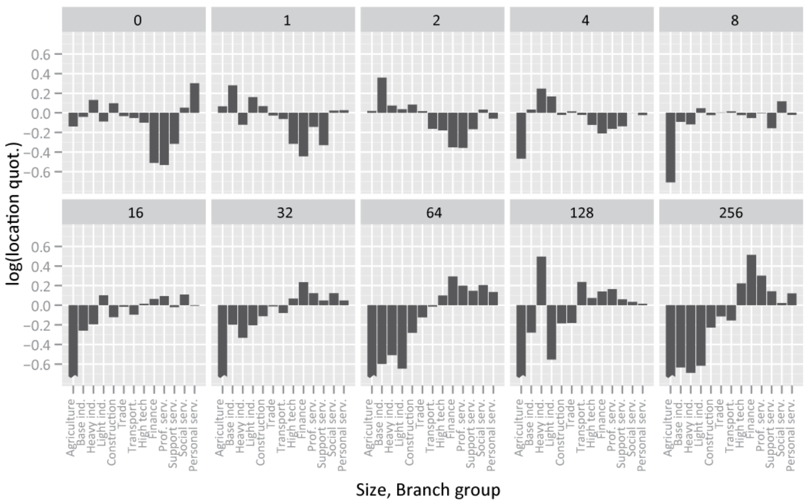


Chart 6-28: Location quotient by branch group and urban center size class, 2008

In 2008 as in 1975 urban center size plays an important role in their economic profile (*Chart 6-28*). Many changes are apparent, the first of which being the quasi-disappearance of agriculture as a player in centers of any size, whereas in 1975 it played a significant role in the smallest centers. Those smallest centers, extending up to 8’000 jobs, are the ones which have structurally undergone the most changes. In particular, their service structure was reinforced, particularly personal and social services, although progresses were also made in business and financial services. Nevertheless their structure remained rather unassuming with industry still well represented, at least in relative terms. The economic structure of medium-sized cities evolved in step with that of the country at large, which meant that their profiles remained rather unaffected between 1975 and 2008, showing a structure rather like the national mean but with a certain industrial deficiency. The deindustrialization process is seen above all in larger centers, above 32’000 jobs. In those centers, industrial branches have seen their importance strongly decrease. Those centers also lost positions in construction, trade, transportation and wholesaling, to the profit of financial activities and to a point of professional services. Thus, in the big five but also in the larger centers which immediately follow: St-Gallen, Lucerne and Winterthur, the economic structure has been inching towards ever greater specialization towards the most lucrative and productive activities, while abandoning successively the heavy industry, the industrial specialties, trade, transportation and warehousing. The eight major centers of the country have already undergone those changes, but as of 2008 those were limited to them and seemed not to have spilled over smaller centers the size of Zug, Lugano or Biel, which structural changes were no greater than those of the country.

There seems to be a strong correlation between the economic structures displayed by suburban centers when discriminated by size, whether the size refers to units, clusters or superclusters. In a sense, this is expected: bigger suburban centers tend to form bigger clusters and to be located in bigger superclusters. Smaller units in bigger superclusters tend to be drowned by the sheer mass of their larger counterparts. That said, the fact is that there is a strong correlation in 2008 where there wasn't anything remarkable in 1975, when size effects were strongly tied to suburban unit size, and to it only. By 2008, size effects weren't linked to unit size only – they were linked to their immediate and regional, one would say metropolitan, environment.

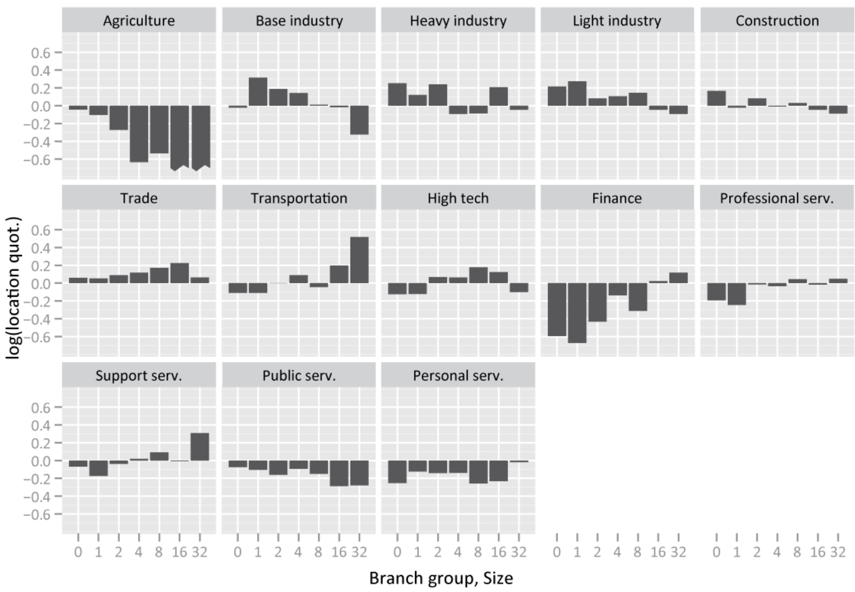


Chart 6-29: Location quotient by suburban center size class and branch group, 2008

In terms of suburban unit size, it appears that activities are somewhat more discriminated by size than they were in 1975, albeit rather less so than in 2008 urban centers (*Chart 6-29*). Expectedly, the presence of agriculture is inversely correlated with unit size, while the inverse effect is true for the basic industries, clearly more present in smaller units than in larger ones. This effect is also present but less legible for light industries and construction, and for heavy industry, the dependency on unit size appears tenuous. Conversely, larger suburban units appear to be keener on trade and transport activities – in effect, the largest edge cities of the country have become its trading powerhouses. Very interestingly, some superior functions start to make their presence feel in suburban space. High technologies are for instance overrepresented in suburban units above 2'000 jobs, the same class of units now equally sporting a proportion of professional services up to the national mean. The largest units, above 16'000 jobs, even sport an excess of financial jobs. This excess becomes sizeable for the very largest units. As unit size grows, public services become scarcer – evidently, public institutions haven't adapted their location to the emergence of large suburban centers. Finally, personal services remain largely unaffected by suburban unit size. As can be seen when looking at the same distributions but by cluster size, the same findings apply (*Chart 6-30*).

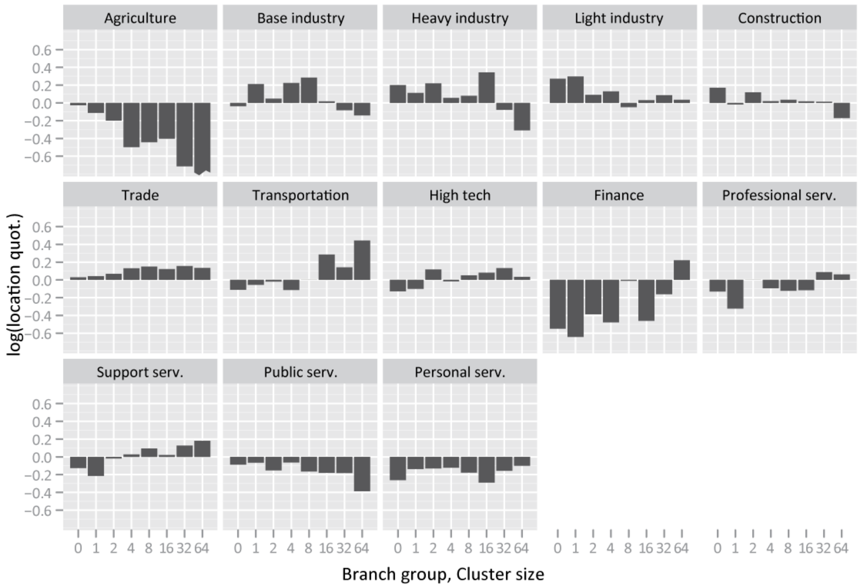


Chart 6-30: Location quotient by suburban cluster size class and branch group, 2008

Suburban centers have evolved the most during the period under study. They have trebled their job share, and as of today every fourth job is situated there. Moreover, we have seen that this massive growth was not obtained at the expense of the economic quality of those places, quite the contrary: with time, suburban economy seems to diversify. A third conclusion can now be reached, and it is that suburban center size matters. Very small suburban centers, those under 4’000 jobs, remain strongly industrial and devoid of most services. Edge cities over 4’000 jobs are qualitatively different. They are service-oriented, their economic structure is dominated by a mix of industrial specialties, trade, transportation, high technologies and professional services, while finance, public and personal services remain lacking. Over 16’000 jobs the economic structure changes again, with a rise of high-end activities, notably finance, concomitant with a very strong rise in transportation activities linked to the position of most major edge cities on vital transportation nodes, and above all airports. While not rivaling the major centers of the country, some edge cities are getting some quality economical functions develop in them.

6.5.2. Classifications according to added value, qualification and creativity

6.5.2.1. Location

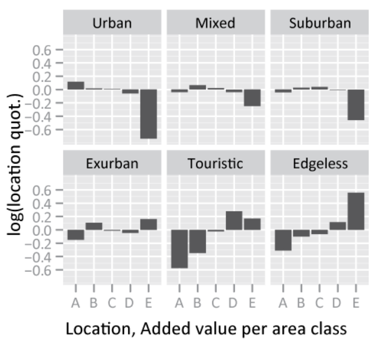


Chart 6-31: Location quotient by added value per area class and location, 2008

While the economic structure of the differing locations has changed with time, as has their relative importance, it may be that more fundamental determinants of location remained stable. In particular, did the behavior towards different qualities: added value per acreage and per job, interaction demand, qualification levels and creativity evolve with time (*Chart 6-31*)? A first answer is given by the distribution of jobs according to their added value per floor area. Two findings stand out: first, the distributions are virtually the same for 2008 as they were in 1975. Secondly, if anything has changed, it’s that this characteristic is less important today as it was in 1975, and thus that it is less discriminating now than it was then. There still is an overrepresentation of the most productive activities per area in urban centers; however this difference vanishes in mixed and suburban settings, as if floor area productivity wasn’t competitive anymore, except maybe in urban centers. On the other hand, touristic and edgeless space still displayed a tendency to host the least productive activities when measured per area.

The same conclusions are reached when studying added value per job instead of area (*Chart 6-32*): the territorial structures remained the same but were less stringent than before. By 2008, the added value per job of an activity is less discriminant in the way this activity will locate. That being said, urban centers remain more attractive for high added value activities, while touristic and edgeless locations are primarily occupied by low added value jobs. Edgeless space, though, is far less forbidding of high added value jobs than it was in 1975, a possible consequence of the ubiquity of communication networks, internet and cell phones.

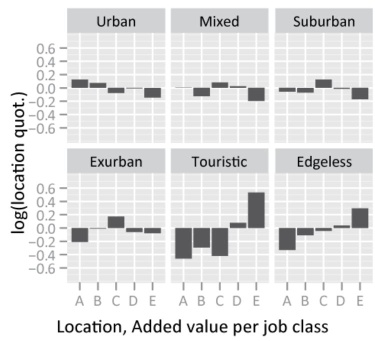


Chart 6-32: Location quotient by added value per job class and location, 2008

Up to a point remarkable stability is also found when comparing 1975 to 2008 by interaction needs (*Chart 6-33*): cities were still largely favored by activities most in need of interaction, which tended to avoid peripheral locations like exurban and touristic centers and of course edgeless space. However, interaction intensive activities were now also present in mixed and in suburban centers, whereas they were largely absent from them in 1975. In those two areas, the interaction profile was now close to the national mean, a clear departure from 1975, when most of the suburban workforce wasn't in need of inteaction. It is very tempting to link the emergence of interaction-intensive activities in those areas by the exponential development of mass communication means: the telephone and the internet allowed people who need to be in daily contact with the outside world to be located elsewhere than in downtowns. They choose suburban settings.

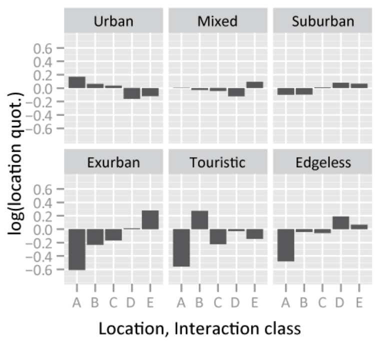


Chart 6-33: Location quotient by interaction class and location, 2008

Stability, still, prevails when looking at the qualification classes, with a twist (*Chart 6-34*): whereas the most qualified workers were very largely urban in 1975, separating urban centers from the rest, by 2008 this dichotomy's border had moved away from urban centers to include mixed and suburban centers. On the contrary, the highly qualified are now less present in peripheral space than they were in 1975 – in that sense, the economy strongly hints at a concentration-decentralization process: urban regions gain against peripheries, while inside urban regions, suburban centers gain on urban ones.

Chart 6-34: Location quotient by qualification class and location, 2008

The same findings are made when looking finally at the creative classes distribution (*Chart 6-35*). Again, the overall impression is one of stability between 1975 and 2008, with the only major move seen by the amelioration of the creativity structure of suburban and mixed centers, in particular regarding the creative core and professionals, which are the two creative classes associated predominantly with the pri-

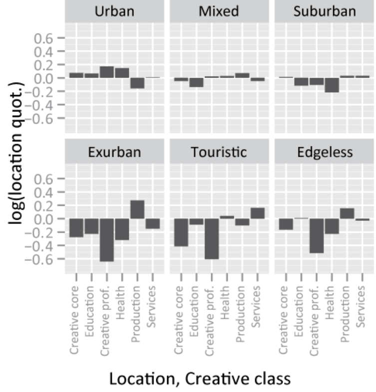


Chart 6-35: Location quotient by creative class and location, 2008

vate sector. Creative core people are now as well represented in mixed and suburban centers than in the country at large, while the very strong deficit in creative professionals noted in 1975 has been mostly bridged. Therefore, while cities remained the focal point of the creative economy, and in fact of creative professionals above all else, mixed and suburban centers strongly gained in creativity during these times, which makes them closer to classical urban centers, and farther away from peripheral locations: exurban and touristic centers, edgeless space, where such evolution wasn't seen. Notably, traditionally public sector creative occupations, in education and health, haven't displayed the same trends – presumably, state involvement in the way those activities are localized prevented them following the above mentioned trend.

6.5.2.2. Size effects

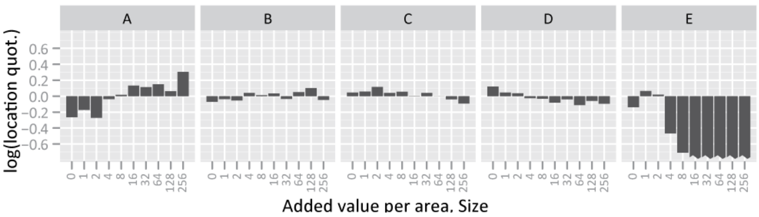


Chart 6-36: Location quotient by urban center size class and added value per area class, 2008

Again, it seems that searching for size effects in urban centers in 2008 yield approximately the same structures than in 1975 (*Chart 6-36*). In terms of added value per floor area, very few changes are apparent: the most productive activities tend to concentrate in larger centers, as in 1975, while differentiation is all but very subtle, if existing at all, for all other productivity levels. However, an important change is seen in 2008 in that the threshold for urban center size with an overrepresentation of highly productive environments has moved up: in 1975, cities with more than 8'000 jobs were including more than their share of very productive working environments, whereas in 2008, only cities with more than 16'000 jobs were concerned. It is as if the cities with 8'000 to 16'000 jobs had lost some edge in the meantime, a result which accords itself well with a metropolitan explanation of the Swiss urban evolution. In terms of added value per person instead of area, no meaningful variations were seen between 1975 and 2008 and the patterns found then were found again almost identical in 2008 (*Chart 6-37*).

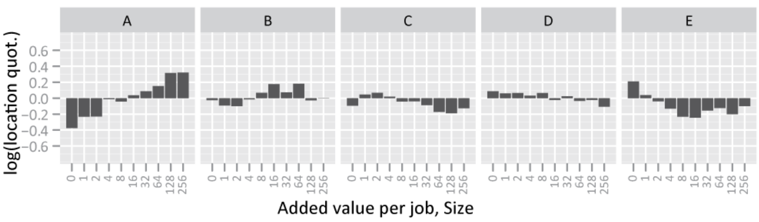


Chart 6-37: Location quotient by urban center size class and added value per job class, 2008

Interaction patterns controlled for size showed the same evolution than added value per area (*Chart 6-38*): in all very few changes except for a shifting of the limit between “small” and “large” cities, from the 8’000 jobs limit to the 16’000 one for the activities most in need of interactions. Changes were largely more spectacular when looking at the qualification levels (*Chart 6-39*). The most qualified activities continued to prefer larger cities, and here also the boundary between small and large passed through the 16’000 jobs limit; this was already the case in 1985. In all, the location gradients according to qualification levels were pretty much similar in 2008 to what they were in 1985. Essentially, cities were displaying about the same qualification discrimination trends towards size than then. Lastly, the creative classes showed similar trends (*Chart 6-40*) – here again, essentially the same structures as in 1975 were found, with the same limit shift from 8’000 to 16’000 jobs for the representation of creative professionals.

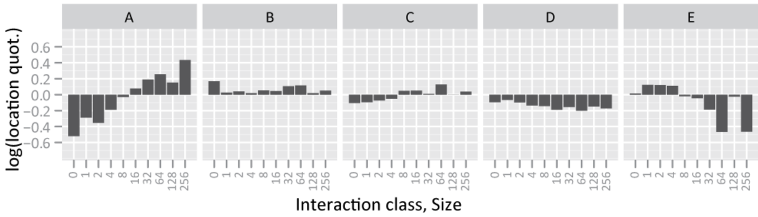


Chart 6-38: Location quotient by urban center size class and interaction class, 2008

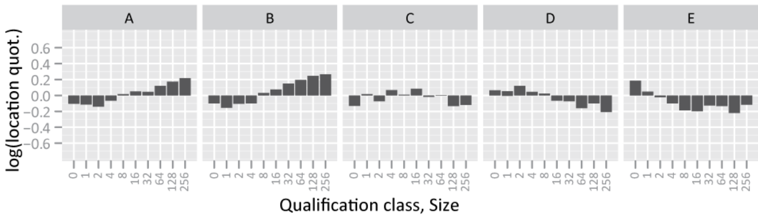


Chart 6-39: Location quotient by urban center size class and qualification class, 2008

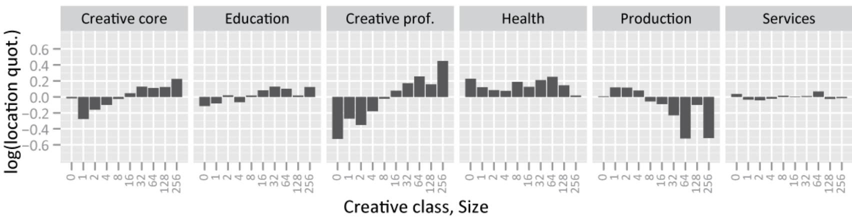


Chart 6-40: Location quotient by urban center size class and creative class, 2008

As in 1975, suburban centers appeared less discriminated by their size than urban centers (*Chart 6-41*). Except in the extreme classes, where some gradient was found, added value per job or per area didn’t show much variation according to suburban center size – however the presence of a positive gradient for the most productive activities, and a negative one for the least productive activities attest that a differentiation process is at play in suburban centers, albeit far less developed than in urban centers. Likewise, interaction prone activities are now present at their national mean in large suburban centers, which confirms that in those places at least, the communication quality is now as good as in urban centers. Rather surprisingly, discriminations found in 1975 in terms of qualification levels weren’t really there anymore in 2008, as if suburban space had become undifferentiated, at least by size, during the period under review – the effect seemingly being that what was then only possible in the biggest

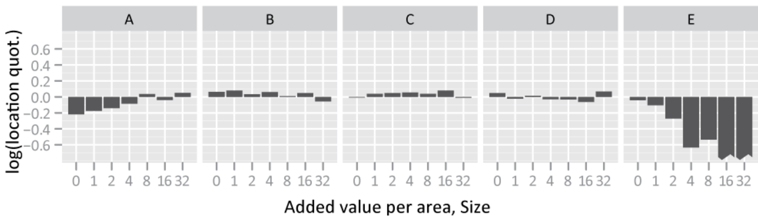


Chart 6-41: Location quotient by suburban center size class and added value per area class, 2008

suburban centers of the time is now commonplace in all edge cities above 2’000 jobs: qualified jobs have percolated down in most sizeable suburban centers.

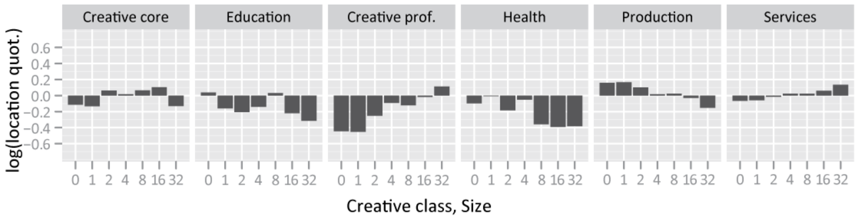


Chart 6-42: Location quotient by suburban center size class and creative class, 2008

In terms of creativity, the most striking move from 1975 was that creative people now pervade most suburban centers (*Chart 6-42*). Creative core professionals are overrepresented in all suburban centers over 2’000 jobs, whereas they were underrepresented in all categories in 1975. Creative professionals, virtually inexistent in suburban centers below 16’000 jobs in 1975 are now present in edge cities over 4’000 jobs and even overrepresented in the largest ones. Moves in the public sector creative people, as well as in the producer and servant classes weren’t as spectacular.

In all, results show that, beyond a general and very solid stability trend, the qualification of complete urban center is somewhat more exclusive now than it was in 1975, with the limit between small and large urban centers having moved up one ladder: to have genuine urban qualities, urban centers need to be bigger now than they needed to a generation ago. In the same time, important but subtle structural changes have happened to suburban centers. As a whole, qualities which were only present in the largest suburban centers of 1975 are now far more common, in far smaller units. Not only have suburban centers grown, most of them have radically bettered their economy and the quality of the jobs found there, an evolution probably made possible by the generalization of post-modern communication means like the internet, the email and the cell phone.

6.5.3. The 2008 central network: between evolution and stability

The picture drawn by the economic structure and the distribution of the different worker classes in 2008 shows two seemingly antagonistic trends. The first trend is that of a strong evolution, exemplified by the structural changes of the economy from an industrial-productivist one to a post-industrial, knowledge based economy, and territorially by the concomitant rise of suburban centers as a real alternative to a city-exclusive dominated economy. Between 1975 and 2008, the different locations accompanied the general structural changes of the economy and quite naturally this evolution was seen in all locations: the major part of the variations between 1975 and 2008 are purely structural. That being said, apart from those general structural trends, some additional, spatial variations are seen. Cities are less industrial now than then, in a manner which isn’t explained only by generic structural changes: there has been a genuine industrial exodus from the urban centers, which lone exceptions such as the pharmaceutical industry still heavily located in Basle can’t hide. If industry has by 2008 essentially left urban centers, especially large ones, it seems to be followed, at a distance, by several other occupations, which showed strong tendencies to disseminate, among which the high technologies, trade and transportation, all activities without too much need for interaction with the city. Thus, cities ended up specialized in the highest economical functions of all, finance and professional services. This duopoly is complemented by the political functions, which still privilege the city as the locus of power.

With every fourth job in 2008, suburban centers have become major economic players in Switzerland. Not only have they grown explosively between 1975 and 2008, but they have seen their economical structure diversify by hosting more and more service activities, and notably those leaving the urban centers: trade, transportation, but also some high end activities like the high technologies and to a certain extent the business services at large. In contrast, other locations didn't show much move and appears a bit monolithic in their specialties, exurban centers as industrial holdouts, touristic stations as leisure places, and edgeless space as an all encompassing matrix. The latter experienced both a significant decrease in economic significance, and a certain diversification of its economy, both being largely due to the decline of agriculture.

But then, overriding those notable changes, results also confer an image of stability, if not in terms of economic structure, in terms of workforce qualities: added value, interaction needs, qualification and creativity. Here, changes were above all structural and people with approximately the same qualities as before worked in approximately the same settings. The sole real change in this picture is the rise seen in suburban workers qualifications and creativity, which marks the fact that suburban centers have started to become acceptable workplaces for at least a good slice of qualified, creative people, most notably those in high technologies: scientists, engineers, computer professionals, who don't need the constant interaction people in banks and some consultancies need. In fact, the economical structure changed, while the qualities of the people exerting those activities largely didn't. It seems to mean that economic structures aren't as durable as geographic, location-based structures, which has some far-reaching and stunning consequences when used as a basis for thought experiences. For instance, it might be that the massive development of suburban centers is a consequence of the massive development of just the right kind of activities, those which occupational needs and structures are best fitted to suburban space. In essence, the strong development of high technologies was bound to benefit edge cities the most as high tech activities need perfect infrastructure: new, wired and adapted buildings, generally some space, but with no particular needs to interact with clients, consultants and competitors than other activities. However, the rare moves seen in the structural changes have tended to favor suburban space: the largest edge cities are starting to look like urban centers in terms of qualification and specialization of their economy. There must be more to suburban development than the coincidental development of activities made for suburban space – nevertheless, this probably explains a lot about their emergence.

6.6. Some dynamical specifics

6.6.1. Job shares against location

We have already given plenty of indications about the way the urban network evolved since 1975, but before we close this chapter we'd like to illustrate those changes through two specific points of view, the first of which is the way job shares according to different structural and quality classifications are distributed along location types.

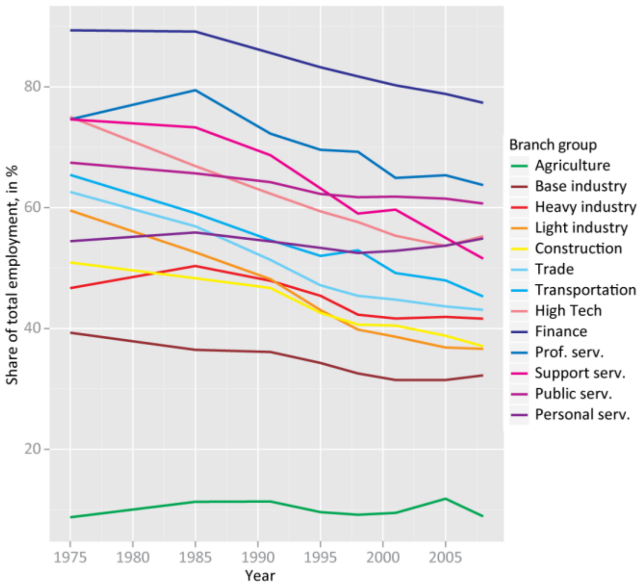


Chart 6-43: Share of total employment in urban centers by branch group, 1975-2008

The four charts used in this paragraph display the way the branch groups of the Dessemontet classification are distributed in different locations from 1975 to 2008 (*Chart 6-43*). It can be seen that in general the prevalence of urban centers on the economy has decreased with time and most activities have seen the job share occupied by urban centers decline a bit. This decline is particularly strong for industrial specialties, which went from 60% in 1975 to less than 40% in 2008, and for high technologies, from 75% in 1975 to 55% in 2008 although there's been a recent upturn in the urban job share of high tech activities. Support services have also seen its urban job share decline sharply, a trend which starts to be also evident for the most noble of all activities, finance and professional services, although their decline is more recent. Conversely, some activities have maintained their urban base, most evidently public services and personal services. While the first mentioned can readily be explained by the lack of economical incentives to make the public sector move, the latter could be linked to the fact that cities are becoming more person-oriented than economically motivated - in any case, the evolution of the urban share in personal services is spectacularly against the general trend.

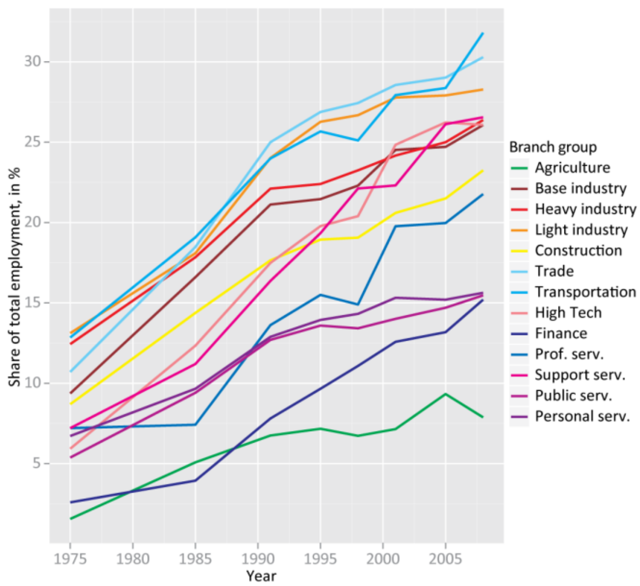


Chart 6-44: Share of total employment in suburban centers by branch group, 1975-2008

Suburban centers have gained job shares in all activities, in great part because of their very strong overall development since 1975 (*Chart 6-44*). However, amidst this pattern of growth different trajectories are seen. With a suburban job share around 30%, the industry as a whole, trade and transportation suburban jobs are now almost as numerous as those of urban centers. Those branch groups are also those which have seen the most suburban growth of all, accompanied in that feat by the odd couple of high technologies and support services, both of which have more than a quarter of their jobs in suburban settings. Conversely, the branches that have resisted the most in cities are those which show the slowest growth in suburban settings: public services and personal services – the modest penetration of the latter again indicating that suburban settings are less conveying to fulfilling personal needs than to economical exchanges. Last, since 1985 the growth has been very spectacular for financial and professional activities, even if, with about 15% and 22%, their suburban job share can't compete yet with the urban center primacy in these domains.

Perhaps the most intriguing trajectories are shown by the exurban centers. Those, evidently, were the only ones to suffer that spectacularly from the 1990s economic crisis, and in general terms they saw very strong growth up until 1991 and then stagnation at best (*Chart 6-45*). During these times, their economic structure has changed, with a very strong industrial push, first of less qualified domains in the base and heavy industries, and then, as base industries crashed, of light industry, so that in all their economic structure, while still arch dominated by industry, has somewhat bettered. In a way, industry is even more dominant now in exurban centers than it was in 1975, as most other economic sectors have shown not much dynamism in those places. Recently, though, trade and transportation have made some inroads there, demonstrating their disseminating trends there.

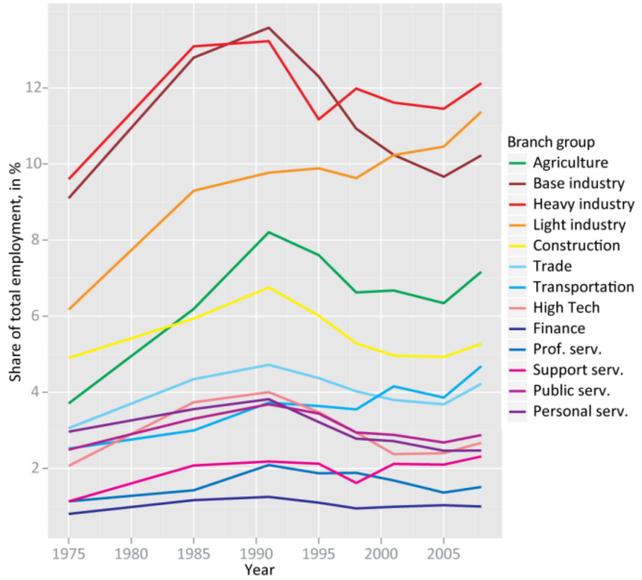


Chart 6-45: Share of total employment in exurban centers by branch group, 1975-2008

Finally, edgeless space displays above all the slow but steady decrease of its importance in the economy (*Chart 6-46*). Admittedly, this decrease was above all the feat of pre-1991 evolution, and since then edgeless space global job share has remained fairly constant, both in absolute and in structural terms: whatever it has lost since 1991 was because the economical structure evolved, not because edgeless space was a particularly bad place to conduct business. Since then, too, very few structural moves are seen, except maybe the position taken by construction activities, which has now about 30% of all its jobs located there. Conversely, base industries have slowly left edgeless space to concentrate in more central places like exurban and suburban settings, so that they are not disproportionately represented in edgeless space, to the contrary of 1975.

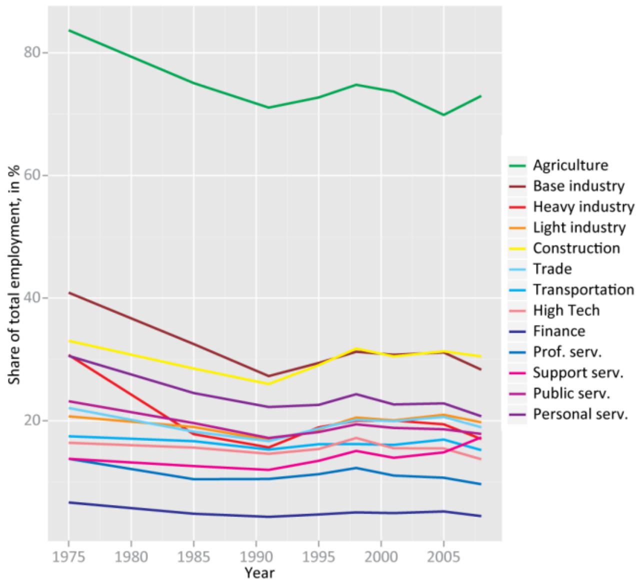


Chart 6-46: Share of total employment in edgeless space by branch group, 1975-2008

In several instances it is of interest to see how our classifications behave to this respect. In most cases, the evolution of the job share our different classifications yield against location closely follow the absolute trends which we have already described and nothing much more can be ex-

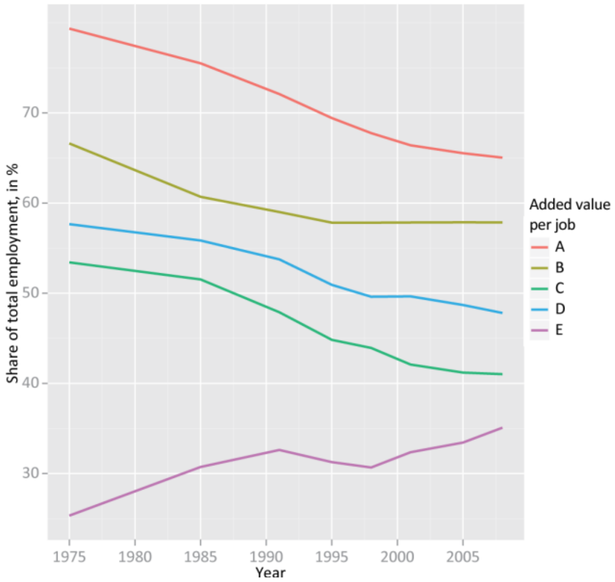


Chart 6-47: Share of total employment in urban centers by added value per job class, 1975-2008

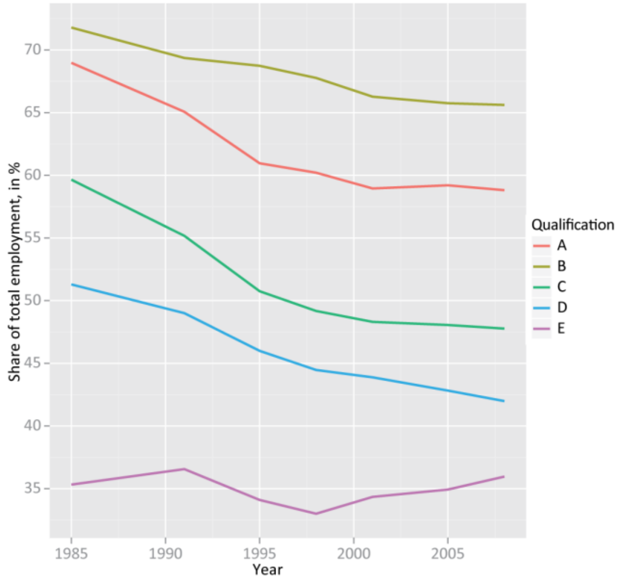


Chart 6-48: Share of total employment in urban centers by qualification class, 1975-2008

tracted from them. However, some several patterns found on the charts which follow warrant, from our point of view, some informative comments.

For instance, data from the added value per job and from the qualification level seem to agree on the fact that urban centers are less exclusive places with regard to highly qualified and productive people than it once was (*Chart 6-47*). Although 80% of the most productive workers were working in urban centers in 1975, by 2008 this figure had dropped to 65%, mirroring a similar decline seen in all productivity categories, except the weakest one: 25% only of the least productive workers of 1975 were working in urban centers, a figure which has risen to 35% in 2008. The exact same evolution is seen with regard to qualification levels, with an added twist, being that the most qualified of all workers were less concentrated than those who came immediately behind them (*Chart 6-48*): urban centers are somewhat less enticing to qualified people than it was, and more interesting for unqualified workers. Here also, cities have somewhat lost their edge.

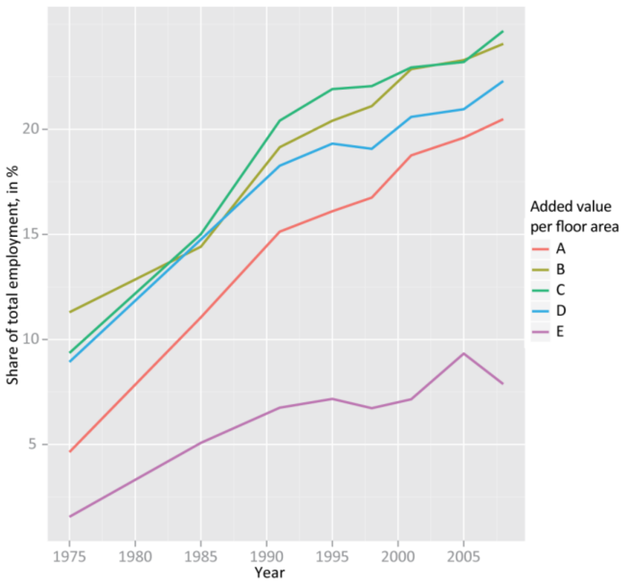


Chart 6-49: Share of total employment in suburban centers by added value per area class, 1975-2008

Conversely, suburban settings have seen their quality bettered as well as their absolute numbers and thus their general job share. In terms of added value per floor area, the rise of the most productive workplaces as measured per floor area has been the most spectacular, passing from less than 5% of all such jobs in suburban space in 1975 to more than 20% in 2008 (*Chart 6-49*).

The same trend was seen when looking at the interaction needs, with a strong progression of interaction-intensive activities in suburban space, from a 3% to a 17% suburban job share for those – however, activities which didn't require too much interaction progressed at the same pace (*Chart 6-50*): the third interaction class from 6% to 23%, the fourth from 6% to 27%, which remind us that there is still a division of labor in place between those activities in constant need of exchanges and those in the back-office, the first still preferentially in urban centers, the latter more and more in suburban settings.

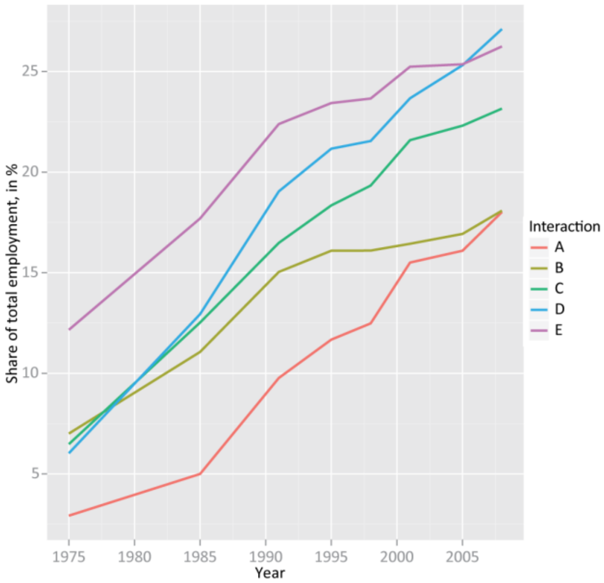


Chart 6-50: Share of total employment in suburban centers by interaction class, 1975-2008

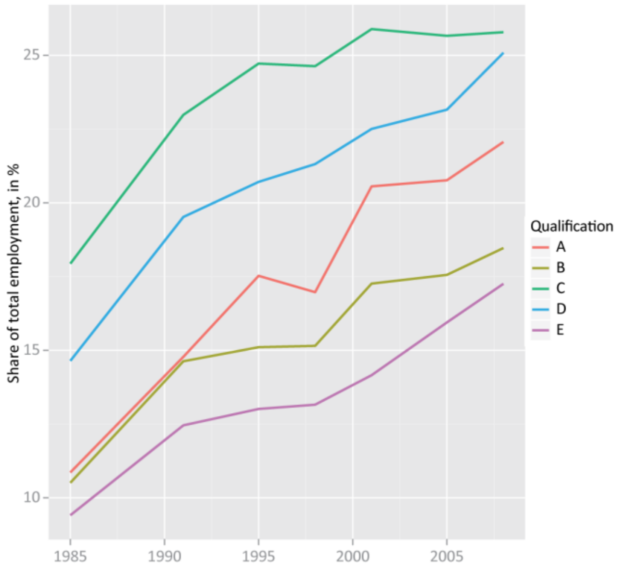


Chart 6-51: Share of total employment in suburban centers by qualification class, 1975-2008

In 1985, suburban space was the domain of the lower top middle qualification activities, which were overrepresented in suburban centers, the middle formations largely so (*Chart 6-51*). While it remained so during a first period of growth, since the mid-1990s, the proportion of middle qualified people in suburban space has flattened just above 25%. Meanwhile, all other qualification levels have seen more and more of their workers work in suburban settings, with a special mention for the most qualified of all, which went from 11% in 1985 to 22% in 2008.

The evolution of the creative classes distribution gives an interesting resume of the structural changes which are affecting the economy (*Chart 6-52*). As expected, all segments of the creative division of the workforce went down in urban centers, however very different trajectories were seen: health professionals remained fairly stable, with around 70% of their workforce remaining in cities, while education and science professionals saw their urban job share dip only slightly from 60% in 1975 to about 55% in 2008. Interestingly, those two categories are heavily linked to

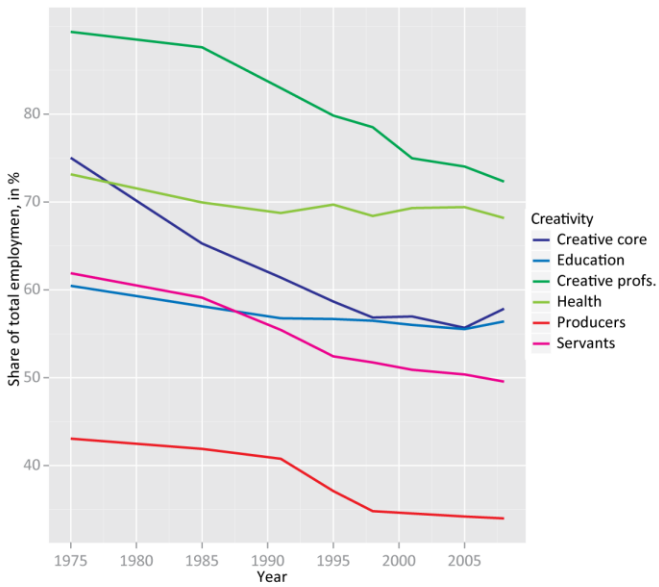


Chart 6-52: Share of total employment in urban centers by creative class, 1975-2008

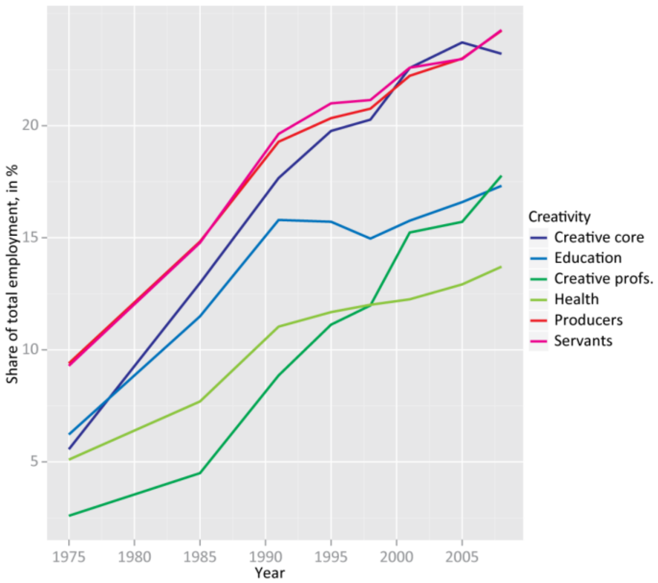


Chart 6-53: Share of total employment in suburban centers by creative class, 1975-2008

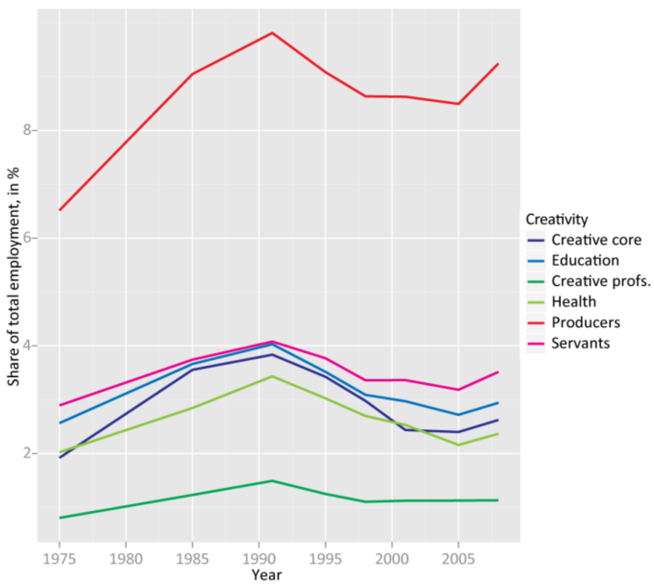


Chart 6-54: Share of total employment in exurban centers by creative class, 1975-2008

the public sector, which didn't follow the same territorial dynamics which the private sector followed. The creative people belonging to the private sector saw their proportions plummet, the creative core from 75% to 60%, the creative professionals from 90% to 73%. Admittedly, they are still overrepresented in urban centers, but a sizeable number of them now work elsewhere. Non creative classes have known have also decreased and in a way that in definitive made cities more creative than ever in structural terms, if not in terms of overall dominance.

In 1975, the suburban economy was clearly dominated by non creative occupations, and it has somewhat remained so, with both producers and servants going from a suburban job share of 10% in 1975 to about 25% today (*Chart 6-53*). However, the most spectacular rise have been the fact of the private sector creative people, which went from 6% to 24% suburban job share for the creative core, and from 2% to 18% for the creative professionals. At this point the creative core people are as well represented in the suburban centers than in the cities, while this isn't the case of creative professionals. However, between 2005 and 2008 a return to the urban centers has been seemingly affecting those core creative people, which is seen in the urban and in the suburban chart.

Finally, while marking progressions, public sector creative occupations, in health and educations, have progressed the least and are now the least represented of all creative classes in suburban space, which wasn't the case in 1975 (*Charts 6-54 & 6-55*). Finally, compared to those big changes in urban and suburban settings, exurban and edgeless space show great stability and the remaining overwhelming dominance of productive functions in both locations for the whole of the period under review.

6.6.2. Centrality against location and size

We come now to comment the differing patterns of centrality as we've uncovered them using the centrality definition given in § 6.2.3. Specifically, we will look at how centrality was apportioned when controlling for locations, and we'll have a look at supercluster size to check for an actual metropolitan effect.

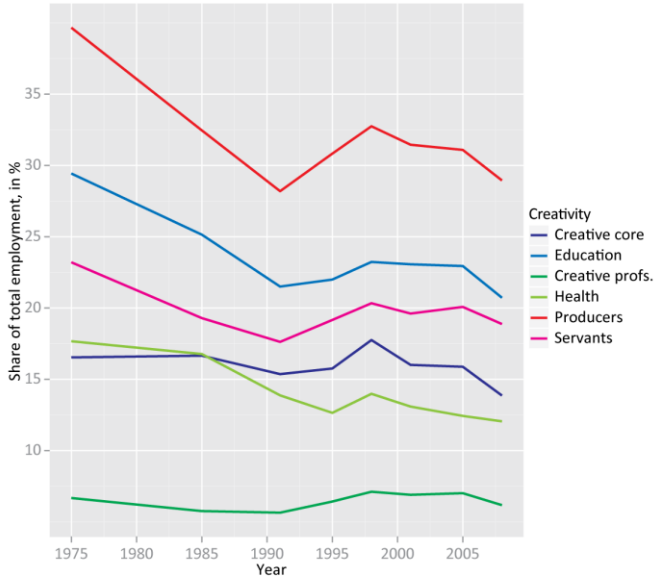


Chart 6-55: Share of total employment in edgeless centers by creative class, 1975-2008

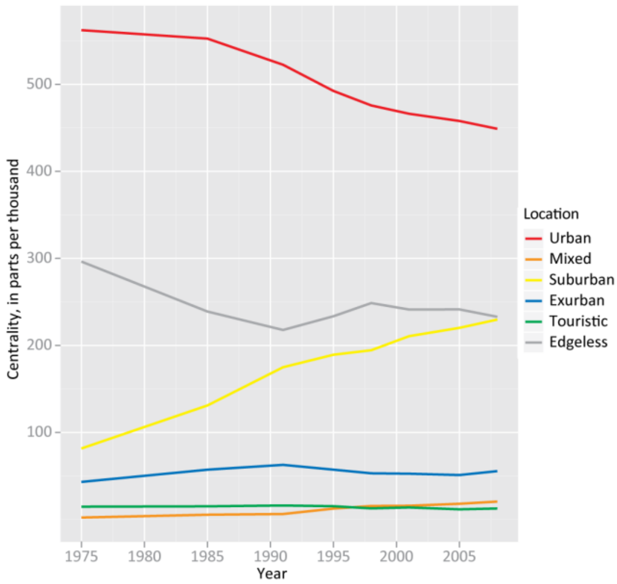


Chart 6-56: Total centrality by location, 1975-2008

Centrality is a robust measure in that it doesn't give much different results when classes on which it is computed are changes (*Chart 6-56*). In that part, we have used the Dessemontet classification to control for centrality. The Dessemontet classification counts the primary sector as one class, and discriminate the secondary sector in four classes and the tertiary sector in eight classes. When computing centrality across all activities, the following findings are made. In 1975, urban centers represented 56.4% of all central functions in Switzerland for 54.3% of all jobs – that is to say, urban centers importance was largely commensurate with their size. Edgeless space had 29.6% of the country's centrality, for 30.7% of its jobs, which marked a slightly peripheral economy, counting less central functions and more menial ones that the rest of the economy. With its 8.6% job share, suburban centers accounted for 8.2% of the country's centrality, and exurban centers showed some structural strength, with 4.6% of the jobs for 5.6% of the centrality. By 2008, things had changed. Urban centrality went down 44.9%, a decrease more important to that of its job share, now 48.2%, which means that in all, not only have cities lost in centrality because of their lost job shares, but also because of purely structural decay in the urban economy. Edgeless lost quite more, down to 20.2% of the jobs but 23.3% of the centrality of the country, a sign of its slowly diversifying economy as its centrality share was catching up with its job share. Suburban centers represent now 23.2% of all jobs, and 23.0% of the central functions. In all, the evolution of centrality closely follows that of the job numbers and share – a rather normal result, but this structural explanation doesn't account for the strong loss of centrality experienced by cities.

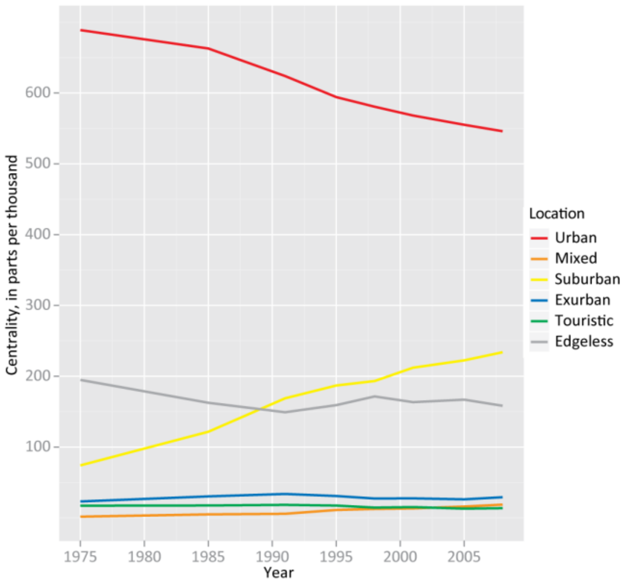


Chart 6-57: Tertiary centrality by location, 1975-2008

Part of the explanation lies with the fact that we computed centrality across all economic functions. Centrality was in effect devised to be applied essentially on service activities, within the Christallerian paradigm (*Chart 6-57*). The results are different. In 1975, Urban centers accounted for 68.9% of tertiary centrality, against 65.3% of all tertiary jobs; edgeless space had a 22.0% of tertiary job share, but 19.5% of tertiary centrality; suburban centers had 7.4% of tertiary centrality against 7.9% of tertiary jobs, exurban centers weren't that significant tertiary players with just 2.6% of all tertiary jobs and 2.3% of its tertiary centrality. In tertiary terms, then, urban centers were more dominant, they concentrated more central functions than when computed at the global economical level: centrality was more urban in the tertiary sector than in the economy as a whole. By 2008, the picture had changed. With a 55.6% tertiary job share, urban centers now account for only 54.6% of the country's tertiary centrality. Conversely, suburban centers, with 21.8% of the tertiary workforce, account now for 23.4% of its centrality. Edgeless figures are at 16.2% of the job share and 15.8% of the centrality. It seems, then, that the same finds cans be made at the tertiary level than at the global economy level: not only have urban centers shrunk; they have also lost genuine tertiary diversity in the meantime. The diversity lost in urban centers was gained, essentially, in suburban centers. However, as a whole the effects are subtle – the massive moves are in job shares. But they are accompanied by subtler but nonetheless real qualitative moves which exacerbated the trends in urban and suburban settings.

Finally, we use centrality to assess for equilibrium and variations at the supercluster level. Superclusters include urban centers as well as the suburban centers which gravitate around it. In purely Christallerian logics, one would expect the job shares to be equally apportioned between all size classes. However, we expect an excess of centrality to be present in the upper levels of the superclusters hierarchy, as in Christaller, larger centers have a more diverse economy than smaller ones. This, indeed, is what is seen when looking at the distribution of centrality in superclusters when controlling for supercluster size (*Chart 6-58*): large superclusters hold a disproportionate share of the country's centrality; however, this was already true of the job shares of those centers. By 1975, superclusters above 64'000 jobs accounted for 31.1% of all jobs, and 35.2% of central functions,

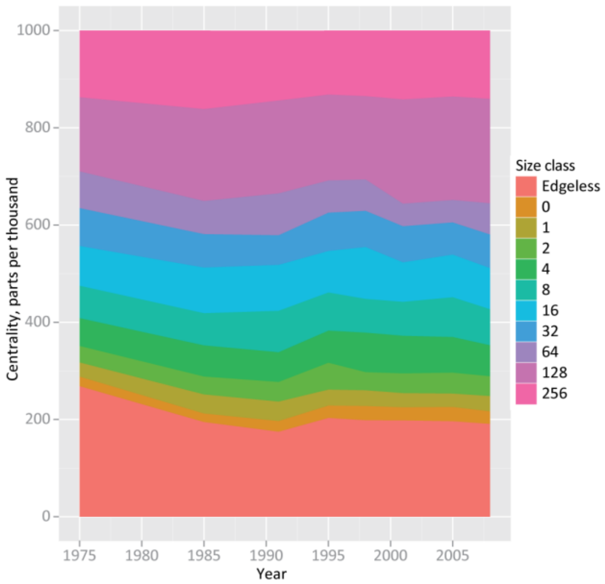


Chart 6-58: Centrality by supercluster size, 1975-2008

smaller superclusters for 38.2% of all jobs and 36.5% of overall centrality, and edgeless space for 30.7% of all jobs and 28.3% of the centrality. Admittedly, larger superclusters were already dominating the economy. From 1975 to 1991, edgeless jobs and centrality share fell sharply, to the profit of the larger superclusters up to 1985, then of smaller ones. Growth of smaller superclusters went on to last up to 1995, while the largest superclusters went through a slowing period from 1985 to 1991, then a decrease period; it can be said, then, that from 1985 to 1995 the trend favored smaller superclusters over larger ones, at least in relative terms. However, this remained an exception: before 1985, and again since 1995, the larger superclusters have grown stronger than the smaller ones, with the result that in 2008, superclusters over 64'000 jobs represented 41% of both jobs and centrality in the country, while smaller superclusters grouped 33.3% of centrality and 35.9% of jobs, edgeless space accounting for 20.2% of all jobs and surprisingly 22.0% of the centrality. As a whole, on the period, it can be readily seen that larger superclusters are slowly taking the edge over smaller ones: as time goes, larger centers are becoming larger while smaller supercluster lag behind – of course, the biggest lag is that of edgeless space itself, which lost a third of its jobs and a quarter of its centrality. Those losses have profited exclusively the large superclusters.

The picture drawn at the tertiary level reveal the same tendencies, with a relentless progression of large-scale superclusters, which accounted for 40.7% of all tertiary jobs but 45.9% of the tertiary centrality in 1975, and went to represent now 48.1% of all tertiary jobs and 52.0% of the centrality of the country. During the same time, smaller superclusters wend down from 37.3% to 35.7% of all tertiary jobs, and from 35.7% to 33.3% of tertiary centrality. For its part, edgeless space went from 22.0% of all tertiary jobs and 18.6% of its centrality in 1975 to 16.2% and 14.7% respectively in 2008. Here also it can be seen that the retreat of edgeless space profits above all to larger units.

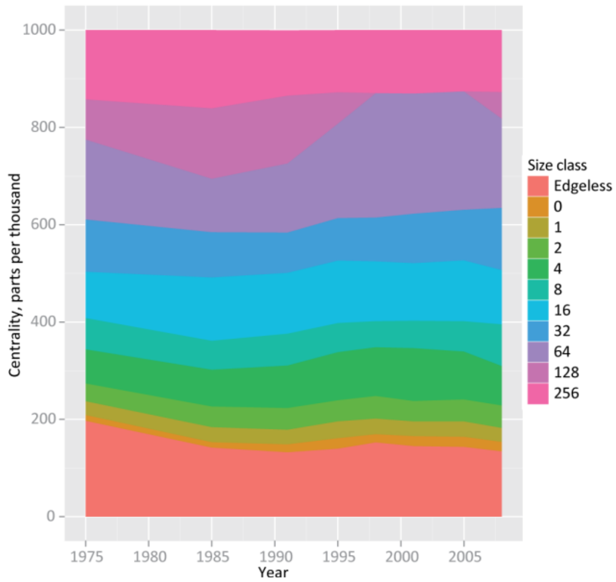


Chart 6-59: Tertiary centrality by supercluster size, 1975-2008

Two conclusions can be reached. The first is that by and large metropolitan processes are probably at play in Switzerland, since we would expect metropolization to produce the results actually seen: a disappearance of rural relevance in economical terms and the takeover of the country by ever larger metropolitan spaces to the detriment of smaller centers. The second is that while the emergence of suburban centers nibbled away at the importance of urban centers, at larger scales they had probably the inverse effect, reinforcing the regional, national and international influence of the largest urban centers by helping them form larger and more powerful superclusters.

6.6.3. Some evolutionary patterns

Here we summarize the specific findings we've made in this section. The first conclusion to which we come is that urban centers at large have specialized since 1975. At the time, they were still true Christallerian places, which group all economic functions, some of which were unique to them. This seems not to be the case anymore by 2008 or at least, we witness an urban system in transition towards more spatial segregation of activities. For instance, industrial functions are vacating the cities, but this is also the case of some important service activities: trade, transportation and high technologies, all domains at least superficially linked to the industry, whether by land consumption for the two former, or by association for the latter. This leaves the city as a somewhat poorer place than before. Its main specialties, now, reside in the public sector, the financial activities and the professional services. Those functions are amongst the most productive of all and therefore the cities haven't lost their edge – but they're poorer nonetheless. This was seen in the way the most qualified, productive and creative functions, once the exclusive monopoly of urban centers, have tended to disseminate outside the cities in the last thirty years. Not only have centers become poorer in structural terms, they have lost the exclusivity they held over prestigious functions during the same period. Cities, in definitive, have managed to keep their exclusivity in only one clear domain, and it is that of politics. Political centers are still firmly rooted in cities and there's no reason to believe this will change in the foreseeable future.

Suburban places have undergone an inverse evolution: they have grown explosively, and they have diversified. While still far from the structures of the urban centers, their initial take of industry, trade and transportation activities has been complemented by other domains, of which high technology is the most visible member. Hosting the high tech means hosting the geeks and in an informational age this could prove to be momentous in the future. The fact is that the creative core professionals are now joining suburban workplaces in droves, which of course enriches the suburban workplace immensely and can have some far reaching side effects. Their massive arrival has had an effect on some less productive activities which have to leave – this can maybe explain the progressive transition of edge cities from an industrial to a service based economy, and have repercussions in exurban centers, which, although remaining firmly and overwhelmingly industrial in nature, have seen the industrial specialties slowly reinforcing in them as they are progressively leaving the cities and maybe the suburban centers as well.

For its part, edgeless space remains that inert matrix we alluded to in preceding chapters and seems not to show any proper dynamics, acting as a passive repository for moves which affect above all some other location types. That being said, it has seen a diversification of its economy, albeit that happened more because of the decay of the formerly dominant economic activity or edgeless space – agriculture. That being said, the advent of the mass communications means in the last two decades have allowed some functions to locate just about anywhere and there is little doubt that the slow but steady diversification of edgeless space is at least in part linked to this phenomenon, allowing geeks, again, to work almost anywhere they want – it just happens that some of the creative core people want to work in the countryside or in the mountains, and that some creative professionals want to work at home in their posh residential suburbs. All those moves contribute to the betterment of edgeless economy. In all, though, edgeless space has strongly shrunk with the advent of suburban centers which have devoured some of it.

In all, the parallel developments seen, above all, in urban, suburban and edgeless cities point all strongly to metropolization. Cities specialize, suburban centers develop massively, and the union of the two allow the most central cities to become, at the national and international level even more central, while somewhat evening it out with their suburban centers, which, in their protective presence, grow ever more massive and slowly but surely makes everything else less and less relevant in the economy – exurban centers as monolithic industrial villages, touristic resorts as economic monocultures, edgeless space as shrinking matrix. Maybe Lévy is right after all: everything is becoming urban (Lévy et al 2008).

Everything may be urban, but not the way Christaller envisioned. In fact, this chapter's results are a more convincing indictment of the urban network's departure from the Christallerian model than results found in previous chapters. The whole Christallerian edifice is founded on the idea that major centers group all service functions, some being unique to them – in fact, a large city contains all the functions of a smaller one, plus some functions found only at its level and above. Urban centers conformed to such a model up until the rise of edge cities and even for some time after their emergence, since suburban centers started out as industrial. However, it seems that the economy of the urban centers is clearly evolving away from a complete, Christallerian structure towards a specialized one. Not only that, but the lost economical functions aren't all low value, low wage, low productivity affairs: witness the retreat of the high technologies from the central place, the slow erosion of creative people in cities, and the concomitant rise in size but also in diversity of the suburban centers, from technological parks to design schools – it may be that cities are still favored by creative people to live in, a testimony of which is the trend-bucking concentration witnessed in personal services, but they are not seen anymore as the sole places where the creative people can work. Urban centers seem to be evolving towards an economy dominated by some, but not all, superior functions, above all finance but also professional services, some functions geared towards the high end professionals who live there, such as personal services. The latter also include hotels, which reminds us that business of congresses and meetings is still a very urban one. Lastly, cities are the locus for politics and public services and as those have a response time to economic upheavals which is far longer than for the private sector, one can't help but think that the fact that the public sector is becoming more and more dominant in cities is probably going to last for ages, transforming them into ever more administrative and public service centers. Meanwhile, many productive functions, the activities, the workplaces, the exchange places, the transportation nodes and bases, seem to slowly leave urban centers to disseminate in suburban centers or in edgeless space – our hunch would be to think that it is for the long-term. How very much un-Christallerian.

Christallerian no more, but surely metropolitan. Suburban centers can be linked to a parent center into superclusters which seems to have asserted their dominance on the urban network, and what was found in preceding chapters can be readily found again in the results found here, which tend to demonstrate that while urban centers lost functions and job shares to suburban centers, together the largest superclusters are getting more and more central functions. We have seen in preceding chapters that towards the end of our period of study, the number of urban centers, and consequently of superclusters, has greatly fallen. However, this fall in cities numbers didn't benefit, in any way, peripheries or rural space as was the case in preceding urban crises: edgeless space didn't profit from those crisis periods. Instead, the disappearance of whole levels of the former urban hierarchy, mostly at the bottom end of them, benefited essentially the large cities, the conurbations formed by coalescing urban and suburban centers, in one word:

the metropolises. In that sense, the urban history of the last 35 years seen through the economic structure and worker quality is one of dissemination of central functions from a number of Christallerian centers towards a greatly reduced number of metropolitan areas, in which suburban centers, while still well behind their urban parents, start to look ominously like the future of our urban spaces.

6.7. Management summary

In this chapter, we studied the way the economy and the workers were structured between centers, suburbs, exurbs and edgeless space in order to unearth structural differences between those different locations, and to look at their evolution through time. The idea behind this quest was to be able to qualify places in terms of economic structure and diversity, and in terms of workforce quality, an aim that we will further in the next chapter with a study of the command and control relationship between businesses and places.

The findings made in this chapter are as follows:

A review of the available literature showed that by and large research viewed that urban centers remained the dominant economic place at least since the industrial revolution, and that suburban and exurban locations were thought to be subservient to the higher end urban functions, although a growing current put some emphasis on the concomitant development of metropolization and of suburban development.

In general terms, the Swiss economy between 1975 and 2008 underwent gentle but far-reaching changes, transiting from an industrially dominated economy still very present in 1975 to a knowledge-based one. However, this transition has been happening since before 1975, and there is no sign that it has arrived to a new equilibrium point yet.

The economy was seen to be transiting also from a fordist form of organization dominated by large integrative concerns to a post-fordist economy where businesses concentrated on their core competencies while subcontracting side issues to specialized partners. This resulted in the explosion of consultancies and expert-based independent companies.

The depth of this transitions seems to show that as a place in the international economy, Switzerland is specializing more and more towards high added value activities, while subcontracting low productive activities to other countries and regions – to this effect, the gradual decline of agriculture and basic industry. This could have far reaching consequences: the transition from a fordist productive economy to a flexible service-oriented, knowledge-based economy is also one from a strong social contract to a socially less conscious, more liberal form of economy where the winners win more, and the losers lose more than before. It is also an economy where low skilled people struggle to get opportunities or in some extreme cases even to integrate the economy.

Cities were found to rule the economy in 1975. By and large, Alonso-Muth models of bid-rent curve and of land competition between activities seem to account well for the urban structure: highly productive activities were concentrated in urban centers while lower productivity sectors were rejected to the sideways – however, this was only valid for the most productive, the most discriminant functions of all, largely like what would be expected from a Christallerian urban system: some activities were present everywhere, more exclusive ones in cities only, and the rarest ones were only found in the largest centers.

The economic structure of the cities was found to have changed a lot in 2008, and not only for structural reasons. By 2008, cities had started to specialize in some domains while clearly letting some other domains go. Essentially, urban centers have become the centers of high end economic and political functions, with finance playing a particular role. During the same time, suburban centers have developed explosively, both in absolute terms and in quality – not only is their economy larger than before, it is also more diverse.

The structural changes of the economy weren't mirrored by changes in the qualities workers from different places displayed – in that sense, stability prevailed and it is as if the major changes we just mentioned were above all happening because of spatial reallocations due to evolving economic preferences for different workers than before: the rise of suburban centers could for instance be linked to the rise of the geeks: computer scientists, high tech workers, all occupations where daily contact with the outside world isn't needed. The rare moves seen in the qualities of workers from different workplaces since 1975 seem to favor suburban centers, which have grown more diverse and more strategic in terms of workers qualities.

The developments seen in the last 35 years clearly mark the urban system's farewell to Christaller. The fact that urban centers have started to specialize in several well determined activities while letting other go, often to nearby suburban centers, is a testimony of the fact that the market logic of Christaller has been replaced by something else, a logic of spatial differentiation and complementarities, even when looking at service activities – the idea of territorial complementarities being an old one in industrial geography. Suburban centers, meanwhile, have gained in economic substance and variety, another nail in the Christallerian structure's coffin.

Metropolization is seen to be happening in Switzerland between 1975 and 2008. The phenomenon manifests itself by the way the urban system has morphed, with large superclusters taking more and more functions against smaller ones, those slowly disappearing or coalescing into larger entities. While at the local level, the suburban centers challenge their urban parents, at the regional level the most massive suburban centers join forces with their top-tier urban parents and help them dominate the country's economy and play a role in the international urban competition.

7. The spatial patterns of the command and control structure of the economy, 1985-2008

7.1. Introduction

This last chapter of the empirical part of our work is devoted at furthering the finds made in chapter 6 regarding the specialization of the different places with respect to their location and size. In chapter 6, we studied the economy in structural terms and in terms of their workforce quality. Here, we aim at studying the hierarchical relationships between the different economic units. Establishments can be distributed according to their hierarchical status. The vast majority of Swiss establishments are independent units: they are not depending on headquarters, nor do they control subsidiaries or branches. However, some are indeed headquarters or subsidiaries. It is then interesting to concentrate on those to see if their spatial distribution can help us learn more on the way territories structure themselves with regard to the commanding structures of the economy. Likewise, for those censuses for which we have the information, it may be of interest to see how establishments which are members of multinational companies are behaving and if they are located differently than other companies, whether they are Swiss subsidiaries of an international company, Swiss branches or headquarters of a Swiss multinational company.

In particular, this chapter aims at answering the following questions: is there a geographical pattern of economic command and control, i.e. do some locations seem privileged to host command activities while others are relegated in subservient occupations? Does the domestic economy structure itself along the same lines than the globalized part of the economy does – whether the latter is controlled by Swiss of foreign companies? What is the role of the activity towards those questions? Do public owned establishments behave differently than privately owned ones? We now aim at providing answers, or at least hints, at those interrogations.

7.2. Literature review and data considerations

7.2.1. A small literature review about the command and control structure of the economy at the intra-metropolitan scale

During the last decades, those of globalization and the advent of many globalization studies it has been realized by major researchers and scientists that the way the larger companies of our capitalist societies are organized is important in the way the urban hierarchy organizes itself. Sassen 1991, for instance, argues that the globalization process ushers in a new category of global cities coming to occupy the upmost stage of the urban stage, with truly global functions found only in this select company of global megalopolises – in a sense this is "neo-Christallerian" as it implies that global cities have everything other cities have, plus some characteristics unique to them. To Sassen 1991, the global cities are made global by the fact that they host a disproportionate amount of global companies' headquarters, getting thus a disproportionate amount of control over the global economy. In the same vein but in larger terms, Castells 1996, following many others, links globalization with a new international division of labor, with higher-end functions remaining in developed countries while low-skilled, low-cost work is devolved to developing or emerging countries. Taylor et al 2002 squarely brought home the notion that the new international structure were finally an expression of economic power and that the way global cities evolved and controlled the economy was a reflection of the way. However, most of the studies pertaining to the control and command structure of the economy and its link to geographical space are international in scope, and there is a certain dearth of studies researching the spatial patterns of such relationships at the local or regional level. Manners 1974 was already lamenting on the dearth of data, and even more studies, on the subject.

That's not to say nothing has been written on the subject. Manners 1974 was to our knowledge one of the first authors to see a functional discrimination between offices whether they were located in downtowns or in suburban spaces. Manners duly noted that while headquarters as well as independent companies were preferring downtowns, once a company had been split into many functional units, some of the subsidiaries were displaying a preference for suburban locations, which were already associated with various advantages including, but not limited to costs. Manners 1974 already noted that with time the quality of the suburban economy was getting better and that some higher-end functions were slowly colonizing it. In particular, some offices with headquarters functions, like regional headquarters of national or international companies were prone to leaving the central business district to occupy office parks in the suburbs, replacing day-to-day contacts with the ubiquitous telephone. Manners 1974 based some of his finds on studies which dated from the late 1950s, which were already finding that suburban space was developing not only in numbers but also in quality (Horwood & Boyce 1959). Allen J. Scott studies (Scott 1983a, 1983b, 1984, 1986) focused more on the actual relationships between headquarters and subsidiaries and its spatial component. Of a rather strict Marxist point of view, Scott allotted a considerable amount of time unpicking the hierarchical relationships of the spatially and functionally disintegrating industrial complexes in the Los Angeles region. Scott pointed out the importance of subcontracting between manufactures as a reason for location choices, in a post-Weberian paradigm. In his view, subcontracting was a result of functional disintegration, which in turn lead to easier and greater spatial dissemination of functions. Thus, to a restructuring of the firm and of the economy corresponds a truly geographical restructuring (Scott 1986). For Allen J. Scott, the disintegration of the firm resulted both in the subcontracting to external firms but also to the establishment of the multisite enterprise, the latter move authorizing the spatial separation between different functions. To him, the major impact of the spatial disintegration of the enterprise resided in internal delocalization processes, but he noted that they explained the emergence of technopoles and office parks.

While Scott concentrated on industries and manufacture, Coffey & Polese 1989 focused on the services and found approximately the same results, minus the post-Weberian approach of Scott. They also showed that the disintegration of the enterprise and the functional and spatial dissemination didn't mean that regions were now equal in the spatial competition for jobs and functions, with metropolitan areas strongly benefiting, and lagging regions having trouble to keep up; in producer services, dissemination was occurring most notably within metropolises. They also addressed the command and control component of the economy and noted a highly centralized pattern for headquarters and for those producer services catering to them. According to them, not only are headquarters strictly metropolitan, they tend to discriminate between metropolises by locating preferentially in the largest and most significant ones, and with them the services they need. In all, Coffey & Polese 1989 described an elaborate producer services geography, formed of metropolitan spaces competing for headquarters, and inside the metropolis the continuing domination of large centers occupied by headquarters and their afferent services, and of perpetuating divisions of labor between high-skilled, high-interaction centers and low-skilled peripheries. To them there was no doubt that through the headquarters they hosted, central business districts were dominating and controlling the other spatial units of the metropolis. As we said, Saskia Sassen (Sassen 1991, 2000 besides others) retook the same lines and came up with powerful arguments about how the economic geography was reshaped by the disaggregation of the fordist firm and the advent of the producer services – she noted in particular the need for the new dominant classes to dispose of a servant class which was severely less privileged. However, her focus remained global, her unit of analysis the metropolitan area.

Rozenblat & Pumain 1993, Rozenblat 1994 found approximately the same trends in Europe by looking at enterprise networks. By doing so they unearthed interesting trends. Notably, international firms were tending to largely prefer the biggest cities of any country to locate a subsidiary there, which means that those large centers were at an advantage to host regional or national headquarters of foreign companies – generally, one or two of the main cities are used as gateways for foreign investment. They also noted big differences in the way those subsidiaries were located according to their function and domain of activity, which all were rather close to what was discovered in the last chapter: a strong gradient towards metropolitan centers for command and service activities, a preference for dissemination for industrial or menial tasks. In a very French way, the authors link these spatial differences to a need for proximity with political power, where the decision centers are the same in political and economical spheres, a find that we indeed confirmed in the preceding chapter for Switzerland. However, Rozenblat and Pumain's scale of study was also the metropolitan area, or at least the city.

One of the first studies we know which truly dedicated its scope to the urban-suburban dichotomy in terms of quality and control was conducted by Muller 1997, which recognized a near complete lack of research on this precise subject and the near total dominance of the global scale in studies devoted to this subject. After Garreau 1991, which was more of a journalistic survey than a scholarly work, he was one of the first authors to point out the importance which suburbia was taking inside the major metropolitan areas of the time, with its strengthening gathering of regional and national headquarters and a mix of technopoles. Muller 1997 also noted that national headquarters of companies foreign-owned tended to locate more and more in the suburbs, and more specifically at or near business poles or concentrations in suburban space, i.e. suburban centers. Thus, he unearthed a corpus of empirical evidence against the popular conception that power lies at the center while suburban space executes the orders. Boiteux & Huriot 2000 conducted similar studies in France and found essentially the same pattern: high-end producer services were migrating out of the central business districts towards major centers in the suburban belts of major metro areas of the country. However, Boiteux & Huriot 2000 pointed out the fact that the evolution of the metropolitan economy could be understood in two different ways: either there is a generic hierarchical relationship between metropolises of different significance and size, and inside metropolises between centers and peripheries, all units being rather comparable, in a rather post-Christallerian way. Or, it could be conceived that metro areas are specializing into various domains of which they become a main focal point and that a new regional division of labor is at play, in a more post-Weberian way.

In all, we haven't found much literature devolved on our subject. Command and control structures of companies and firms are well studied, but not at the scale we're interested in. When the scale is right, that is, when relationships within metropolitan space is studied, in most cases the command and control structure of the economy isn't and the studies are more like our preceding chapter, looking into economic specialization and in particular high-end activities. A stark illustration of this situation is given by the fact that we haven't found any Swiss literature on the subject of the command and control structure in the Swiss economy. As we'll see, business census data containing some information about command and structure of the economy is available for all censuses since 1985, a corpus of no less than seven business censuses which have been largely ignored by the research of the country. In that sense, our study is guaranteed to break new ground: no major exploitation of the data regarding territorial patterns of command and control has been conducted in Switzerland.

7.2.2. Data considerations

In order to study the command and control structure of the economy as well as its links to the international markets, the following data is at our disposal.

All business censuses since 1985 allow distinguishing establishments in three categories: headquarters independent company and subsidiary. A link is provided between headquarters and subsidiaries, so that one can identify which subsidiaries are linked to a given headquarter, and conversely to identify any subsidiary's headquarter. This link is of type one to many: headquarters can command one or many subsidiaries, but subsidiaries depend on one, and only one, headquarter. While this is incredibly valuable information, it is important to understand the limits of the enterprise networks one can create with it. First of all, the link concerns only establishments which are genuinely and integrally part of the same company. Thus, a company which is formally independent even though entirely owned by another company or a holding will be listed here as independent. This may not be very important in the fordist organizational model in which most large companies are integrated, but is more of an annoyance with the post-fordist economical model which privileges formal disintegration. Likewise, no foreign company can directly control subsidiaries in Switzerland. Such a company has to establish Swiss headquarters to control the subsidiaries. Such headquarters will also be listed as independent – for all but two censuses, there is no way to distinguish between the controlled Swiss headquarters of a global company, and the headquarters of a genuinely independent company.

The business censuses for 1995 and 2005 contain some additional information. At the company level, the insertion into the international economy is apprehended in two ways. The first is capital ownership: it is known whether the company is held by foreign capital or conversely if it detains foreign subsidiaries or holds capital in foreign companies. For those two censuses, then, it is indeed possible to distinguish between genuinely Swiss headquarters and national headquarters for a foreign company. The second way those two censuses allow for quantification of the insertion into the global economy is by measuring at the company level the presence and importance of importations and exportations in their turnover. It is known, at this level, whether importations and exportations are present and if yes, whether they represent up to a third, between a third and two thirds, or more than two thirds of their turnover.

7.2.3. Research program

Of course, data considerations strongly affect the way we explore the command and control structure of the Swiss economy and in a way, the research program is dictated by the way data is made available to us. Nevertheless, as we've said in a preceding section, to our knowledge the command and control data included in the last seven business censuses hasn't been used in a spatial context. What exists allows us to devise a research program in three parts which has never been undertaken before.

The first part covers the 1985-2008 time spans and thus explores the spatial patterns displayed by headquarters, subsidiaries and independent establishments regardless of their insertion on the global markets. Those patterns can be studied both in terms of establishment and job numbers, against center location and size, according to their branch group and ownership status in terms of private or public ownership.

The second part of the study will be devoted to more geographical aspects of control. The mutual locations of headquarters and subsidiaries will be explored, aiming at studying whether there are preferential relationships between certain types of locations, and how proximity relationships play a role. Overall, the idea is to devote a little more attention on the geographical patterns shown by the enterprise networks. These studies can be made for all censuses since 1985, and will only include studies against location and size, as well as a discrimination whether the subsidiaries are situated in the same supercluster than their headquarters or not.

The last part of our study will be conducted only on the 1995 and 2005 censuses, for which the data is available, and will focus on international relationships, from two vantage points: ownership relations, and exchange relations. For those two censuses, we will monitor patterns shown by foreign ownership or exchanges against the same categories than for the first tier, i.e. branch groups, public ownership, public or private ownership, location and size. In this part, we will return to the enterprise networks to see if there are significant differences in territorial patterns between the Swiss-only networks and those owned either by a foreign company or by a Swiss multinational.

In all, those three forays into the structure of the economy should inform us on the way the command and controlling relationships between establishments and companies are mapped into space, and conversely if some spatial types seem more inclined to host either the commanding structures or the subsidiary ones.

7.3. The distribution of headquarters and subsidiaries, 1985-2008

7.3.1. 1985

7.3.1.1. The national scale

As in all free market economies, the vast majority of establishments are unique independent entities which are neither controlled by, not control any other establishment. In 1985, at the national scale, the following finds are made. Of the 414'500 establishments of the country, 80.2% were independent units. One in five establishments, then, were part of a multi-establishment structure, the large majority of them (15.8%) as subsidiaries, the remaining part (4.0%) as headquarters. In terms of workforce, the importance of the multi-establishment companies is better measured: in a total workforce of 3'173'000 full-time equivalents, a bit more than half (54.2%) were hosted by independent entities, while just under half of them were held by multi-site companies, the majority (27.7%) in subsidiaries, against 17.9% in headquarters. With a mean of 34.3 jobs per unit, headquarters establishments were bigger than their subsidiaries (13.5 jobs per unit), themselves bigger than independent entities which counted a mean of 5.2 jobs per unit.

In terms of public or private ownership, Switzerland was probably one of the most liberal economies of the world and the direct involvement of the state in the general economic life was rather limited: only 8.1% of all establishments and 14.8% of all jobs were held in publicly owned establishments. It is worthy of note that publicly-held establishments were close to double the size of privately-owned ones, at 13.9 jobs per unit against 7.1.

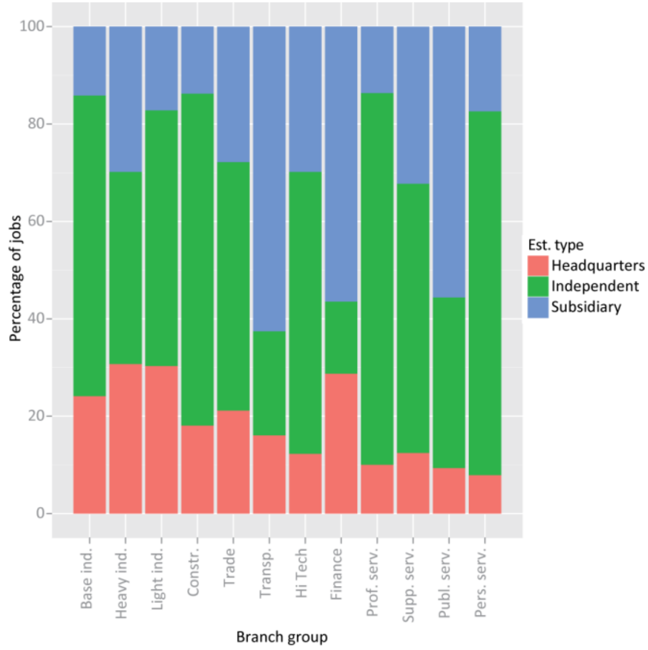


Chart 7-1: Job share by unit status and branch group, 1985

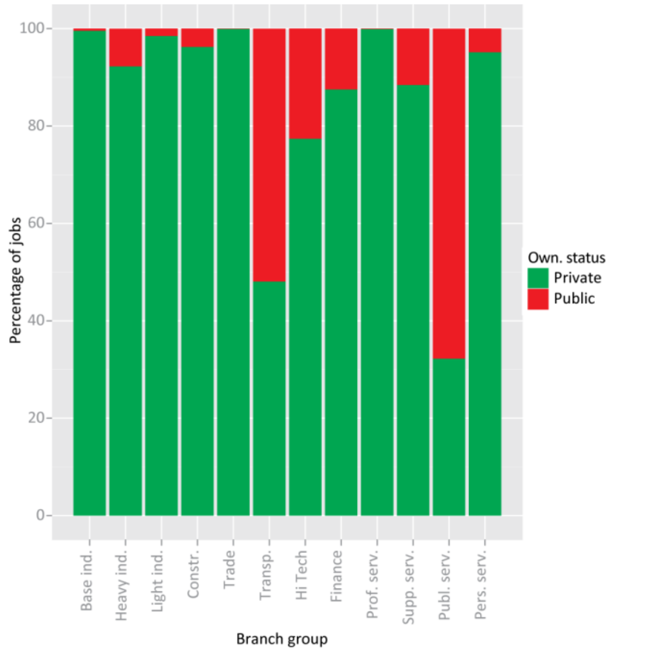


Chart 7-2: Job share by ownership status and branch group, 1985

There were great discrepancies between the different branch groups when looking at their command and control structure (*Chart 7-1*). The secondary sector displays a hybrid structure, between sizeable numbers of independent companies along a more structured economy dominated by job-strong headquarters – those represented a full quarter of the employment in heavy and light industries along with job-sparse subsidiaries, especially in light industry. In other domains, the integrated, dual structure of headquarters and subsidiaries dominated. This was particularly the case in transportation, public and financial services. In those three domains, the fordist economical organization in seats and branches was still very much the norm. Lastly, some domains displayed a strong post-fordist organization dominated by independent companies, such as most notably in the professional and personal services. A general trend showed that in terms of job numbers headquarters were more staffed in the industrial sector than in the services one, but such a generalization was impossible for subsidiaries. Some branches hosted many of their jobs in subsidiaries, most notably in the fordist organized branches: transportation, finance and public services, while others had very few of their workforce in such dominated entities: professional and personal services but also construction and base industry.

The public part of the Swiss economy in 1985 was also very much discriminated by activity (*Chart 7-2*). Public companies and establishments logically dominated in public services, although a third of all public service jobs were still held in nominally private establishments, most notably in the health sector. There was also a strong presence of the State in transportation services, by way of railways and urban public transportation, along the privately-held companies in air and road transportation. Some state presence was also seen in the high tech sector, mostly because of the inclusion of the state phone company in this branch, and in financial activities, mostly due to state-owned cantonal banks along with the Swiss National bank and the International Settlements Bank in Basle.

7.3.1.2. Location and control

At first sight we would expect command and control structures to be more present in central areas than in peripheral ones, and as a first approximation this is what seemed to happen (*Chart 7-3*). Jobs held in independent companies were more and more dominant from center to periphery, going from less than half the workforce in urban centers to more than three quarters in edgeless space. Conversely, the head-quarters are more present in central space, with more than 20% of all jobs in urban space held by headquarters, against less than 10% in edgeless space. The exact same thing can be said of subsidiaries, also more present in central space than in periphery: more than a third of all urban jobs were held in subsidiaries, against just one in six in edgeless space. In fact, the center-periphery gradient was more pronounced for subsidiaries than for headquarters; the latter, for instance, were as present in suburban space as in urban ones, while there was a clear difference between urban and suburban settings when it came to subsidiaries. In all, there seemed to be a clear preference of big economic structures for central settings over peripheral ones, with two interesting twists. The first was that in 1985 already, suburban space seemed as commanding as urban centers. Secondly, subsidiaries were even more concentrated on cities than headquarters– that is to say, headquarters tended to locate their subsidiaries preferentially in urban centers.

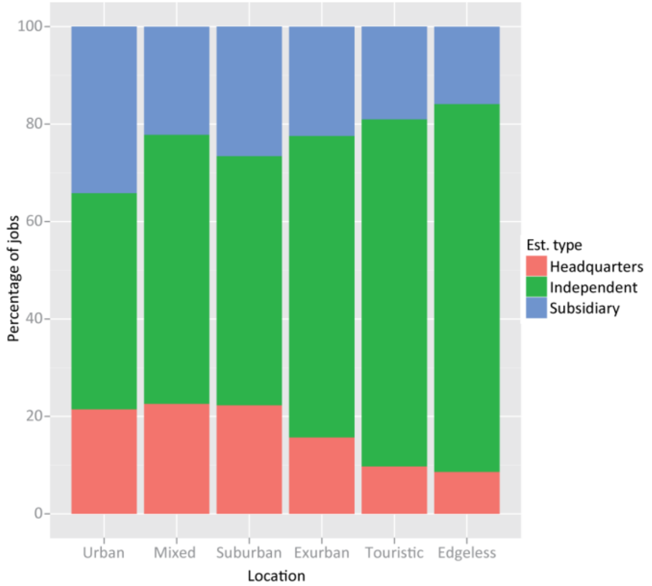


Chart 7-3: Job share by unit status and location, 1985

The urban difference was more visible when looking at the ownership status, as publicly owned units tended to be located preferentially in urban centers (*Chart 7-4*). With 19.1% of their jobs in the public sector, urban centers were the only location type overshooting the national mean, and with the small exception of mixed centers, the proportion of publicly-owned jobs in cities was twice that of the rest of the country. As we've said in the preceding section, public sector units tend to be more integrated than the economy at large, counting more subsidiaries and headquarters than most other domains. When returning to the preceding paragraph

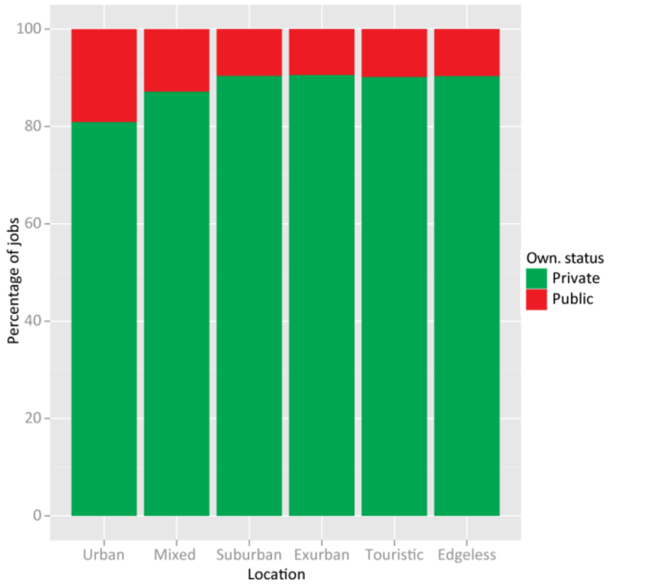


Chart 7-4: Job share by ownership status and location, 1985

we now find that suburban space had attained the same level of leadership in the economy than the cities, without benefiting from the public-sector boost in the same way urban centers could. This gives us a first indication of the economic strength of the suburban centers, back in 1985.

It is difficult to pinpoint those effects to structural differences in activities. Most integrated industrial and construction businesses had roots in then urban centers. In heavy and light industries, suburban locations were above all the choice of independent companies, while integrated concerns favored cities for their seats and some of their subsidiaries, and exurban centers for some other subsidiaries. Construction showed a very strong gradient, with major concerns based in cities and small independents in the periphery. Suburban space showed specificity when looking at trade, as it was the location of choice for integrated concerns – independents were more numerous both in urban centers and in the periphery. Transportation was already very strongly suburban, as many of its major seats were already situated there, most notably the airlines. In the high tech sector, cities dominated with the multi-site companies, while suburban locations were completely dominated by smaller independent firms. The financial sector, integrated as it was, showed the strongest gradient of all, with urban centers dominating completely the rest of the country. Command centers were in cities, and subsidiaries everywhere, but very strongly in peripheries. In this domain suburban centers fared no better than edgeless space. This was mainly true, also, of the professional and support services, at least for the multi-site part of these independent-dominated sectors. Personal services were organized the same way, although here suburban space structure was closer to urban ones. Finally, public services showed a very strongly integrated structure, especially in cities. Surprisingly, in urban centers the subsidiaries dominated more strongly than elsewhere, very probably because schools and hospitals were counted as such.

7.3.1.3. Size effects

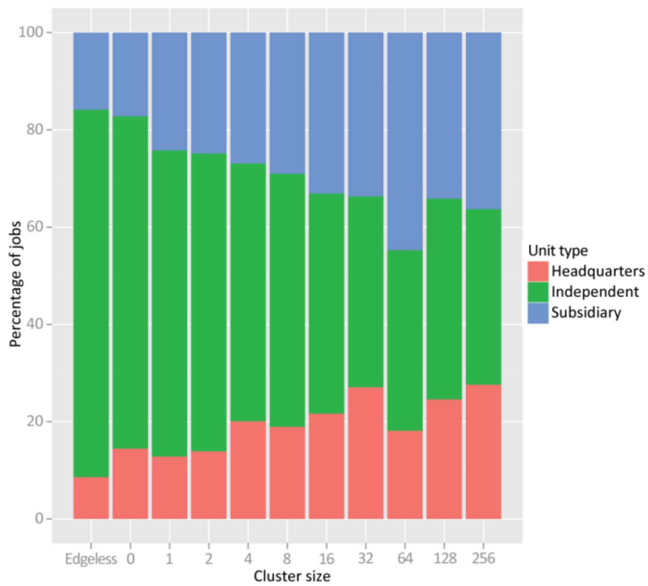


Chart 7-5: Job share by unit status and cluster size class, 1985

There was a very clear size effect in the way headquarters, independent companies and subsidiaries located themselves throughout the territory (*Chart 7-5*). In locations less than 4'000 jobs the proportion of jobs held in independent companies was larger than the national mean, strongly so in edgeless space, and in centers up to 16'000 jobs, independent jobs outnumbered all other job types taken together. In contrast, in the largest cluster of all, they represented just over a third of all jobs. As for the center-periphery dichotomy, both headquarters and subsidiaries were displaying a strong center-periphery gradient, with their best positions in the largest centers, and their worst positions in edgeless space. The progression is not totally regular and we can observe a clear shift in the 64'000 to 128'000 jobs category, which had less headquarters but more subsidiaries than the other ones, an effect due to the presence of Berne in this class.

We find the same progression, with the same discontinuity, when looking at the ownership status of the establishments (*Chart 7-6*). As expected, jobs in publicly owned structures were far more numerous in large centers than in smaller ones and in edgeless space. Jobs in public services were even representing close to 30% of all jobs in the 64'000 to 128'000 jobs cluster size class, again due above all to the presence of the federal capital Berne in this class. Apart from this spike, though, it is interesting to note that from 8'000 jobs up, clusters had approximately the same proportion of public service jobs, somewhere between 15% and 20%, regardless of their size, as opposed to smaller locations where size had a controlling effect. It was as if once a given size is reached, a certain level of public services were going to be present.

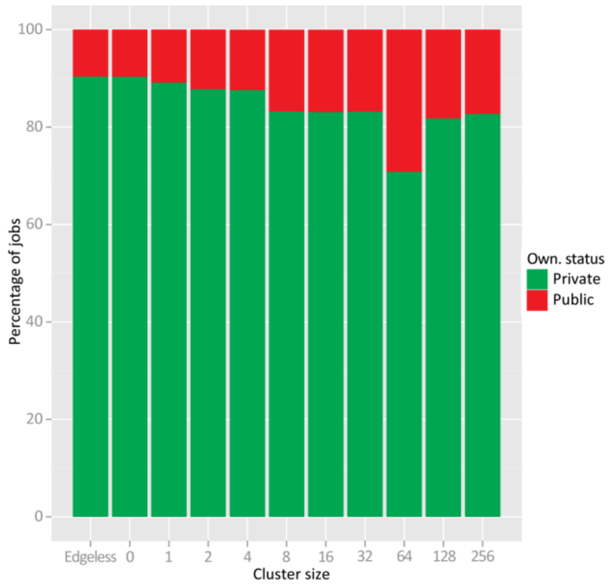


Chart 7-6: Job share by ownership status and cluster size class, 1985

It might be that the size structure is blurred by the fact clusters of all locations are taken together, and thus it may be useful to look at the size structure when controlling for location. When doing this for urban centers alone, globally the same finds are made than before (*Chart 7-7*). There still is a strong size effect in the mutual shares taken by integrated companies, stronger in big urban centers, and independent ones, stronger in smaller centers. The most striking difference with the previous studies concerns subsidiaries, more clearly linked to urban center size than to general cluster size, which reinforces the idea that subsidiaries, more than headquarters, are a distinct feature of cities, especially large ones. The fact is that the subsidiary gradient is far more spectacular than the headquarters one. In a way this isn't as surprising as it seems to be, as headquarters location may depend on serendipity or on its owner's of founder's whim, whereas a strategy of expansion through the establishment of subsidiaries may be far more thought through.

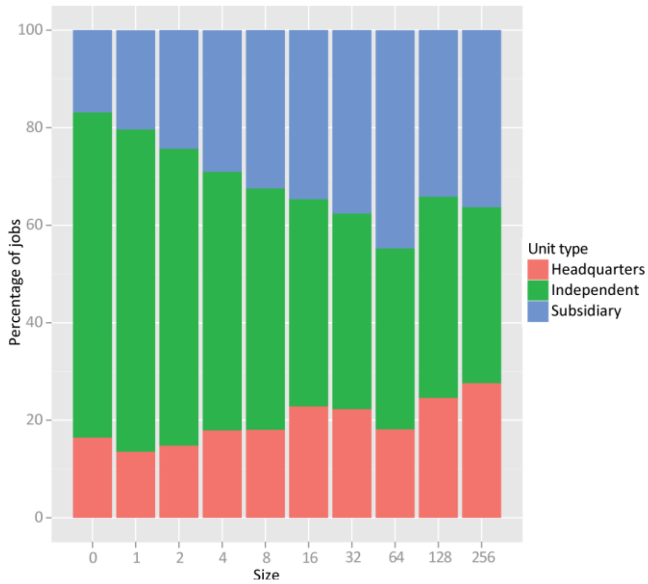


Chart 7-7: Job share by unit status and urban center size class, 1985

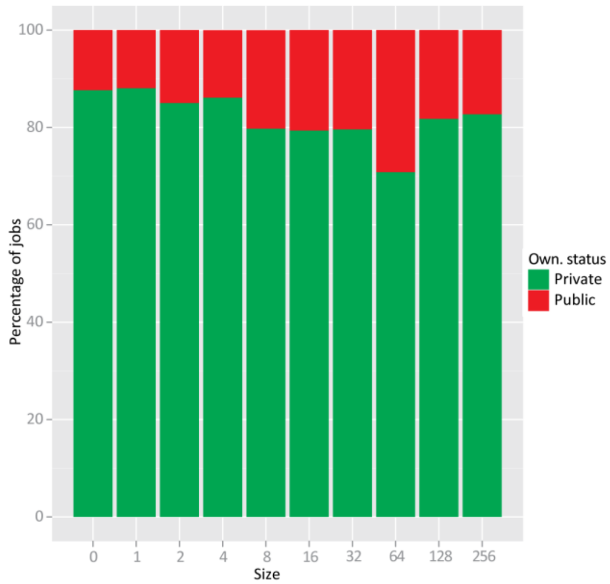


Chart 7-8: Job share by ownership status and urban center size class, 1985

In terms of ownership status, the same study seemed to reveal a two-tier relationship between public job share and urban center size (*Chart 7-8*). Urban centers below the 8'000 jobs threshold seemed to have a distinctly lower public job share than larger centers, although the gradient seen at the general level wasn't found for the urban centers, and although those smaller centers still disposed of a rather high public job share – at least higher than for their size class, when compared to suburban and exurban centers. Above 8'000 jobs, all urban centers seemed to get approximately the same public job share regardless of their size, with the glaring exception of the size class which included Berne. Interestingly, the same study made for suburban centers at the cluster level does not yield any meaningful results – it is as if cluster size had no definitely visible effects of their command and control structure.

More generally, the center size effects on control and command seem too pure to be attributed to differing economic structures between different center sizes. The fact of the matter is that size, in itself, and especially when concerning urban centers, seemed to have a major effect on the way headquarters, independent companies and above all subsidiaries were located. In particular, it seems that location decisions which were the most likely to be carried out in a Cartesian manner were strongly favoring urban centers, preferably larger ones.

7.3.2. 2008

7.3.2.1. The national scale

The vast majority of establishments still are unique independent entities which are neither controlled by, not control any other establishment. In 2008, at the national scale, the following finds are made. Of the 451'750 establishments of the country, 82.6% are independent units, a figure slightly superior to that of 1985. One in six establishments were part of a multi-establishment structure, the large majority of them (14.4%) as subsidiaries, the remaining part (3.0%) as headquarters. Both figures are down since 1985, the more significant fall being that of headquarters, which have lost a quarter of their share since 1985, while subsidiaries are down only a tenth. A consequence of this differential fall is that whereas in 1985 there were a bit less than four subsidiaries per headquarter, this number has risen to close to five subsidiaries per headquarter in 2008.

In a total workforce of 3'511'000 full-time equivalents, a bit more than half (57.2%) are hosted by independent entities, while three out of seven are held by multi-site companies, the majority (27.1%) in subsidiaries, against 15.8% in headquarters. As compared to 1985, the independent job share has risen three percentage points, while both subsidiary and headquarters job shares have retreated – again, the headquarters retreat is more significant than the subsidiary one. In both cases though, establishment retreat has been more important than job share retreat, meaning that restructuration has occurred and that the surviving entities are now larger. This is confirmed by the average size of establishments. Headquarters host a mean of 40.5 jobs in 2008, 6 more than in 1985. For their part, subsidiaries host now 14.6 jobs, one more than in 1985, while independent companies size has only very slightly risen at 5.4 jobs per unit, up 0.2.

In terms of public or private ownership, Switzerland still has one of the most liberal economies of the world and the direct involvement of the state in the general economic has even slightly receded since 1985, with 7.3% of all establishments (down 0.8 point) and 14.3% of all jobs (down half a point) held in publicly owned establishments. It is worthy of note that publicly-held establishments size has grown significantly since 1985 to a mean of 15.3 jobs per unit, up 1.4 points since 1985, whereas privately owned units have kept the same mean size between 1985 and 2008 at 7.2 jobs per unit.

At first sight it seems that the command and control structure of the economy has indeed evolved away from the fordist model: independent companies were on the rise while integrated ones were less numerous than in 1985. However, the evolution, while noticeable, isn't massive – indeed it could be entirely due to structural effects with the rise of independent sectors and the fall of integrated ones. Thus in this case it is really useful to go and look at specific patterns through activities.

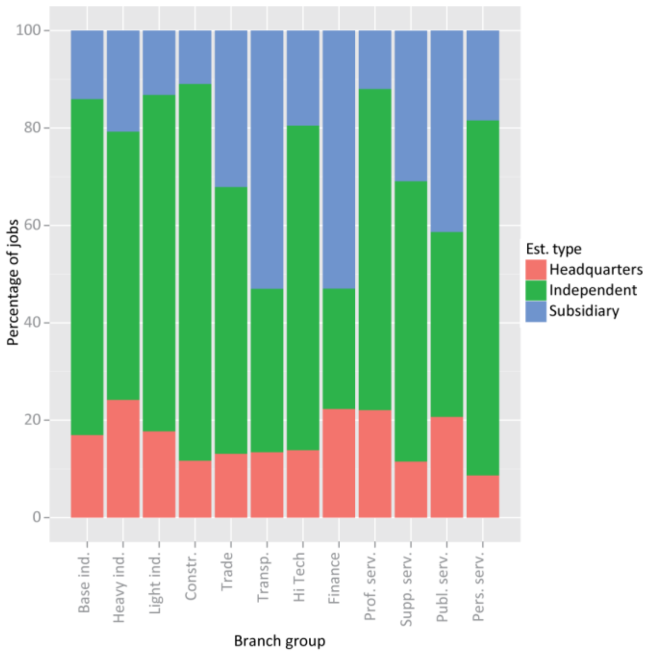


Chart 7-9: Job share by unit status and branch group, 2008

The command and control structure, when dispatched by branch group, seemed less organized than in 1985 (*Chart 7-9*). At that time, the industrial sector displayed a distinctly more integrated structure than the services, but this distinction has receded greatly up to 2008. In fact, the post-fordist disintegration in the industrial sector is clearly illustrated, with strong retreats of both headquarters and subsidiaries in the base and light industries and in the construction; the heavy industry, for obvious reasons, resisted better to this wave, although here as elsewhere jobs in headquarters and subsidiaries went also down. More generally, the same trend applied to service domains, although less spectacularly than in the secondary sector. Some domains distinguished themselves. Trade saw concentration: while the headquarters job numbers receded, the subsidiaries job numbers progressed, the only branch group where this happened. It may be linked to the recent arrival in the Swiss market of foreign supermarket chains alongside the two traditional Swiss giants. Professional services also buckled the trend – this branch group, which originated in small independent companies, started to integrate itself, which resulted in far more jobs held in headquarters than before, although jobs in subsidiaries didn't progress. Lastly, public services saw the inverse trend as trade: that is more job share to headquarters, and less to subsidiaries.

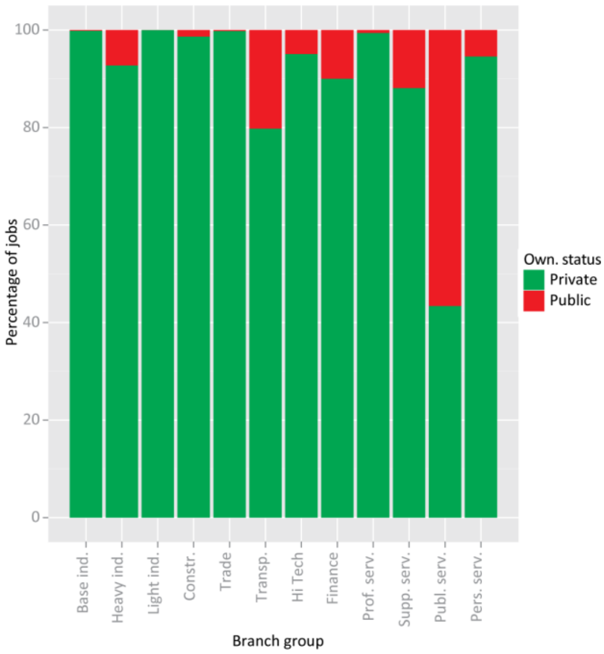


Chart 7-10: Job share by ownership status and branch group, 2008

In terms of ownership status, the moves were more starkly seen (*Chart 7-10*). Essentially, all branches saw a significant retreat of publicly controlled jobs, the retreat being particularly massive in transportation and high technology, where it is due to the transformation of some major public services like the railways, the postal service and the national phone company into independent companies. These retreats, then, do not automatically mean a state disengagement, but a change in the way state control is applied, going from direct administration to control through the board; in effect, the new state companies which emerged from this change are now largely more autonomous with regard to the state than before. In public services, a clear retreat of publicly owned jobs was seen, which can be linked to the empowerment of some more state services, most notably in the health and residential care sectors. More interestingly, despite the general retreat observed across all branch groups, the general job share of publicly owned units has remained the same, around 15%. This is due to the fact that branch groups where public ownership is important, most notably the public services at large, have swelled since 1985: a structural effect has helped state controlled jobs to remain as important in the economy as they were in 1985 even though it sectorally lost job share everywhere.

Taken together, those changes illustrate well the transition towards a post-fordist economy. State control is most certainly receding where its control was once complete, by giving true self-governance to newly established state companies which take over from former state monopolies. In the private sector, disintegration seems to be the rule, in particular in formerly well integrated domains such as the industry and the public services. In some domains the transformation of the Swiss economy has taken particular ways. In trade, jobs in subsidiaries have risen, which those in headquarters have fallen, indicating concentration with less headquarters and more subsidiaries. On the contrary, some disintegration has happened in public services where big institutional networks were seemingly broken down in smaller ones. Finally, professional service have evolved away from the small independent company model with the rise of integrated businesses in this domain.

7.3.2.2. Location and control

As the general economy was slowly transforming we would expect the changes to appear when looking at the location structure, and indeed some evolution is seen (*Chart 7-11*). The first remark is that the general structure of the economy found in 1985 remained rather untouched: centers still have a more integrated economy than peripheries. In terms of evolution, the disintegration trend seen at the national level was also found in most location types. Independent job share progressed everywhere, while headquarter jobs declined along with subsidiary ones. There were strong differences between locations, though, with suburban and exurban locations displaying the most changes. Both saw their headquarters job share lose strongly, so that a clear gradient is now seen between urban centers and suburban ones, which wasn't the case in 1985. Furthermore, suburban centers show a slight reinforcement of their subsidiary job share, which is quite unique to them. In all, it seems that suburban centers saw their command and control structure evolve the most, not surprisingly given the fact that they grew immensely during the period under review. The changes in suburban space can be explained in two ways. First, suburban space started out most notably as an integrated space, with a disproportionate share of headquarters and subsidiaries, but since 1985 independent companies have started to consider suburban centers as credible location alternatives. Secondly, the integrated part of the suburban economy saw concentration much in the way trade did, and for this exact reason: concentration and subsidiary development moves made by the retail sector were most noticeable in suburban space. Finally, as we said before, subsidiaries are most likely to be located through a Cartesian way and it might bear significance that their job share happens to be rising in suburban space only.

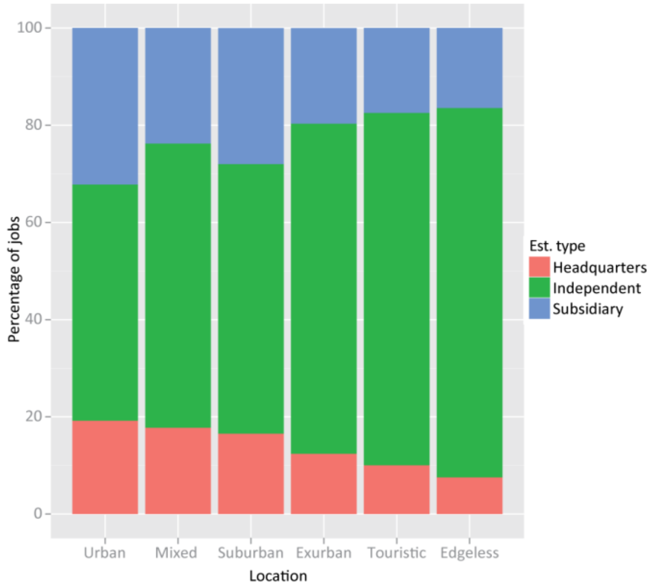


Chart 7-11: Job share by unit status and location, 2008

In terms of ownership status nearly the same structure was found than in 1985 (*Chart 7-12*): urban centers and to a lesser extent mixed centers were adorned with far more publicly controlled jobs than the rest of the country, with approximately the same figures than in 1985. There was a marginal job share decrease in urban and mixed centers, as well as a marginal increase in suburban and edgeless spaces, so if anything there was a slight trend towards structural deconcentration. Stability, however, indicated that publicly controlled jobs behaved as the rest of the economy – that is, they deconcentrated rather sharply since 1985.

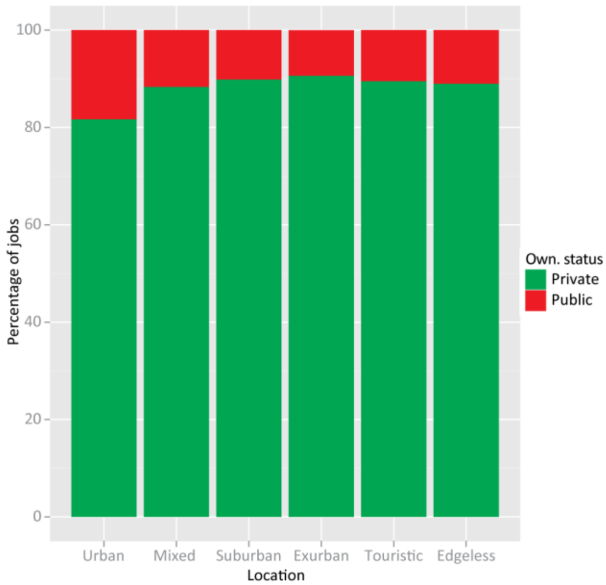


Chart 7-12: Job share by ownership status and location, 2008

Branches have restructured themselves strongly since 1985 and thus it is very difficult not to attribute at least part of what we've found so far in terms of location changes to branches structural evolution. However, some interesting structures are seen when looking at the way branch groups behave in terms of command and control structure in 2008. Most branches were affected above all by their major structural moves. Exceptions concern the construction sector, where a strong disintegration move happened, which left urban and suburban centers in strong command of the remaining integrated enterprises, while peripheries had lost many of their integrated structures. Transportation readily deconcentrated, to the point where the integrated structures of this domain are now held in suburban and exurban locations – the emergence of exurban places as command centers for transportation and warehousing is a novelty. A triple move of integration, disintegration and deconcentration is happening in the high tech sector, with a stronger presence of headquarters overall but particularly in suburban and exurban centers, a sharply lower share of subsidiaries – as if large companies were disintegrating whereas smaller start-ups were developing and sprouting branches. In the financial sector suburban and exurban space somewhat lost their complete dominated status. Likewise, the strong integration processes which affected the professional services were visible everywhere, but especially in suburban space where the headquarters job share has quintupled since 1985 to 25%, despite the very strong absolute rise of both suburban centers and professional services in them. Suburban centers also progressed, although less spectacularly, with support services. Lastly, in the public services the disintegration of large structures into smaller network benefited above all to cities, which were hosting a disproportionate amount of subsidiaries in 1985 and which saw a strong reinforcement of their autonomous public units by 2008.

In all, while changes were primarily due to structural changes in the economy, the suburban centers are clearly winning new functions through structural and territorial changes. Suburban centers gained not only in size but also in control functions in at least three very important domains: finance, professional services and high technology, along with commanding shares in transportation. Thus, one of the finds of the preceding chapter seem confirmed: suburban centers not only grew quantitatively, they also bettered themselves in terms of quality.

7.3.2.3. Size effects

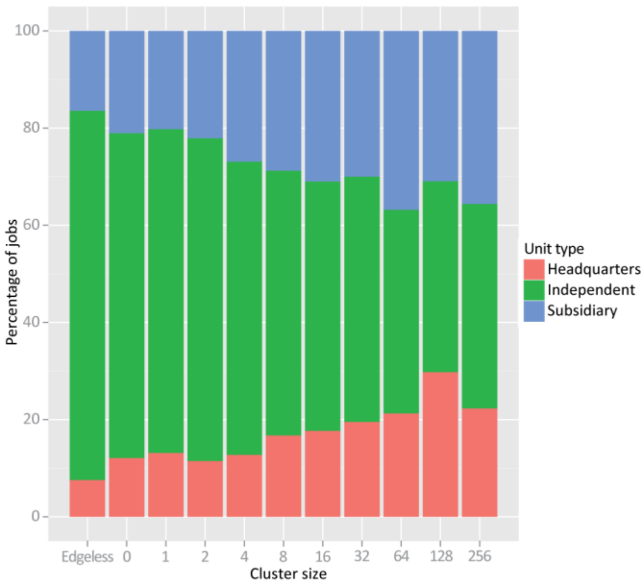


Chart 7-13: Job share by unit status and cluster size class, 2008

Now looking at the center size dependencies, while the general structures noted for location types held for size classes – the economy is more integrated in large clusters than in small ones, which are dominated by independent companies, an interesting fact is to be noted (*Chart 7-13*). Disintegration has been more clearly felt in larger clusters than in smaller ones. In edgeless space and in smallish centers, arguably because they were already dominated by independent structures, the general picture is one of stability. Big changes happened in larger centers, maybe over the 2'000 jobs threshold, definitely over the 4'000 jobs one. In medium-sized centers the headquarters fall was stronger, while in major centers, above the 32'000 jobs limit, changes affected subsidiaries as well as headquarters. It is as if the medium-sized clusters grew somewhat more subservient while the largest clusters grew more commanding – although moves are relatively small when compared to the disintegration processes. The finds would be commensurate with a stronger control of larger clusters over smaller ones.

Changes regarding the ownership status when controlling for cluster size were more subtle, and very much akin to those seen when looking at differing locations (*Chart 7-14*). There is still a tendency to have more public sector jobs in larger clusters than in smaller ones, but the discrepancy has been somewhat reduced since 1985, with slightly more public job share in smaller location, and slightly less in larger clusters. The one strong exception concerns the 64'000 to 128'000 jobs size class, which went from 30% of their jobs in public hands in 1985 to 20% in 2008. This is explained by the presence of Berne in this class, which hosted most of the commanding functions for those public services which were autonomized since 1985.

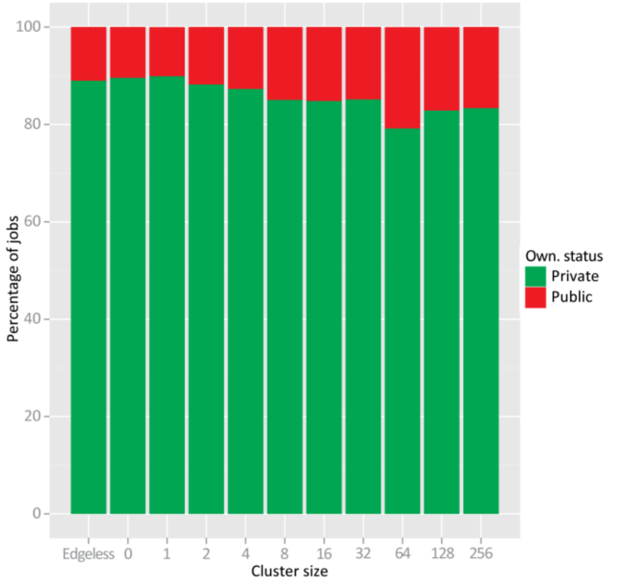


Chart 7-14: Job share by ownership status and cluster size class, 2008

A look at the evolution of command and control structures in urban settings discriminated by size is telling – the moves noted before about cluster size classes are starker seen when looking just at urban centers (*Chart 7-15*). In a general context of falling shares for integrated companies, whether headquarters or subsidiaries, the headquarters job share fell strongly in all urban centers with less than 32'000 jobs, while climbing in larger urban centers. In parallel, subsidiaries receded strongly in urban centers larger than 4'000 jobs, while progressing in smaller centers, the subsidiaries fall being particularly noticeable in larger centers. In all, the size gradient displayed by subsidiaries in 1985 was greatly reduced, while the headquarters gradient somewhat was reinforced – control and command is more and more confined to larger centers, while those same centers slowly get rid of their subsidiaries; subservient activities come more and more onto smaller urban centers. A step further and we'd been saying that since 1985 large cities and more generally large clusters have asserted their power and command onto smaller units. That we can't say yet. In terms of ownership status, changes were seen along the same lines than for cluster size classes and we haven't posted the relevant chart.

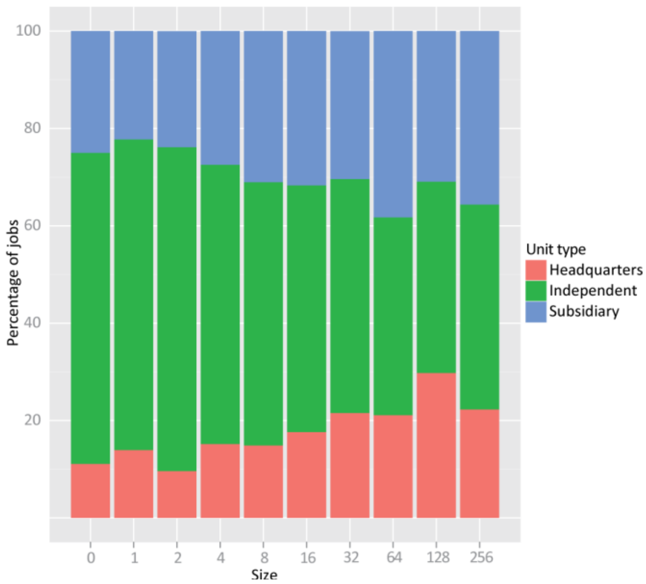


Chart 7-15: Job share by unit status and urban center size class, 2008

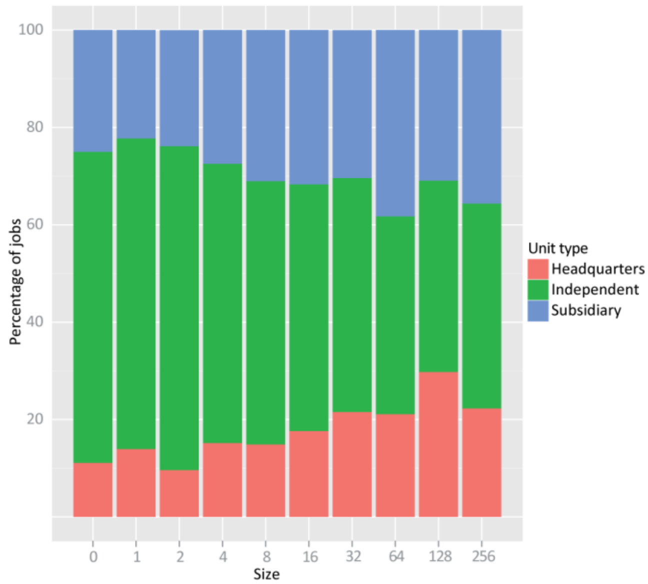


Chart 7-16: Job share by unit status and suburban cluster size class, 2008

While in 1985 we felt that suburban cluster size had no effect on the way the economy was structured, such is not the case anymore (*Chart 7-16*). By 2008, there was a significant trend pertaining with suburban cluster size: the economic structure of large clusters was more integrated than in smaller ones – that is, large suburban clusters have begun to differentiate qualitatively from their smaller counterparts. More interestingly, a side-by-side comparison of urban units and suburban clusters show that suburban clusters have approximately the same structure than urban centers of equal size, especially towards the larger ones, over 16'000 jobs. This means that in terms of command and control structure of the economy, the dozen of larger suburban clusters are as significant as similarly sized cities – that is, cities like Biel or Winterthur.

In itself this is a quite potent assessment of the territorial changes which affected the country since 1985 – by 2008, suburban centers started to look distinctly like similarly sized cities, if not in terms of economical structure, at least in terms of commanding functions, at a time when indices seem to indicate that larger cities themselves are assuming more and more control over smaller ones – a further testimony of the territorial economy's departure from the Christallerian central place model, towards what looks set to be metropolitan processes.

7.3.3. Crises as modernizing agents of the economy

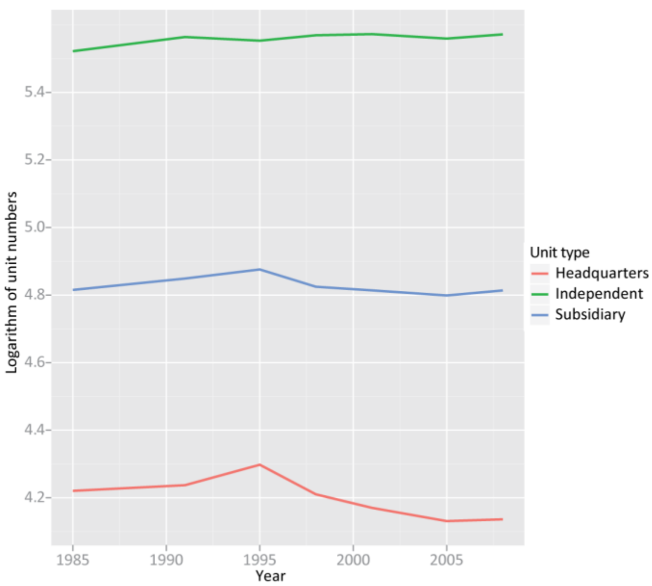


Chart 7-17: Unit numbers by unit status, 1985-2008

In preceding chapters, one of the major features we discovered is that in terms of structures, the economy was transitioning remarkably smoothly through periods of crises and booms alike. Thus, it was possible to model the transition from the industrially based fordist economy of 1975 to the information based post-fordist economy of 2008 as a continuous process. Such is not the case, however, with command and control structures. Here, crises provoke restructuration and the way the economy is restructured may have a major if indirect impact on the way it then redeploys.

The three charts we present now figure the general evolution trends seen between 1985 and 2008 (*Charts 7-17 to 7-19*). Between 1985 and 1991, everything climbs, most notably job numbers in all unit types, as wee as unit numbers. The mean size of units remained rather stable except in headquarters which tended to add staff. The picture drawn at this time was a classical growth picture, with minimal structural change.

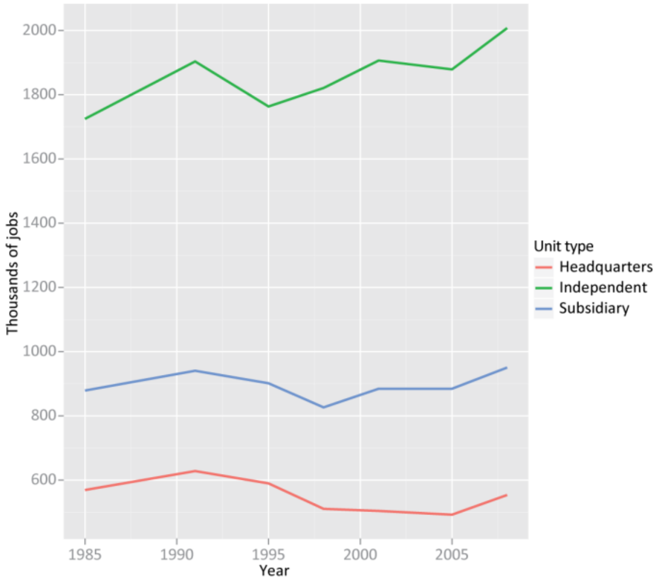


Chart 7-18: Job numbers by unit status, 1985-2008

In 1991, a severe economical crisis hit Switzerland, which would last for the better part of the decade. It is very interesting to see how this crisis evolved in two parts when looking at the command and control structure of the economy. The first part of the crisis saw general job number decline, in particular in independent companies. Both the number of independent companies and its job numbers went down. Job numbers went also down in integrated companies, both in headquarters and in subsidiaries, however, both categories saw their unit numbers rise during the same time, with a consequence that as units their mean size went severely down. This can be interpreted along two ways. The first is that headquarters and subsidiaries alike were shedding staff, but were surviving as entities, while independent companies were hit harder. The second way of thinking is that disintegration started in integrated companies by letting small networks go, which would explain the rise in headquarters numbers between 1991 and 1995.

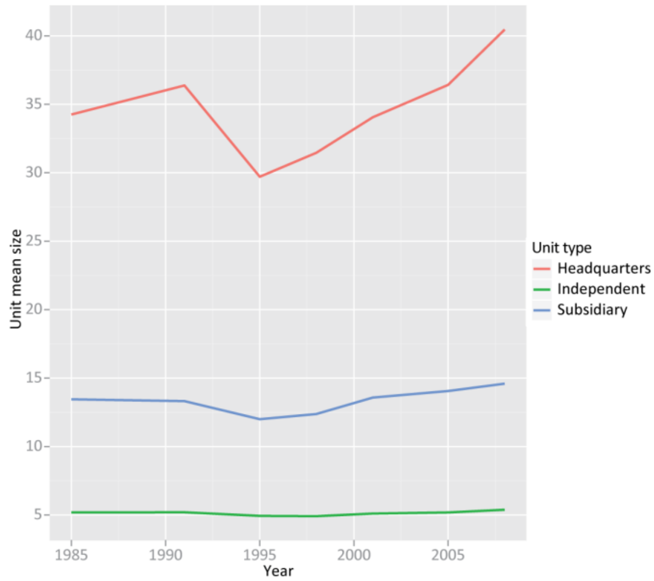


Chart 7-19: Unit mean size by unit status, 1985-2008

As the crisis drew on an on during the latter half of the decade the economy entered a second restructuring phase. The number of independent companies, as well as their job numbers started to rise again and thus the independents saw the rebound first. However, integrated companies, which had weathered the first part of the crisis better, were now experiencing the crisis at full strength. Between 1995 and 1998, headquarters and subsidiaries alike lost both units and workers. Whereas up to 1995, units were shedding workers, by 1998 companies were shedding units. As a consequence, the mean size of headquarters and subsidiaries shot up, the remaining units being larger than the ones axed. Disintegration also explains how independent companies resisted better during this period.

The trend seen for the 1995-1998 period was a long-lived one, as it survived through all subsequent periods; up to 2005 the numbers of both headquarters and subsidiaries went steadily down while their mean size went up, which seems to indicate that the restructuring of integrated companies, initiated by the enduring crisis of the 1990s, was perpetuating well after the economy recovered. Only during the 2005 to 2008 economic boom did headquarters and subsidiaries numbers go up – and in a much muted fashion when compared to the preceding boom, between 1985 and 1991. If disintegration means modernity, then it seems that economic crises have a great potential to start modernizing moves. Once launched, those moves then go on well beyond the economical recoveries which follow crises. The second remark is that independent companies react more swiftly to economic crises, as is witnessed between 1991 and 1995, and then again between 2001 and 2005. They also tend to rebound also quicker than integrated companies. Thus, the disintegration process which has seized the country since 1995 and which doesn't seem to abate results in a less stable economy which reacts with swiftness and maybe brutality to economic down and upturns.

7.4. The mutual links between headquarters and subsidiaries: geographical patterns

7.4.1. 1985

7.4.1.1. General remarks

The goal of this section is to monitor for territorial preferences in the mutual relationship between headquarters and subsidiaries, in terms of geographical or locational proximity, and also in terms of size. We'll try to detect if there is a preference for headquarters to be situated in certain locations while subsidiaries are in certain others, whether the subsidiaries are located preferentially near their headquarters, or if size plays an important role with large locations controlling smaller ones. In this study we will often distinguish between public and private sectors as the relationships between headquarters and subsidiaries seem to be markedly different in public and private sectors.

The first generic remark which can be done regarding this part of the research is that in 1985 there was a strong tendency for subsidiaries to be located at proximity of their headquarters. Of the about 879'000 jobs which were located in subsidiaries, no less than 44.4% were located in the same supercluster than their headquarters, against 55.5% located elsewhere. Proximal relationships were particularly prevalent in the public sector, which represented 42% of all subsidiary jobs in 1985. In the public sector, 55.1% of all subsidiary jobs were located in the same supercluster, a figure which was at only 36.7% for the private sector. Thus it seems that there was a first major difference between privately owned integrated companies, oriented more on interurban relationships, and public services where hierarchical relations were more local in scope. A second big difference between the two is that in terms of relationships, privately owned company networks tended to be top-heavy, with slightly more jobs in headquarters (532'600) than in subsidiaries (508'700). In the public sector, subsidiaries were very job-intensive (370'100 jobs) against small but powerful headquarters (only 36'700 jobs). Thus, the typical private headquarter was about four times as big as its typical subsidiary, of which it had typically about four; meanwhile, the typical public headquarter had about the same size as its typical subsidiary, but it typically controlled twelve of them. Thus, a first picture can be drawn of two widely different networks, the private ones composed of big and powerful headquarters controlling relatively few, smaller subsidiaries more often than not situated in another supercluster, while in public services, smallish headquarters controlled a swarm of similarly-sized subsidiaries close by. Both are so different than one another that from now on they will be treated separately.

7.4.1.2. Location relationships

A first examination of the data at hand shows that integrated companies are very much urban: in 1985, 65.0% of private headquarters jobs, as well as 62.7% of private subsidiary ones were held in urban centers. 17.3% of private headquarters jobs and 15.9% of private subsidiaries were held in suburban space. In both those locations, these figures exceeded their national job share – both locations were more integrated than the country at large. All locations showed an inclination to control structures in the same location type: thus, 69.0% of jobs controlled by urban headquarters were in urban settings, slightly more than the 62.7% subsidiary job share of urban centers. This effect was far larger in other locations: 33.2% of all jobs controlled by suburban headquarters were in suburban settings, double its national job share; likewise, 44.5% of all jobs controlled by edgeless headquarters were in edgeless space, about treble its national job share. This preference effect was very much due to the proximity effect: close to 30% of all jobs controlled by an urban headquarter were situated in the same urban center, while 20% of all jobs controlled by a suburban headquarter were situated in the suburbs of the same supercluster.

Things become more interesting when looking at the cross-participations. As we've said, while 62.7% of all private subsidiary jobs are hosted in urban centers, urban headquarters controlled 75.4% of all subsidiaries jobs – in 1985, cities had a certain control over the rest of the country. Suburban figures were at 15.9% and 12.6%, showing a distinctly subservient position, especially when compared to urban centers. In edgeless space, the figures were even more skewed, at 13.9% and 7.6%, showing a higher dependency level on the external world. This shows even more when looking at the full table below:

Job share in subs (%)		**Subsidiaries**						
		Urban	**Mixed**	**Suburban**	**Exurban**	**Touristic**	**Edgeless**	**Total**
	Urban	52.0	0.3	10.8	3.4	0.7	8.2	**75.4**
	Mixed	0.6	0.1	0.0	0.1	0.0	0.1	**0.9**
	Suburban	6.1	0.1	4.2	0.7	0.0	1.5	**12.6**
	Exurban	0.9	0.0	0.3	1.1	0.0	0.6	**2.8**
	Touristic	0.1	0.0	0.0	0.0	0.5	0.1	**0.7**
	Edgeless	3.1	0.0	0.6	0.5	0.1	3.4	**7.6**
Headquarters	**Total**	**62.7**	**0.5**	**15.9**	**5.8**	**1.2**	**13.9**	**100.0**

Table 7-1 : Share of subsidiaries jobs by subsidiaries and headquarters locations, private sector, 1985

As can be seen in this table, urban centers were firmly in control of the economical command structure in 1985. They controlled most of the urban subsidiaries (52.0% out of 62.7%), but also more than two thirds of all suburban subsidiaries jobs, three fifths of exurban ones, more than half the touristic ones and about five eights of edgeless ones. Cross comparison also favored urban centers, with 10.8% of subsidiary jobs being suburban center jobs controlled by urban headquarters, while the reverse was true of only 6.1% of all jobs. The imbalance was even more pronounced in other locations: 3.4% against 0.9% in exurban space, 8.2% and 3.1% for edgeless space. Only mixed centers, the very few of them then, behaved like cities at the time.

In the public sector, essentially the same trends were seen, only more so. 72.7% of subsidiary jobs were held in urban space; the second location to this respect was edgeless space, with 13.9% of subsidiary jobs. As compared to the private sector, suburban and exurban centers were quite depleted, with respectively 9.1% and 3.3% subsidiary job shares, figures about two thirds of their private values. As already noted, the state was organizing itself along a center-periphery pattern which ignored somewhat suburban and exurban centers. The public sector showed a very strong, almost exclusive tendency to locate headquarters and subsidiaries in the same kind of location, which can be squarely attributed to the fact that it showed a very strong affinity to proximal locations: the clear majority of subsidiary jobs were held in the supercluster where their headquarter was located.

When cross-relations were observed, urban dominance was even stronger in the public sector than in the private one. While 72.2% of all public subsidiaries jobs were held in cities, urban headquarters controlled 91.1% of all subsidiaries jobs. Accordingly, in all other locations control was relinquished: suburban space accounted for 9.1% of all subsidiaries jobs but only 2.7% of all subsidiaries jobs were controlled by suburban headquarters – similar dissimilarities were seen for exurban centers (3.3%-0.8%) and edgeless space (13.9%-5.0%). As could be expected with such dominance, cross-relations are rather sparse and quite unidirectional, with urban centers controlling subsidiaries in other locations being the norm.

Job share in subs (%)		**Subsidiaries**						
		Urban	**Mixed**	**Suburban**	**Exurban**	**Touristic**	**Edgeless**	**Total**
	Urban	72.2	0.4	6.5	2.6	0.7	8.8	**91.1**
	Mixed	0.0	0.1	0.0	0.0	0.0	0.0	**0.1**
	Suburban	0.1	0.0	2.6	0.0	0.0	0.1	**2.7**
	Exurban	0.0	0.0	0.0	0.8	0.0	0.0	**0.8**
	Touristic	0.0	0.0	0.0	0.0	0.3	0.0	**0.3**
	Edgeless	0.0	0.0	0.0	0.0	0.0	5.0	**5.0**
Headquarters	**Total**	**72.3**	**0.4**	**9.1**	**3.3**	**1.0**	**13.9**	**100.0**

Table 7-2 : Share of subsidiaries jobs by subsidiaries and headquarters locations, public sector, 1985

In all, in 1985, the territorial patterns displayed by the command and control ties of the economy when opposed to location provided a rather expected picture of urban dominance over other locations, and in particular over suburban space.

7.4.1.3. Size relationships

We now turn to general relationship between control and command and supercluster size, always separating between the private and the public sector. In the private sector, a strong size effect was immediately visible when looking at the figures. 42.2% of the subsidiaries jobs were held in superclusters over 64'000 jobs, 27.7% in medium-sized ones, between 8'000 and 64'000 jobs, while 16.3% were held in smaller superclusters, below the 8'000 jobs threshold; edgeless space accounted for 13.8%. Headquarter jobs were more attracted to the top tier, with corresponding figures of 47.7%, 27.5%, 13.9% and 11.0% - at first sight it can be seen that the greatest superclusters concentrate more headquarters jobs than subsidiaries ones. As for locations, there was a strong tendency for headquarters to control subsidiaries in similarly sized superclusters, since, depending on the size class, the share of subsidiaries jobs controlled by a headquarter situated in a similarly sized superclusters varied between 31.8% and 44.6%. As before, this reflected a strong tendency to proximal relationships: 36.7% of all subsidiaries jobs were controlled by headquarters located in the same supercluster.

The study of cross-participations gives further indications: larger superclusters controlled smaller ones. While 42.2% of subsidiaries jobs were held in the largest superclusters, those superclusters hosted headquarters which controlled 59.4% of those jobs, the differences being striking for the greatest supercluster of all, Zurich (15.4% against 26.3%). By contrast, medium-sized centers were slightly seen as subservient, as they controlled 24.1% of all subservient jobs, of which they hosted 27.5%, a tendency more clearly seen in smaller superclusters (8.9% against 13.9%) and in edgeless space (7.7% against 13.8%). Further examination shows that the smallest supercluster size class which controlled more jobs than it held was the 64'000 to 128'000 jobs class: a testimony of the domination of several large superclusters had on the whole geography. The full table overleaf gives the following results:

Job share in subs.		**Subsidiaries**											
		E-less	**0**	**1**	**2**	**4**	**8**	**16**	**32**	**64**	**128**	**256**	**Total**
Headquarters	**E-less**	3.4	0.1	0.3	0.2	0.5	0.5	0.6	0.3	0.3	0.8	0.7	**7.6**
	0	0.2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.8**
	1	0.3	0.0	0.6	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.1	**1.5**
	2	0.4	0.0	0.0	0.7	0.1	0.1	0.2	0.1	0.0	0.1	0.1	**1.8**
	4	0.9	0.0	0.3	0.2	1.9	0.4	0.3	0.2	0.1	0.2	0.3	**4.8**
	8	0.7	0.1	0.4	0.3	0.2	1.8	0.3	0.1	0.1	0.2	0.3	**4.6**
	16	1.6	0.1	0.4	0.4	0.9	0.4	4.5	0.4	0.1	0.5	1.0	**10.3**
	32	1.1	0.1	0.1	0.5	0.9	0.6	1.3	3.4	0.3	0.5	0.6	**9.2**
	64	0.7	0.1	0.1	0.2	0.4	0.6	0.4	0.4	2.8	0.6	0.3	**6.5**
	128	2.5	0.1	0.3	0.8	1.8	1.1	2.1	1.5	1.5	11.9	3.0	**26.6**
	256	2.0	0.1	0.6	0.5	1.3	1.9	2.5	2.0	1.6	4.9	9.0	**26.3**
	Total	**13.8**	**1.0**	**3.3**	**3.8**	**8.2**	**7.3**	**12.1**	**8.3**	**7.0**	**19.7**	**15.4**	**100.0**

Table 7-3: Share of subsidiaries jobs by subsidiaries and headquarters supercluster size class, private sector, 1985

What can be seen, albeit not in a very spectacular way, is that as a general rule headquarters in a given supercluster are far more likely to control jobs situated in similarly sizes or smaller superclusters than in larger ones. Figures above the diagonal of the preceding table, which represent such control of superclusters on larger ones, are far smaller than the figures situated below the diagonal, which represent control of larger superclusters on smaller ones. Once the proximity effect taken into account, the picture drawn by the size relationships is very clearly one of control of the smaller superclusters by the bigger ones.

As for the location analysis, the territorial patterns shown in the control and command structure of the public service when studying size effects showed the same structures than the private sector, only stronger, once the effects of the very potent proximity effect were removed. While just under half of all public subsidiaries jobs (46.2%) were located in the greater superclusters, those same superclusters controlled 71.0% of all public subsidiaries jobs. With such an imbalance, all other supercluster size classes showed a subservient structure: medium-sized superclusters accounted for 27.1% of public subsidiaries jobs, but controlled only 19.6% of them, the figures being 13.1% and 4.4% for small superclusters, and 13.8% and 5.0% in edgeless space. There was, then, a very clear domination by large superclusters on the rest of the country. More precisely, it can be shown that as a whole, only one supercluster size class dominated all the others: the 64'000 to 128'000 jobs size class, which included Berne, accounted for 22.0% of public subsidiaries jobs, but controlled 51.0% of those – a very visible display of the administrative power of Berne at the time.

The study of the cross-relationships show first that the same rules seemed to apply to integrated public establishments than to private ones – there was practically no subsidiary controlled by a headquarter situated in a smaller supercluster than itself. Some specific traits are also readily visible: in all size classes except the one including Berne, the vast majority of headquarters jobs are situated in the same size class as the subsidiaries they control, and very probably in the same supercluster – only from Berne, it seems, did public control extend clearly beyond its supercluster.

Job share in subs.		**Subsidiaries**											
		E-less	**0**	**1**	**2**	**4**	**8**	**16**	**32**	**64**	**128**	**256**	**Total**
	E-less	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**5.0**
	0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.3**
	1	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.6**
	2	0.1	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.2	**1.3**
	4	0.2	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	**2.3**
	8	0.6	0.0	0.4	0.1	0.1	2.3	0.0	0.0	0.0	0.2	0.0	**3.7**
	16	0.9	0.1	0.3	0.3	0.7	0.4	8.0	0.4	0.0	0.2	0.0	**11.3**
	32	0.3	0.0	0.0	0.2	0.1	0.1	0.2	3.8	0.0	0.0	0.0	**4.6**
	64	0.9	0.1	0.3	0.3	0.3	0.5	0.1	0.0	5.9	0.1	0.0	**8.5**
	128	5.5	0.5	0.9	1.7	2.5	2.4	5.3	2.7	3.2	21.5	5.4	**51.5**
Head-quar-ters	**256**	0.5	0.2	0.0	0.1	0.2	0.2	0.0	0.7	0.0	0.0	9.2	**11.0**
	Total	**13.8**	**1.1**	**2.5**	**3.4**	**6.0**	**5.9**	**13.6**	**7.6**	**9.1**	**22.0**	**14.9**	**100.0**

Table 7-4: Share of subsidiaries jobs by subsidiaries and headquarters supercluster size class, public sector, 1985

A quick look at the size relationships crossed with locations shows that when considering urban centers and the private sector, while in absolute numbers the engagement of larger superclusters was way stronger than that of medium-sized ones, which were themselves way more engaged than small superclusters – in absolute terms, as we remarked before, larger centers dominated the landscape. A more subtle effect was seen also on the distribution of jobs controlled by large urban centers, in that they clearly showed preference for medium and large superclusters, as if headquarters in those large urban centers weren't really considering extending control to small superclusters or edgeless locations. By contrast, such an effect wasn't seen in medium-sized centers, or in smaller ones – medium-sized centers apportioned their jobs almost equally between the four categories under review, while smaller centers were showing a preference towards similarly-sized other centers, and edgeless space, the latter showing extremely strong preference for itself.

Jobs		**Subsidiaries**						
		Edgeless	**< 4'000 jobs**		**4'000-64'000 jobs**		**> 64'000 jobs**	
		n/a	Other	Same scl.	Other	Same scl.	Other	Same scl.
Headquarters	**Edgeless**	17331	2982	0	5091	6	7449	0
	< 4'000 jobs	5860	2355	7453	3365	0	2508	0
	4'000-64'000 jobs	14568	10042	0	11997	29966	13622	0
	> 64'000 jobs	21452	18817	0	45384	0	51286	67917

Table 7-5: Urban subsidiaries jobs controlled by urban headquarters, according to their supercluster size and geographical relation, 1985

The same exercise conducted on cross-relations between urban and suburban centers both ways, and on suburban to suburban relations gives similar results with an even stronger preference for similarly sized superclusters. In resume, strong level effects were in place which favored relationships between centers of similar size, a testimony of the metropolization inception.

In all, the command and control picture seen in 1985 is clearly the one conventional wisdom would expect. In terms of location structure, urban centers showed dominance on all other locations. In terms of size, large centers dominated smaller ones. Once the very important proximal relationships were taken into account, the general picture was one of domination of the big urban centers on the rest of the territory, with a double structure of control: from larger to smaller, and from central places to peripheries.

7.4.2. 2008

7.4.2.1. General remarks

The first change we notice when looking at 1985 and 2008 figures is that in all, the job share of subsidiaries have remained relatively the same, with 950'000 jobs located in subsidiaries in 2008, against 879'000 in 1985. A major difference showed, though, in the public-private distribution of those jobs, as the share of the public services plunged from 42% of all subsidiaries jobs in 1985 to just 32% in 2008. This seems to mean that the general stability showed a strong rise of the job numbers of privately-owned subsidiaries, compensated by a fall in publicly-owned ones.

A more thorough examination partly mitigates the preceding remarks. Looking at the job distribution between headquarters and subsidiaries in the integrated entities shows that the private and public sectors have structurally evolved along quite different paths. In the private sector, the consequent rise in subsidiaries jobs, from 508'700 to 649'400, was compensated by a fall in headquarters ones, from 532'600 to 451'100. The inverse process was observed in the public sector, with a fall in subsidiaries jobs number, from 370'100 to 300'800 to which corresponds a rise in headquarters ones, from 36'700 to 102'400. Thus, the integrated part of the private sector evolved towards more integrated structures while in the private sector very strong disintegration moves were seemingly at play which made many new smaller networks from a few larger ones. Those moves translated into changes in the mean networks: a typical private headquarter now controlled about six subsidiaries, against four in 1985. Those subsidiaries were still smaller than their headquarters, which counted about three times as much workers. Conversely, in the public sector, the headquarter-subsidiaries ratio had gone down from 12 to 8. However, in the meantime public headquarters had grown strongly in size and now are three times as big as their subsidiaries. In terms of structure, public and private entities showed a certain amount of convergence.

Convergence between private and public companies wasn't apparent, though, when looking at the proximal preference behavior. In 2008, the job share of subsidiaries located in the same supercluster than their headquarters went from 36.7% in 1985 to just 31.0% in 2008: private integrated entities are now less proximal, more regional and interurban than in 1985. The reverse is true of public services, where this job share went up from 55.1% to 66.6%. In that respect both sectors showed widening differences in the way they spatially behaved, a reason to still treat them separately in 2008.

7.4.2.2. Location relationships

A first examination of the data at hand shows that integrated companies are still very much urban with 57.4% of private headquarters jobs, and 56.1% of subsidiaries ones in urban centers – however, those figures are clearly down from those of 1985, 7.6 points for headquarters jobs and 6.6 points for subsidiaries ones. Conversely, figures for suburban space were up, with now 25.5% of private headquarters jobs, and 26.7% of private subsidiaries ones being located there, rises of respectively 8.2 and 10.8 points. Edgeless space registered figures at 11.8% of private headquarters jobs, up 0.9 points since 1985, and 10.7% of private subsidiaries ones, down 3.2 points from then. As in 1985, all locations showed a strong affinity to control jobs in the same location type – in fact this had reinforced since 1985. 70.6% of the jobs controlled by urban private headquarters were situated in urban centers, up 1.6 points, 38.3% of suburban private subsidiaries jobs were controlled by suburban headquarters, up 5.1 points – albeit this rise, being only half the rise of overall suburban presence, means that the suburban preference for suburban settings was relaxing. The same was true, in other proportions, of edgeless headquarters, which controlled job share in edgeless space went crashing down from 44.5% in 1985 to just 18.5% in 2008. As the urban centers went more urban, other location types, while still displaying some preference for similar locations, were becoming more diverse in their control structure. An interesting by-fact is that the urban preference for urban centers has reinforced even though proximal relationships have declined – meaning that interurban center relationships have gone up significantly.

The cross-relationships also reveal much. Urban centers control 62.7% of private subsidiaries jobs, a figure way down from the 75.4% of 1985. Even if urban centers still had more than their share of overall control, their grip on the rest of the territory had gone down. Conversely, the suburban centers role in the command and control functions of the economy exploded – by 2008, suburban headquarters held control over 27.0% of private subsidiaries jobs, against 12.7% in 1985; the former figure is very slightly more than the suburban share of subsidiaries jobs (26.6%), which means that suburban centers had become net controllers.

Job share in subs.		**Subsidiaries**						
		Urban	**Mixed**	**Suburban**	**Exurban**	**Touristic**	**Edgeless**	**Total**
	Urban	39.6	0.9	14.4	2.0	0.4	5.4	**62.7**
	Mixed	0.9	0.2	0.2	0.1	0.0	0.4	**1.8**
	Suburban	12.6	0.5	10.2	1.1	0.0	2.6	**27.0**
	Exurban	0.6	0.0	0.4	0.4	0.0	0.3	**1.7**
	Touristic	0.0	0.0	0.0	0.0	0.2	0.0	**0.3**
	Edgeless	2.4	0.2	1.5	0.3	0.1	2.0	**6.4**
Headquarters	**Total**	**56.1**	**1.9**	**26.6**	**3.8**	**0.8**	**10.7**	**100.0**

Table 7-6: Share of subsidiaries jobs by subsidiaries and headquarters locations, private sector, 2008

A further look at the table shows first that as already stated locational preference was clearly down and in all the share of same-location relationships was down everywhere, regardless of the location type. Urban centers showed a gentle decline in terms of overall control and while holding rather tightly to the urban private subsidiaries jobs, it let go somewhat in other locations. In those locations, it now controlled about half of the private subsidiaries jobs, clearly less than in 1985. Cross comparisons show that if cities were still more in control than other locations, the control imbalance was down. 14.4% of private subsidiaries jobs were suburban jobs controlled by urban headquarters; however the reverse was now true for 12.6% of those jobs – clearly, suburban space was now controlling about as many jobs in urban space as urban headquarters were in suburban centers: the very strong hierarchical relationship seen in 1985 between urban and suburban centers is no more. In the same vein, suburban space is now dominant over all other locations types than urban, generally strongly so.

In the public sector, meanwhile, the same deconcentration trends were seen, with 62.0% of all public subsidiaries jobs held in urban centers against 72.7% in 1985, and a corresponding growth in suburban space, with 16.3% of such jobs in 2008 against 9.1% in 1985. However, within the new bounds set by this deconcentration trends, urban centers remained in full control of the commanding structure of the public sector, controlling 81.0% of all such jobs. By comparison, suburban space hosted 16.3% of all public subsidiaries jobs, but controlled only 8.0% of them. In the public sector then, cities still rule the roost.

Job share in subs.		Subsidiaries						
		Urban	Mixed	Suburban	Exurban	Touristic	Edgeless	Total
Headquarters	Urban	60.4	1.1	9.9	1.6	0.4	7.7	**81.0**
	Mixed	0.0	0.7	0.0	0.0	0.0	0.0	**0.8**
	Suburban	1.1	0.0	6.3	0.1	0.0	0.5	**8.0**
	Exurban	0.2	0.0	0.0	1.5	0.0	0.0	**1.8**
	Touristic	0.0	0.0	0.0	0.0	0.4	0.0	**0.5**
	Edgeless	0.3	0.0	0.1	0.0	0.0	7.6	**8.0**
	Total	**62.0**	**1.9**	**16.3**	**3.2**	**0.8**	**15.8**	**100.0**

Table 7-7: Share of subsidiaries jobs by subsidiaries and headquarters locations, public sector, 2008

In terms of location structure, then, plenty of things have changes between 1985 and 2008. In a general way, cities have lost some of their grip on the command and control structure of the economy, mainly in favor of suburban space. While cities reinforced their mutual ties, the other locations diversified their ties outside their preferred location and started to build intercluster links. In all, while the 1985 command and control structure was very predominantly, almost exclusively urban, it had diversified quite a bit up to 2008, which gave rise to a more equilibrated, more multilateral, in one word more metropolitan territorial economy. At first sight, while 1985 structures were predictable and indeed foreseen, the 2008 command and control structures are quite surprising in their sheer diversity.

All this, of course, refer to the private sector – in the public sector, urban domination is still very much the norm and all evolution could probably be reduced to general structural changes in the overall distribution of jobs throughout the country.

7.4.2.3. Size relationships

Turning to the relationship between supercluster size and command and control structures of the economy, the first major find is that in the private sector, there was a very strong reinforcement of the integrated economy in the largest superclusters, those grouping more than 64'000 jobs. In 2008, those largest superclusters grouped 52.2% of private subsidiaries jobs, and 53.7% of headquarters ones – in 1985, the corresponding figures were 42.2% and 47.7% respectively. Medium-sized superclusters lost heavily in job shares, with 2008 figures at 23.0% of private subsidiaries jobs and 23.9% of headquarters ones, against 27.7% and 27.5% in 1985. Similar situation in small superclusters, with 14.2% of private subsidiaries jobs and 13.2% of headquarters ones, down from 16.3% and 13.8%. Finally, edgeless space accounts for 10.7% of private subsidiaries jobs and 9.3% of headquarters ones in 2008, against 13.8% and 11.0% in 1985. At first sight there is a very clear tendency for subsidiaries and headquarters alike to locate in the largest superclusters, a rise which is way stronger than the general reinforcement of the top tier of the urban hierarchy – as such, this can be interpreted as a strong reinforcement of the intra- and interurban links between the largest agglomerations of the country and thus constituted, to us, the strongest indication of metropolization processes we have encountered so far in this work.

This seems to be further confirmed by the fact that, as already noted, that proximal relationships were declining, at least in shares. In 1985, the job share of private subsidiaries which were located in superclusters of the same size than that of their headquarters was oscillating between 31.8% and 44.6%, depending on the size class considered, with a strong modal grouping around 40%. By 2008, values had spread from 20.0% to 43.0%, with a grouping around 30%. More importantly, there was now a clear relationship between supercluster size and the preference for subsidiaries and headquarters situated in similarly sized superclusters: this preference was still very strong in the largest superclusters, with over 40% of subsidiaries jobs in the same supercluster class, while it was very clearly lower for other supercluster classes: between 20% and 28% for superclusters with less than 8'000 jobs, between 25% and 32% for those between 8'000 and 128'000 jobs. In edgeless space, the preference went also down, from 44.6% in 1985 to 30.8% in 2008. In 1985, there was no relation between supercluster size and prevalence of control in similarly sized superclusters. All this hints at a metropolitan evolution: large centers control subsidiaries in their immediate surroundings and in other large superclusters, while proximal relations cede terrain to interurban ones in smaller superclusters, thus building a intertwined mesh of interurban, horizontal and vertical relations which taken together form the metropolis.

The pattern of cross-participations also reinforces the metropolitan hypothesis. Superclusters above 64'000 jobs host in 2008 52.2% of private subsidiaries jobs, but control 69.9% of them, a figure to be compared to 59.4% in 1985. This is a very strong testimony of the reinforcing control of major superclusters in the economy as a whole. Furthermore, most of this control stems out from the big five – together controlling 63.4% of all private subsidiaries jobs against 52.9% in 1985, Zurich alone controlling 27.1% of them. Interestingly, the Zurich figure has been stable since 1985 and the steady rise in control by the big five must indeed be attributed mostly to the four other members of the big five, which shows the establishment in Switzerland of true metropolitan cores beyond Zurich. Of course, with such figures, all other superclusters seem heavily controlled: the medium sized ones account for 23.0% of private subsidiaries jobs but control only 16.2% of them, the figures being 14.2% and 7.5% for small superclusters and 10.7% and 6.4% in edgeless space. As in 1985, only the big five control more subsidiaries jobs than they host, and this specificity has reinforced since then.

Job share in subs.		**Subsidiaries**											
		E-less	**0**	**1**	**2**	**4**	**8**	**16**	**32**	**64**	**128**	**256**	**Total**
	E-less	2.0	0.2	0.2	0.3	0.5	0.5	0.6	0.3	0.3	1.0	0.6	**6.4**
	0	0.2	0.2	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	**0.9**
	1	0.2	0.0	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.1	**1.1**
	2	0.4	0.0	0.1	0.4	0.1	0.1	0.2	0.1	0.1	0.2	0.2	**1.9**
	4	0.7	0.1	0.3	0.2	1.0	0.2	0.2	0.2	0.3	0.3	0.2	**3.6**
	8	0.7	0.3	0.3	0.4	0.4	1.7	0.4	0.2	0.2	0.6	0.3	**5.4**
	16	0.6	0.2	0.2	0.2	0.4	0.3	1.2	0.3	0.1	0.4	0.2	**4.2**
	32	0.8	0.1	0.2	0.1	0.6	0.4	1.0	1.6	0.2	0.9	0.8	**6.6**
	64	0.9	0.1	0.1	0.3	0.3	0.5	0.5	0.3	2.1	0.8	0.6	**6.5**
	128	2.8	0.4	0.7	0.8	2.1	2.2	2.3	2.9	1.7	15.6	4.8	**36.3**
	256	1.4	0.1	0.2	0.5	0.9	1.2	1.4	1.6	1.9	6.6	11.3	**27.1**
Headquarters	**Total**	**10.7**	**1.7**	**2.6**	**3.4**	**6.4**	**7.2**	**7.9**	**7.8**	**6.8**	**26.4**	**19.0**	**100.0**

Table 7-8: Share of subsidiaries jobs by subsidiaries and headquarters supercluster size class, private sector, 2008

Finally, the examination of the full table of cross-participations shows that there is no barrier anymore for headquarters situated in small superclusters to control subsidiaries in larger ones, as was very clearly the case in 1985. Thus, beneath a very strong controlling drive made by the larger superclusters and particularly by the big five, patterns of control are less unilateral than they were. If it is still as true as ever that larger clusters control the economy, it is not as clear as in 1985 that larger superclusters systematically control smaller ones. It is not near impossible anymore, as it was in 1985, for a small supercluster to host headquarters controlling subsidiaries in larger ones, even though the balance of control is still, all things considered, very much in favor of the largest superclusters of the country: some flexibility has risen in the control patterns between superclusters in step with the metropolization lived by its largest representatives.

As we've just seen, major moves affected the command and control structure of the private sector. We now turn towards the public sector. In 1985, the public sector displayed the same structure than the private one, only in starker tones, with more control by large urban centers over the rest of the country. We've also seen that when looking at locations, public services did not evolve much between 1985 and 2008. In terms of size, however, the greater moves which saw the break-up of many public giants into smaller, more manageable networks had an impact on the control structure displayed by public entities according to the size of their superclusters. To the contrary of what happened with private companies, the level of control of the largest superclusters went significantly down, with superclusters with more than 64'000 jobs hosting 44.9% of public subsidiaries jobs in 2008 against 46.2% in 1985, but controlling 61.4% of them now against 71.0% in 1985. Conversely, medium-sized superclusters control now almost as many public subsidiaries jobs (23.5%) than they host (25.9%), while the imbalance was far larger in

1985, at 19.6% and 27.1%. Smaller superclusters and in edgeless space, though, were still assuming subservient functions in approximately the same levels than in 1985, with small superclusters hosting 13.4% of public subsidiaries jobs and controlling 7.4% of them, while in edgeless space the figures were 15.8% and 8.0%. Thus, public services displayed some level of spatial as well as functional disintegration, which is seen by the level of control loss by larger superclusters to the benefit of medium-sized ones, a result which is entirely compatible with the disintegration strategy we think happened in the Swiss public services. Correspondingly, whereas in 1985 only one size class, including Berne, dominated all the other ones, this time the level of control of this particular size class went down significantly, while two other size classes covering the 16'000 to 64'000 jobs bracket were also dominating. Berne has lost some of its star power in controlling public services.

In public services, it seems that the relaxing of rules seen in cross-relations did not happen. Proximal relations were even more dominant than before, Berne was still seemingly the only supercluster to significantly control something out of its own supercluster, although this control level had gone significantly down with the operational break-up of several public services, and there still were practically no occurrence of headquarters in small superclusters controlling subsidiaries in larger ones. In fact, except for the structural changes noted above, not very much happened to the territorial structures of the public services organization between 1985 and 2008. As such they remain as witness of a fast disappearing age, that of the Christallerian territorial organization of Switzerland's economy.

Job share in subs.		**Subsidiaries**											
		E-less	**0**	**1**	**2**	**4**	**8**	**16**	**32**	**64**	**128**	**256**	**Total**
	E-less	7.6	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	**8.0**
	0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.8**
	1	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	**1.1**
	2	0.1	0.0	0.0	1.5	0.0	0.2	0.1	0.0	0.0	0.0	0.0	**1.9**
	4	0.2	0.0	0.1	0.0	2.6	0.2	0.1	0.1	0.0	0.1	0.0	**3.4**
	8	0.5	0.1	0.0	0.1	0.3	3.4	0.2	0.0	0.0	0.3	0.0	**4.9**
	16	0.9	0.2	0.2	0.3	1.1	0.9	7.6	1.3	0.0	0.0	0.0	**12.6**
	32	0.7	0.1	0.2	0.2	0.0	0.3	0.0	4.4	0.0	0.0	0.0	**6.0**
	64	0.3	0.0	0.0	0.2	0.2	0.2	0.3	0.0	3.8	0.2	0.0	**5.4**
	128	5.1	0.5	0.9	0.9	1.3	2.4	2.1	1.3	1.0	26.7	1.7	**43.8**
	256	0.4	0.0	0.0	0.0	0.2	0.4	0.0	0.4	0.1	0.0	10.5	**12.2**
Headquarters	**Total**	**15.8**	**1.7**	**2.4**	**3.4**	**6.0**	**8.0**	**10.3**	**7.5**	**5.1**	**27.5**	**12.3**	**100.0**

Table 7-9: Share of subsidiaries jobs by subsidiaries and headquarters supercluster size class, public sector, 2008

Finally, a quick look at the size relationships crossed with locations allows the following conclusion. In structural terms, the tendencies seen in 1985 were still very much present: there was a strong preference for headquarters in large superclusters to exert control over subsidiaries also located in large superclusters, a tendency which is absent for other supercluster size classes. The same effect was also still seen when looking at urban-suburban, suburban-urban and suburban-suburban relationships, with similar results, size effects being still very much in place which favored integration and control in the large superclusters. As we found before, suburban centers are now almost as apt at controlling subsidiaries in urban centers as urban centers are at controlling suburban subsidiaries. However, this does not extend to same-supercluster relations: in 2008 urban centers controlled 35'378 jobs in their own suburban centers, the reverse being true of only 17'546 jobs. In 1985, those figures were respectively 30'823 and 10'305. In proximal settings, urban centers still dominate suburban ones.

Jobs		**Subsidiaries**						
		Edgeless	**< 4'000 jobs**		**4'000-64'000 jobs**		**> 64'000 jobs**	
		--	**Other**	**Same scl.**	**Other**	**Same scl.**	**Other**	**Same scl.**
	Edgeless	12827	3290	0	5703	0	6404	0
	< 4'000 jobs	4924	2367	4115	2673	0	2198	0
	4'000-64'000 jobs	10449	6801	0	11064	15688	9698	0
Headquarters	**> 64'000 jobs**	19708	15300	0	42857	0	65703	78797

Table 7-10: Urban subsidiaries jobs controlled by urban headquarters, according to their supercluster size and geographical relation, 2008

A further examination of this table, compared with the one for 1985, shows that in general, cross-relationships between small and medium-sized superclusters have stagnated at best, while to the contrary relationships between large superclusters have grown. While functional and spatial disintegration affected most relationships, especially proximal ones, metropolization effects promoting interurban relationships between metropolitan areas more than compensated for disintegration moves in larger superclusters.

7.4.3. From Christallerian networks to metropolitan ones

The picture drawn from the examination of control and command relationships when looking at location and size at two different epochs illustrates well the transition in which the Swiss economy is engaged with regard to its territorial structure. While already well engaged in transition, the 1985 integrated companies were still displaying expected structures in terms of mutual relationships. Many of the relations which were apparent were proximal, concerning branches in the same center or the same supercluster and only about half of the relations were linking different superclusters. As expected, urban centers dominated clearly all other location types, confirming the primacy of the city as a command center for the economy. In particular, large superclusters showed dominance on smaller ones, which again went with theory and advocated a urban centrality view of the economic organization, as well as of the state administration. Thus far the finds were very much expected.

However, since 1985 the economic structures as displayed by the command and control structure of the economy have changes quite dramatically. First of all, the commanding links which remained after the continuing waves of economic and functional disintegration weren't as one-sided as in 1985 – while urban centers still dominated other locations, some of those other locations, most notably the suburban centers, weren't as subservient than before. In all the economy was more diverse in the way it was organized, it showed more territorial forms of control than before. Interurban links were more prevalent, as if functional disintegration concerned above all proximal relationships. When looking at size, two seemingly opposite conclusions could be reached. First, the amount of domination of the largest centers grew significantly, and mostly horizontally: growth was above all interurban and concerned similarly-sized superclusters. In other words, Switzerland's big five were building stronger and stronger mutual relationships. Meanwhile, the level of control of the big five on the rest of the economy significantly dropped, both in terms of direct control, an effect of post-fordist disintegration, and in terms of mutual relationships, seeing headquarters in small superclusters control subsidiaries in larger centers, a near-impossibility in 1985. Taking it all together, a metropolitan structure emerges from the old Christallerian one.

7.5. Integration in the world economy: foreign ownership and import-export patterns

7.5.1. 1995

7.5.1.1. General remarks

For the two business censuses of 1995 and 2005, it is possible to investigate the level of integration in the world economy as measured by two different ways, first through the ownership status – i.e. whether the considered company owns foreign subsidiaries, or is itself owned by a foreign company, and also through its business links with the external world as measured by the level of its importations and exportations as compared to its gross revenue.

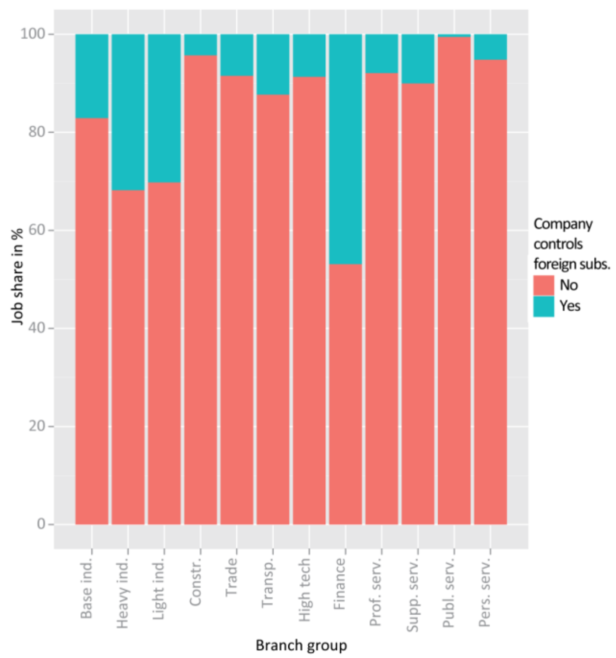


Chart 7-20: Job share by branch group and foreign investment status, 1995

In 1995, 13.2% of the workforce was employed in a company which owned subsidiaries in foreign countries (*Chart 7-20*). At first sight it appears that structural effects were very strongly present in 1995 in the way multinational companies were deployed in Switzerland. At this date, the financial sector was by far the most multinational of all with nearly half its workforce employed in Swiss banks active at the multinational stage. Heavy and light industries had more than a quarter of their workforce employed by Swiss multinational companies, the figure being a bit less than 20% in base industries. In the rest of the economy the overwhelming part of the jobs were held by companies which had no institutional links with the exterior, localism being extremely strong in construction and public services.

In 1995, 5.7% of all jobs were held by subsidiaries of foreign multinationals – as a first remark we note that there was about twice and a half as many jobs in Swiss multinationals than in foreign ones in Switzerland at this time (*Chart 7-21*). Again, the financial sector was the one where the presence of foreign firms was the most important, those subsidiaries holding a bit less than 20% of all financial jobs. International companies were also rather strongly present in light and heavy industries with about one job out of ten held by foreign multinationals, as well as in trade, professional and support services. In all branch groups except one, the number of workers employed by Swiss multinationals greatly exceeded the number of jobs held in foreign ones. The lone exception was trade and retail, where integration on the global markets was as much the fact of foreign companies as of Swiss ones, which may be a consequence of the very peculiar situation of the retail market in Switzerland, dominated as it is by two domestic cooperatives.

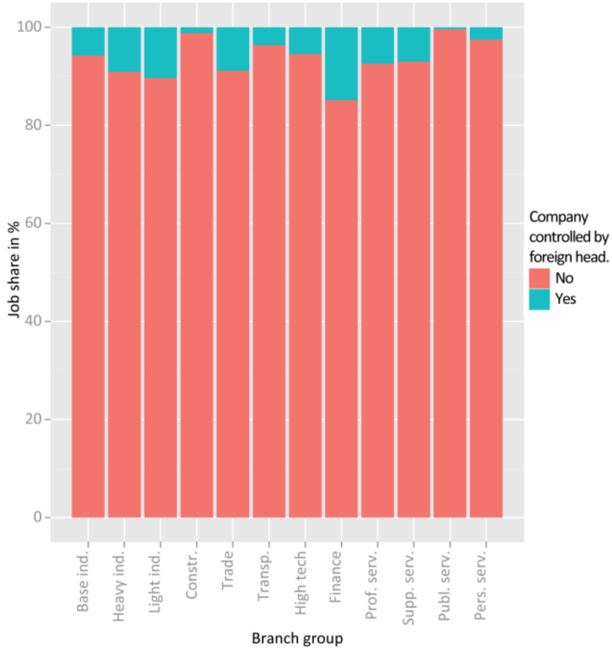


Chart 7-21: Job share by branch group and foreign control status, 1995

Looking at importation and exportation levels, it is immediately apparent that Switzerland was in 1995 an integrated economy. 25.2% of jobs were held by companies which were exporting, 12.5% in companies where exportations exceeded a third of the turnover. In comparison, 33.1% of jobs were held in companies which were directly importing wares and services from abroad, 12.0% where those imports represented more than a third of their company turnover.

Very strong structural differences were seen in 1995 when looking at imports and exports (*Charts 7-22 & 7-23*). The industry at large, and especially light and heavy industries were very active on the international markets, with a large majority of their workforce engaged in companies which were importing and exporting, the value of exports being far more important than the value of imports. Trade and retail again occupied a particular spot, being the only branch which was clearly more active importing goods than exporting them: more than half of trade jobs were held by importing companies, against a small minority in exporting ones. In services in general, the level of implication in import-export was way less important

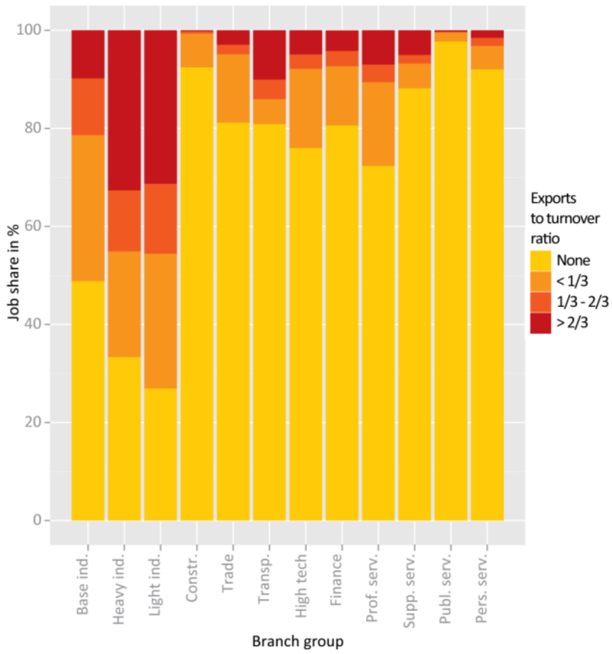


Chart 7-22: Job share by branch group and value of exportations, 1995

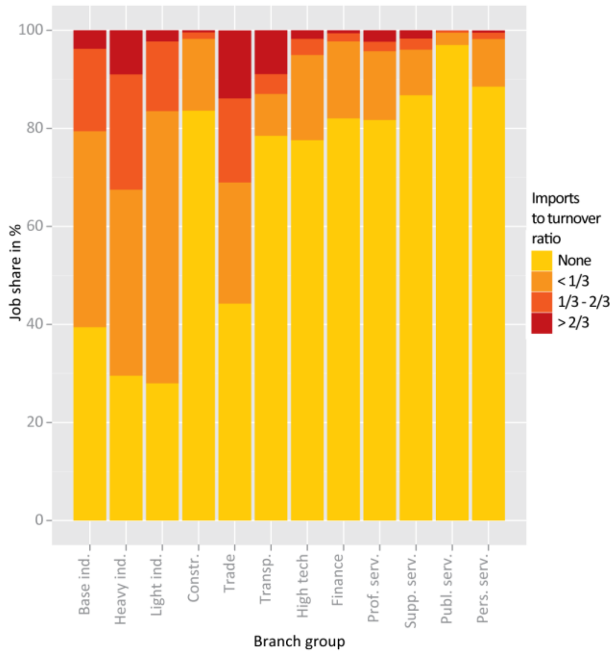


Chart 7-23: Job share by branch group and value of importations, 1995

than in the industry and in trade and retail. Structurally, the level of implication in international markets tended to grow with qualification, thus high tech, financial and professional services have a higher implication level than support, personal and public services. The import-export imbalance also seemed to be linked to branch qualification levels, with highly qualified branches exporting more, and lower qualification branches importing more.

The relatively low level of implication in international markets displayed by the service activities could be explained two ways: the first way would be to consider that Swiss services were genuinely less interested in the international markets than the industries for exports and trade and retail for imports, and that they served the internal market. The second possibility is more subtle and can be explained by describing the bank situation: even though Swiss banks largely worked with foreign capital, as long as financial manipulations were made from Switzerland the turnover generated by foreign capital productivity would not be considered to originate in foreign countries. This effect was particularly potent in banks but could also explain some of the depressed figures seen for some branches: for instance, hotel nights made by foreign tourists, restaurant bills or sales made to them will not be considered exportations.

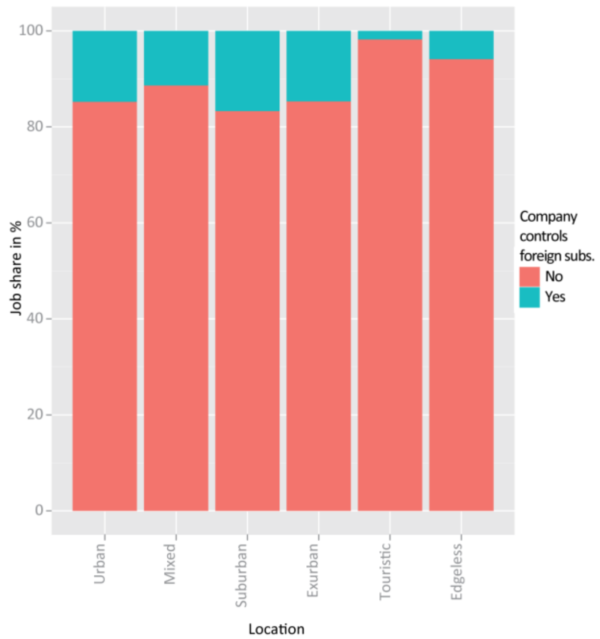


Chart 7-24: Job share by location and foreign investment status, 1995

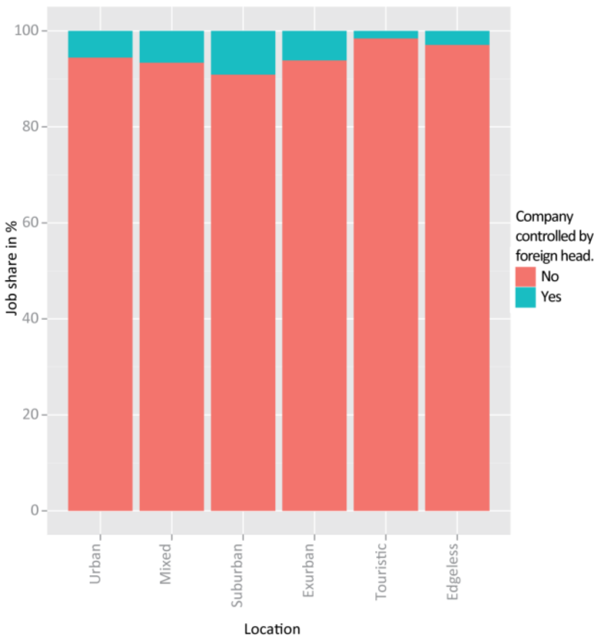


Chart 7-25: Job share by location and foreign control status, 1995

7.5.1.2. Location patterns

While strong differences were seen when studying the economy at the national level while controlling for branch groups, the differences seen between the different locations are more subtle (*Chart 7-24*). Central locations in general, from urban to exurban, were the prime locations for Swiss multinationals. Worthy of note though the fact that there was no urban premium for those companies, which can be explained by the very strong international integration of the industry, itself preferably located in suburban and exurban centers. This was even truer when looking at the implantation of foreign multinational subsidiaries (*Chart 7-25*), which were already clearly more present in suburban and exurban settings than elsewhere, the suburban difference being the most notable – maybe in addition to strong structural effects, it might be that suburban space was the location of choice for foreign multinationals to establish their subsidiaries.

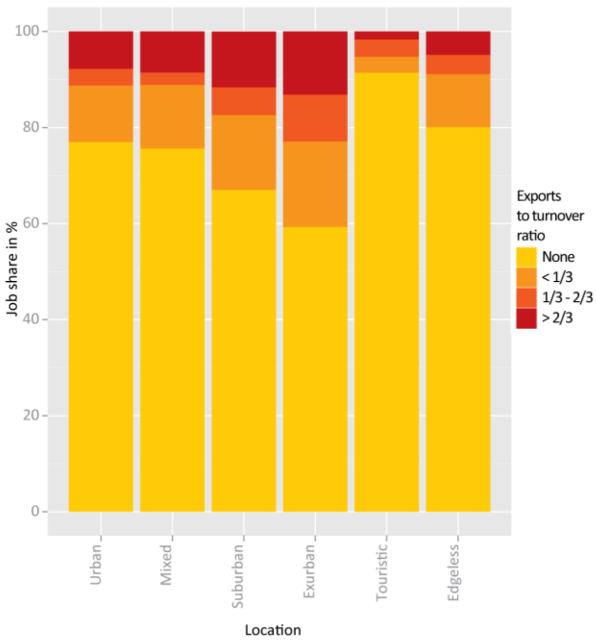


Chart 7-26: Job share by location and value of importations, 1995

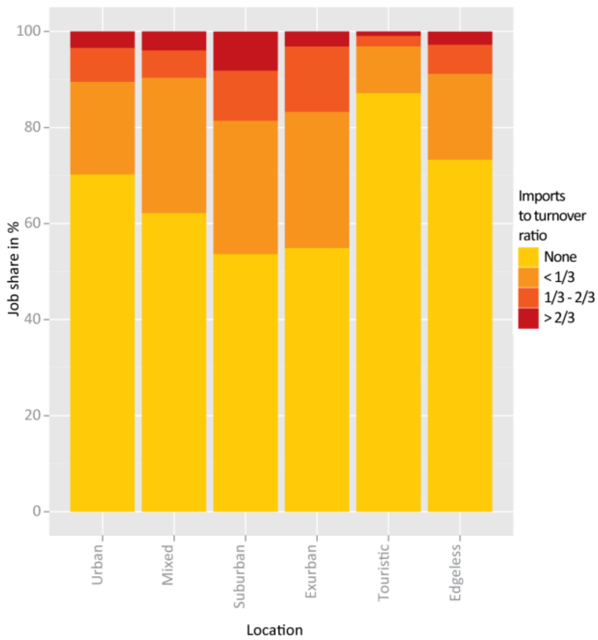


Chart 7-27: Job share by location and value of exportations, 1995

The same trends were seen when looking at imports and exports. Companies which exported at least part of their production were most present in exurban centers, closely followed by suburban centers. Whilst the exurban centers had tended to become less and less significant with the years, a great part of the wares which sported a "made in Switzerland" trademark still came out of them (*Chart 7-26*). When looking at imports, the same general trend was seen except that this time suburban centers are structurally stronger, which can be attributed to the fact that trade and retail, a major source of importations, were located preferentially in suburban space (*Chart 7-27*). In all, suburban and exurban centers imported and exported way more than their job share. Thus, a spatial division of labor was in place by 1995, where urban centers were in charge of financial operations while suburban and exurban centers were points of entry and of exit for Swiss and international wares, when they did not directly originate of end up there.

7.5.1.3. Size patterns

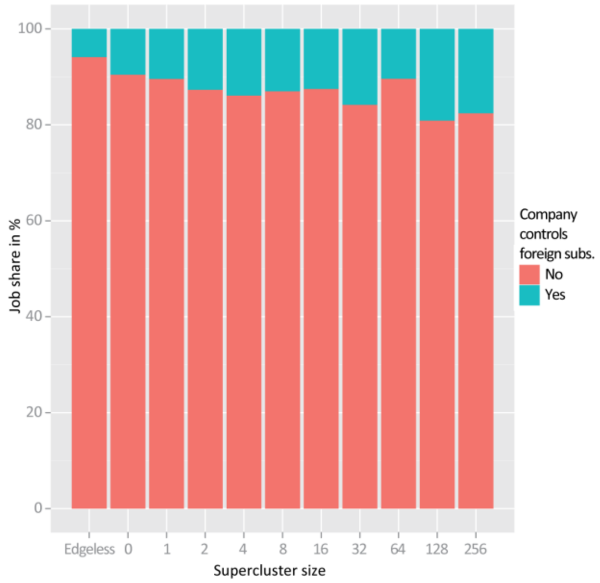


Chart 7-28: Job share by supercluster size class and foreign investment status, 1995

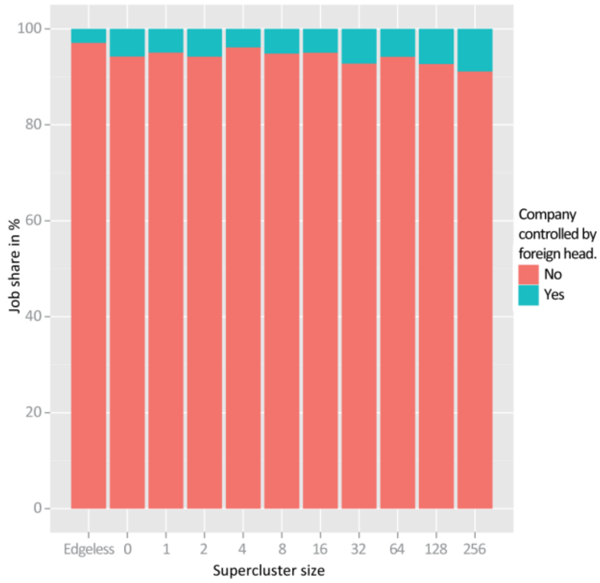


Chart 7-29: Job share by supercluster size class and foreign control status, 1995

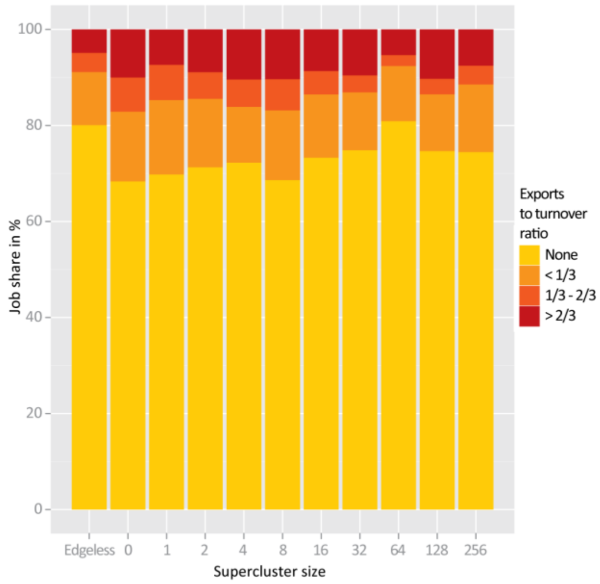


Chart 7-30: Job share by supercluster size class and value of exportations, 1995

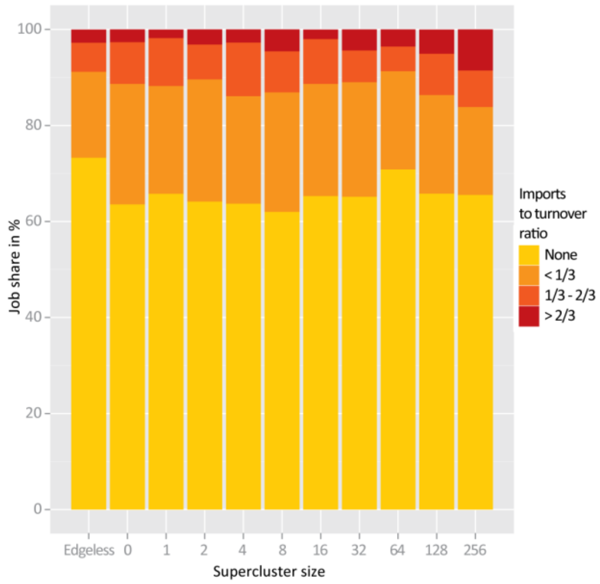


Chart 7-31: Job share by supercluster size class and value of importations, 1995

The size relations were also subtle to pick up in 1995, however they were revealing. Thus, while there was no urban premium as compared to suburban and exurban centers for Swiss multinationals to locate, there was a premium on size: the job share of Swiss multinational in large superclusters, around 20%, was about twice that of small superclusters and four times that of edgeless space: Swiss multinationals clearly preferred large superclusters, in other terms metropolitan areas, to locate (*Chart 7-28*). The same effect was seen regarding the preferred locations of foreign multinationals (*Chart 7-29*). In all, while the precise location was not as important as it could have been, multinationals, Swiss and foreign alike, favored strongly metropolitan spaces, while staying relatively free to locate, within those areas, in urban, suburban or exurban centers.

Curiously, the same trends weren't seen at all when looking at the import and export patterns when controlling for size (*Charts 7-30 & 7-31*). While in all central locations, regardless of their size, export in general more than edgeless space there is no definite trend with regard to supercluster size: small superclusters just about export as much as large ones. If multinationals do clearly prefer big metropolitan environments to locate themselves, such a preference does not extend to actual exporters, which seem to like small centers as much as large ones. Essentially similar conclusions are reached when looking at the import structure controlling by size, except that this time there was no difference between edgeless space and superclusters, at least the smaller ones. If there was an effect, it was that large importers were somewhat more present in the largest superclusters, but the effect was very subtle if at all present. Thus, there was practically no size pattern when looking at the import structure by size.

In all, the picture drawn for 1995 is one of massive structural differences in the way the Swiss economy is interfaced with the world economy. The industry and the financial services were very much international in the way their companies were organized, and for industry internationalization extended to their day-to-day practices, with strong importations and exportations. The international presence was less felt in other economic branches, especially in ownership terms: apart from the financial services and the touristic economy, the service sector was run by Swiss companies for Swiss consumers, and only in trade and retail were importations quite significant. Multinationals showed a preference for central locations, although they were as well represented in suburban and exurban centers than in urban and mixed ones, a testimony of their flexibility towards classical Central Business Districts. They also showed preference for larger superclusters, i.e. for metropolitan areas, to locate themselves. In one word, they were selective on the metropolitan scale but flexible within it. Exporters and importers were also located in centers, with a clear preference for suburban and exurban ones and a liberal attitude towards supercluster size. Thus, the geography of exporters-importers was predominantly urban, especially in formerly peripheral areas, in suburban and exurban space, in small superclusters as well as in large ones. Whereas multinationals were located preferentially everywhere in big superclusters, exporters and importers were located everywhere in suburban and exurban space. Of course, both met in suburban and exurban belts within major metro areas.

7.5.2. 2005

7.5.2.1. General remarks

The decade separating 1995 and 2005 was marked by major evolutions in the way the Swiss economy was organized towards the world economy. Changes are as profound as to be nearly incredible and results were so spectacular that they warranted a return to the original data to see if a coding error had not been committed. However, after due verifications, we had to consider that the results were correct. Here they are.

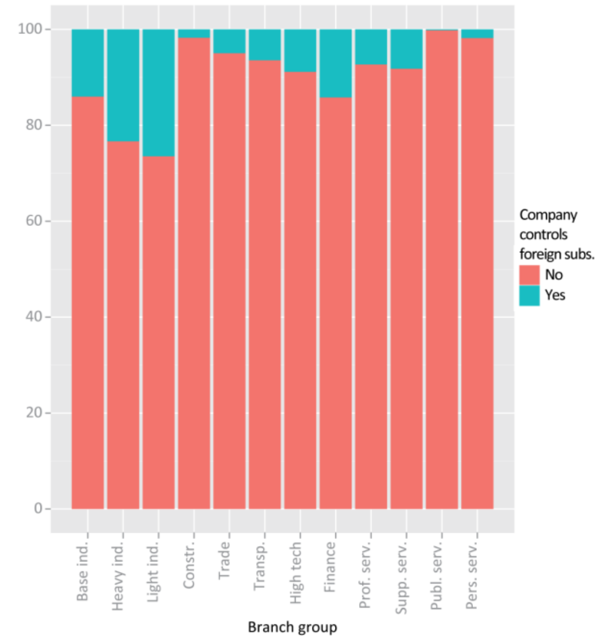


Chart 7-32: Job share by branch group and foreign investment status, 2005

In 2005, only 8.1% of all jobs were held in Swiss multinationals, a very severe drop since 1995 when this figure stood at 13.2%. Jobs in Swiss multinationals have been disappearing extremely fast, a very surprising result. As a quick look at the branch group distribution shows, the retreat of Swiss multinationals was general, but definitely not dispatched the same way through all branches (*Chart 7-32*). Multinationals massively retreated in financial services, where jobs in Swiss multinationals banks and insurance companies went from 46% in 1995 to just 14% in 2005. This catastrophic fall doesn't mean that Swiss banks ceased to be active in the global markets, as we all know, but that they disintegrated their domestic activities from their international ones, thus suddenly making purely domestic whole parts of the Swiss banking system which were formerly aggregated to the world markets. The retreat of Swiss multinational companies was also very strong in transportation activities following the Swissair debacle, in trade and retail with the retreat of the two big Swiss retailing giants on purely Swiss strategies. The retreat was moderate, but real in the industry, which probably indicates some level of functional disintegration – at the same time though, industry at large still presented by far the largest job share of multinationals, at 26% in light industry, 23% in heavy industry and 14% in base industry. In two branches groups, finally, did the admittedly low multinational job share rise. High tech and professional services showed a growing control and a small progression of its Swiss multinationals, which is commensurate with what was found earlier in this chapter about their propensity to integrate at a time of general functional disintegration.

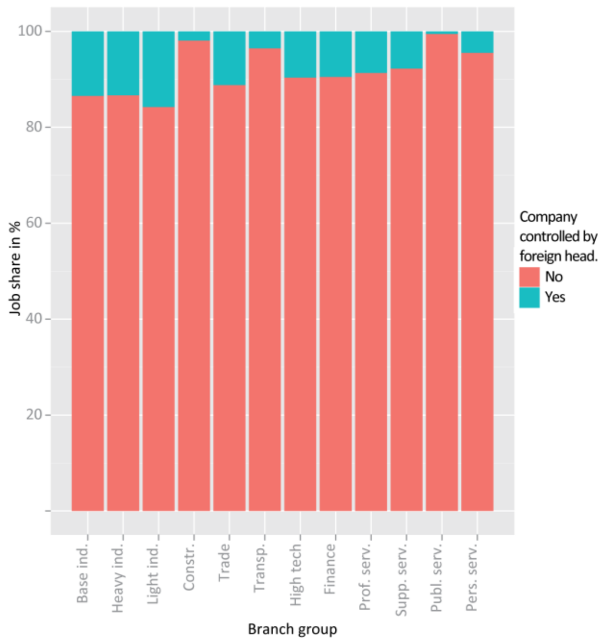


Chart 7-33: Job share by branch group and foreign control status, 2005

While the job share of the Swiss multinationals has gone crashing between 1995 and 2005, on the contrary, the job share which is directly controlled by foreign multinational has risen, from 5.7% in 1995 to 7.4% in 2005; while in 1995 there were five jobs in Swiss multinationals for every two jobs in foreign ones, by 2005 the number of concerned jobs were very similar. The progression of foreign controlled jobs was general and concerned all branch groups, save one: the financial services, which saw such jobs retreat from a 15% share in 1995 to a 9% one in 2005 (*Chart 7-33*): segregation between domestic and international operations has not touched just Swiss banks. Conversely, the degree of control has greatly progressed in the industry at large, especially in the base industries, from 6% to 13% and in light industries, from 10% to 16%. By 2005, the industry was by and large the most controlled sector of the Swiss economy, although a great majority of operators remained independent and – presumably – in Swiss hands. Progressions were also notable in trade and retail with the arrival of several multinationals to compete with the two giant cooperatives, and in high tech, for at least partly similar reasons – the arrival of international telecom companies on the Swiss market.

The import-export structure evolved less than ownership patterns between 1995 and 2005 and general remarks made for 1995 remained valid 10 years on, although integration seems to have retreated a bit. In 2005, 20.4% of all jobs were held by exporting businesses, including 11.3% in companies relying on exportation for at least a third of their turnover – in 1995, those figures were at 25.2% and 12.5%. Importing companies grouped 25.6% of all jobs, including 10.2% of businesses where imports represented at least a third of the turnover – against 33.1% and 12.0% in 1995. In both cases it can be seen that there was a general retreat of jobs implicated in import and exporting companies, although the retreat is stronger for companies which import and export a small part of their production than for businesses which really rely on them. It is as if companies which were active in a small way on the international markets had ceased to do so, subcontracting these tasks to specialized companies; such an explanation would go down well with a disintegration paradigm.

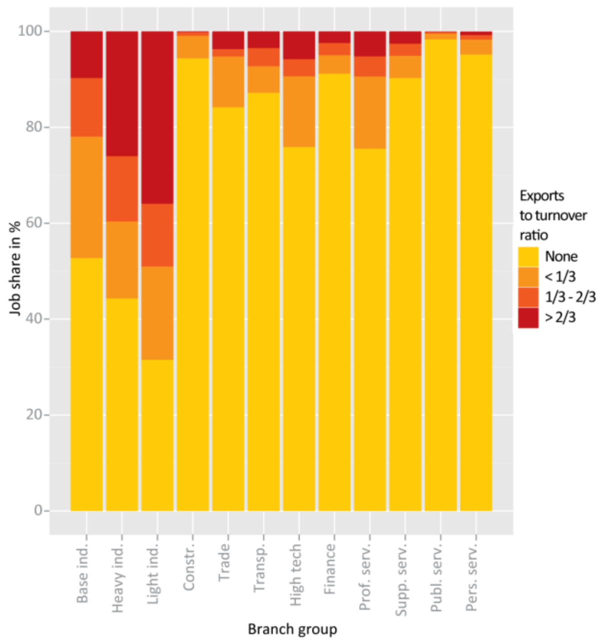


Chart 7-34: Job share by branch group and value of exportations, 2005

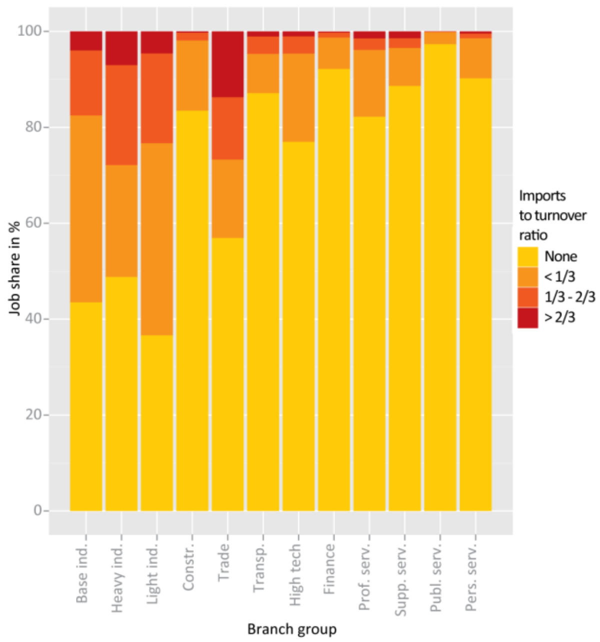


Chart 7-35: Job share by branch group and value of importations, 2005

The structure of the import-export economy hasn't changes much between 1995 and 2005 (*Charts 7-34 & 7-35*). The retreat noted above has been more or less general, letting the industry still very much more implicated on world markets than the rest of the economy. As in 1995, in most sectors exportations are more important than importations, illustrating thus the exports orientation of the Swiss economy at large; the exception to the rule is still, quite naturally, the trade and retail sector. In many service sectors, the import retreat has been more marked than the export one, so that even with a lower job share than before in export-oriented companies, the exports are still more important in 2005 than in 1995.

In structural terms now, in the industry the effect noted above is verified, where the job share of industrial companies heavily involved in exportations has actually grown, except in heavy industries. The same is true of the high tech sector and of the professional services, two branch groups which now stand out as strong exporters in the service sector. Conversely, some sectors have lost heavily in terms of exports, most notably in transportation – again, a possible outcome of the Swissair bankruptcy. As noted above, in general the retreat of imports oriented companies has been more marked than in export oriented companies. Except in the industry, which has cut back on its importations, the sectors which have maintained their exportations are those which have maintained their importations. Thus, the service economy seems to be divided between sectors which are more and more turning towards the domestic economy – transportation is a case in point – and sectors which are slowly integrating into the world economy – chiefly the industries, the high technologies and the professional services. Financial and touristic services would also be included in the list if only we had the data correctly reported.

7.5.2.2. Location patterns

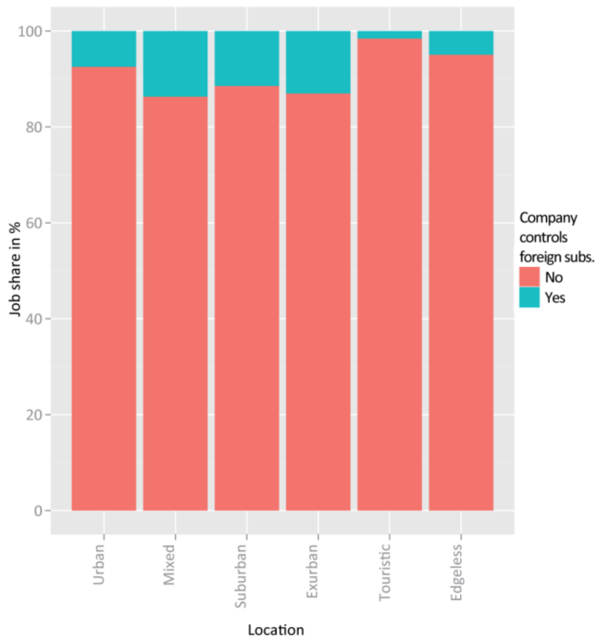


Chart 7-36: Job share by location and foreign investment status, 2005

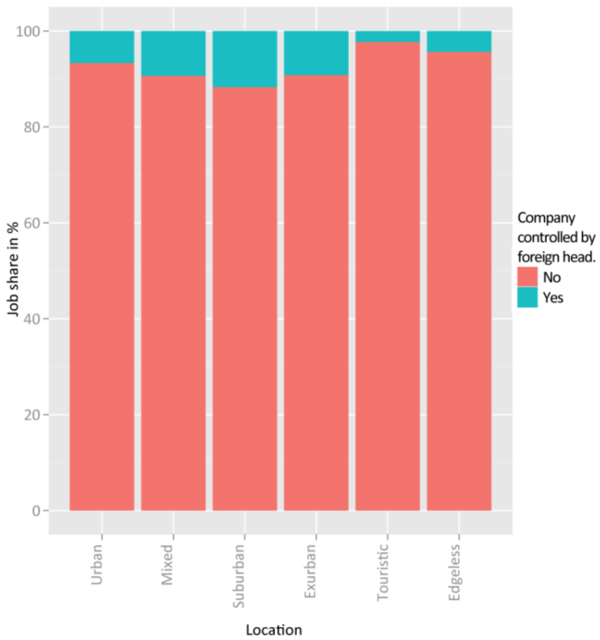


Chart 7-37: Job share by location and foreign control status, 2005

The severe fall registered by jobs held by Swiss multinationals had an impact on all locations (*Chart 7-36*). However, the fall was particularly significant in cities, which saw both the largest absolute and relative retreat of jobs held by Swiss multinational companies, from 15% in 1995 to 7% in 2005. The fall was also sensible in suburban space, which went from 17% to 11%. More generally, the strong fall in urban centers made the overrepresentation of Swiss multinationals jobs in mixed, suburban and exurban centers more obvious than before. However, there is a strong possibility that the reason for this discrepancy remains essentially structural: urban centers lost most of Swiss multinational jobs because that's where banks are and because banks were by far the most disintegrative branch of the economy between 1995 and 2005. As with the

Swiss multinationals retreat, the smaller progress of foreign controlled jobs in the Swiss economy has been general, throughout all locations. This modest but significant growth did not affect the general spatial structure of the localization of foreign subsidiaries in Switzerland, but reinforced somewhat the preference of foreign multinationals for suburban and exurban space (*Chart 7-37*). As before, though, this could be just a structural effect linked to the domains in which the foreign multinational presence is most strongly felt, i.e. industry, trade and retail, and the high tech sector: all those are in effect strongly suburban and exurban.

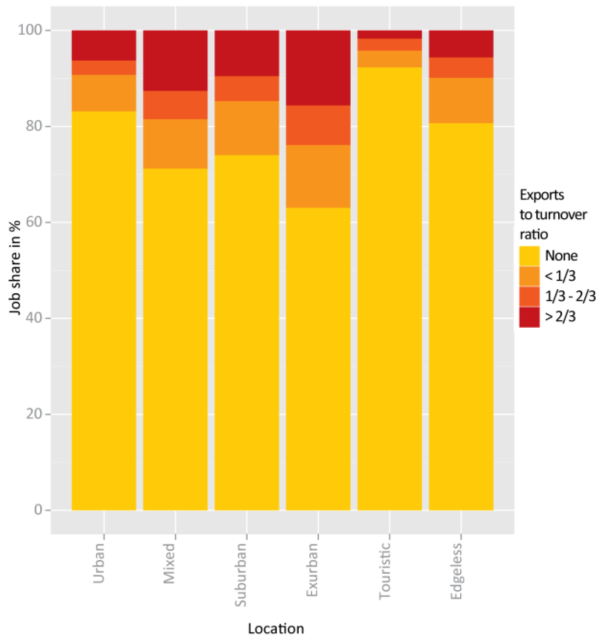


Chart 7-38: Job share by location and value of importations, 2005

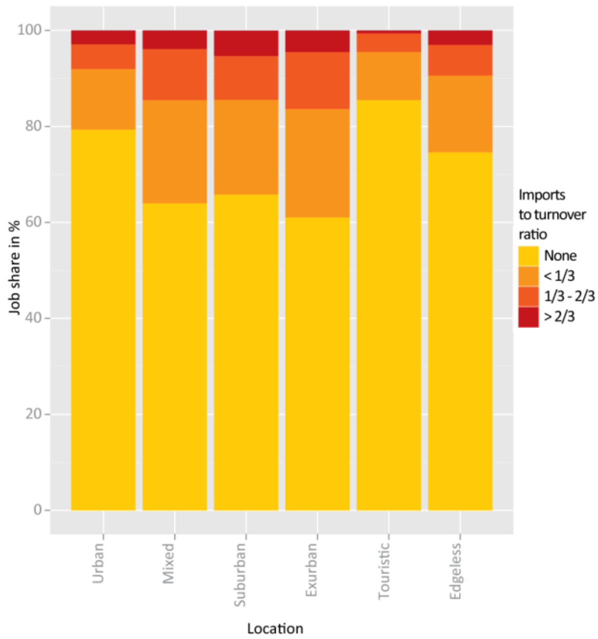


Chart 7-39: Job share by location and value of exportations, 2005

Looking at imports and exports, the 2005 situation is somewhat less legible than the one of 1995. In general, there has been a small retreat of export-oriented businesses between 1995 and 2005. Retreats have indeed been seen in urban and suburban centers, while they professed in mixed and exurban centers, as well as in edgeless space. In all, the new export structure emphasizes the exurban specialization, while blurring the suburban one (*Chart 7-38*). Job share in importing businesses, like exports, have tended to retreat a bit and this retreat has touched places where they were important more than others (*Chart 7-39*). As a consequence and as for exports, the location structure of importing businesses is less readable than in 1995. Both ways, it seems that businesses active on the international markets, whether through exports or imports, are less sensible to location than they were before.

7.5.2.3. Size patterns

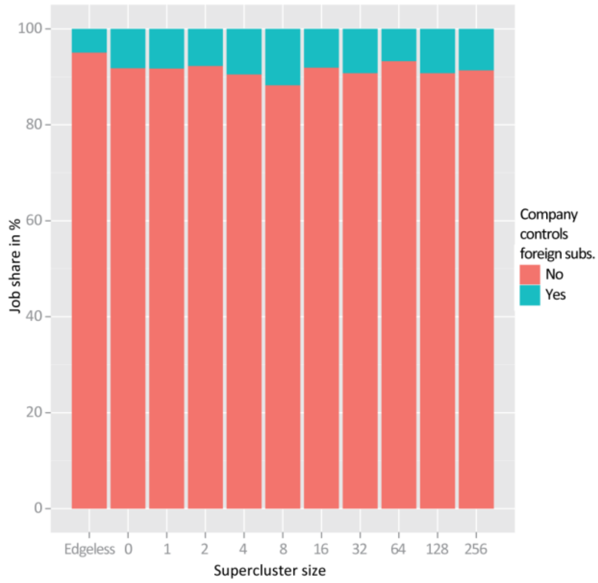


Chart 7-40: *Job share by supercluster size class and foreign investment status, 2005*

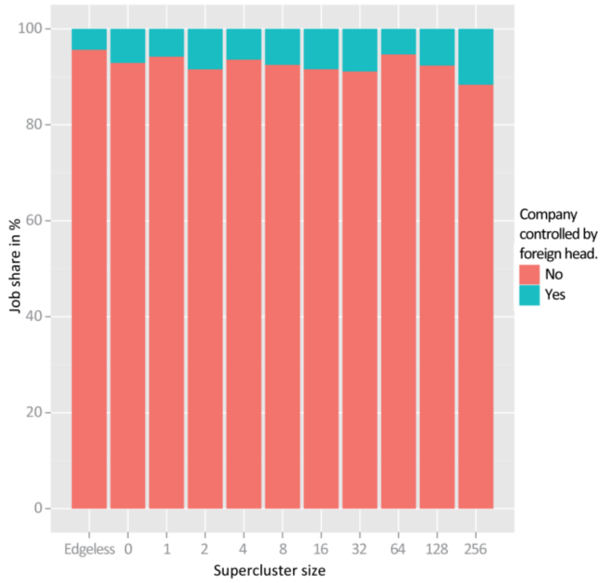


Chart 7-41: *Job share by supercluster size class and foreign control status, 2005*

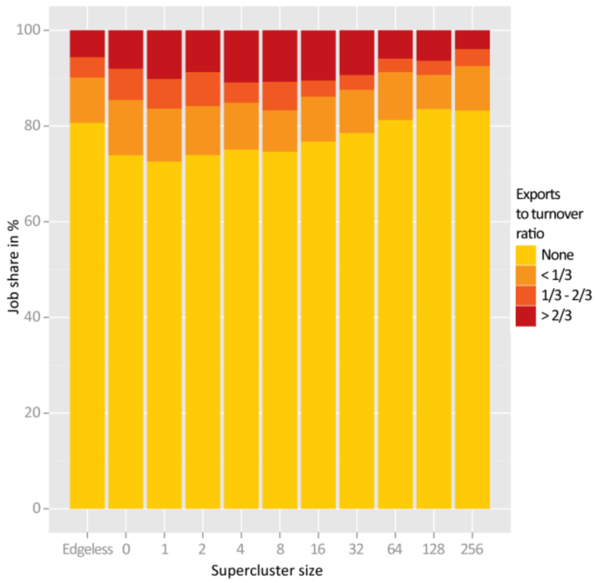


Chart 7-42: *Job share by supercluster size class and value of exportations, 2005*

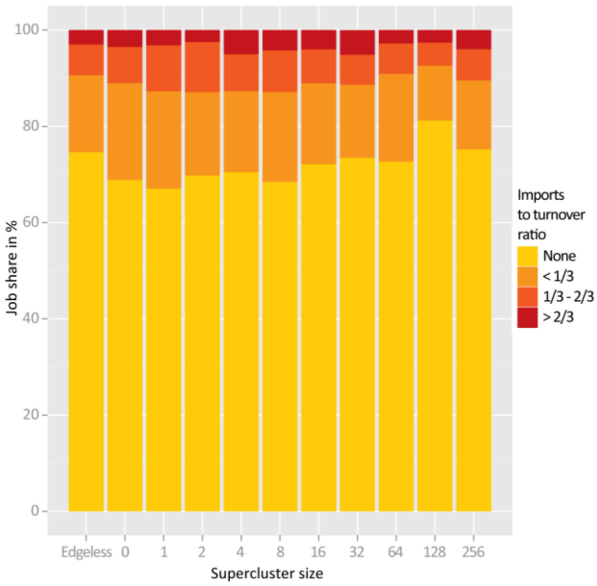


Chart 7-43: *Job share by supercluster size class and value of importations, 2005*

As we've just said, location patterns have been somewhat blurred during the years separating 1995 and 2005. Looking now at size relationships, the same can be said of them. Whereas in 1995 there was a definite relationship between Swiss multinational presence and center size, by 2005, this relation has been lost, and the only clear trend is that there still is a strong difference between edgeless space and centers – however the distribution of jobs depending on Swiss multinational is now about the same in all superclusters, regardless of their size (*Chart 7-40*). The same comment could be done about the location of foreign multinationals, except that in this case there might still be some dependency between the foreign multinationals job share and supercluster size – here, the quality of the relation hasn't evolved much since 1995 (*Chart 7-41*).

Curiously, as the spatial structure of the international ownership patterns sort of dissolved away, when looking at import-export data the opposite happened, with a clear structure of import and export jobs appearing along size classes. In a general way centers were preferred to edgeless locations for exporting businesses, with a second and rather surprising preference for small and medium-sized superclusters over large ones, superclusters from less than 1'000 jobs to 16'000 jobs having a far larger share of their jobs in businesses engaged in exports than larger superclusters (*Chart 7-42*). In larger superclusters, their impact was inversely proportional to size, to the point where in Zurich the job share of exporting companies is no greater than that of edgeless space. Although the relation is less evident when looking at imports, it is nevertheless there, with a clear overrepresentation of jobs linked to importing companies in the smaller and medium-sized superclusters (*Chart 7-43*).

7.5.3. Two competing explanations: metropolitan vs structural

Taking it all together, it seems that the territorial patterns displayed by the Swiss economy's insertion into the global command structure and markets in 2005 have indisputably evolved since 1995. Structurally, there have been massive changes between 1995 and 2005 with, most notably, very significant disintegration moves between domestic and international operations in the service sector, most spectacularly in the banking and insurance businesses. While disintegration was also rife in other branches, it was nevertheless not of the scale the banks endured. This massive structural move had definite territorial consequences which were a strong loss of Swiss multinationals job share, most notably in cities – in fact, most of the territorial impacts measured were linked to structural changes of the sort we just described.

That being said, the outcome of those changes is still interesting to detail. In 1995, we saw that multinationals showed a definite preference for metropolitan areas, although they weren't attached as much to urban centers and could locate in suburban and exurban centers within them, while exporting and importing businesses showed a different attachment to metro areas, preferring suburban and exurban belts to urban cores and showing no inclination for greater superclusters over smaller ones. By 2005, those patterns had evolved. Multinationals had lost their preference for larger superclusters and now pervaded metropolitan superclusters of all sizes in a rather indiscriminate way, however locating more and more in suburban and exurban places instead of urban ones. For their part, businesses active on the international markets have tended to retreat on small and mid-sized superclusters, while losing any preference for a given type of location.

It is rather difficult to interpret these finds. The fact is that in most instances, territorial discriminations have abated between 1995 and 2005, at least within superclusters as edgeless space has tended to remain discriminated. This would seem to confirm the idea that the whole urban infrastructure of the country is becoming metropolitan and that there is less and less advantages gained by locating wisely. In one instance, spatial differentiation has grown: importers and exporters locate more and more in smaller and midsized superclusters, less in greater ones. There are two ways to interpret that find. The first, in line with preceding comments, would be to say that as metropolization engulfs the whole country, allowing all locations to compete on about the same efficiencies then for those businesses it would me more interesting to locate in lesser units, with lower real estate costs. The second, equally probable, explanation is that structural effects dominate everything else and that as the vast majority of establishments in banks in particular and services in general concentrates on domestic markets, what remains strongly integrated to the world economy is industry, which emphasizes their preferred locations: suburban and exurban places, small and medium-sized superclusters. At this point there is no telling which, of those two explanations, is the correct one.

7.6. Management summary

In this chapter, we studied relationships between business entities in terms of hierarchical relations between headquarters and subsidiaries, as well as the insertion in the world economy through capital ownership, either of Swiss capital into foreign subsidiaries, or of foreign capital into Swiss representations, and through the level of imports and exports done by businesses. Here are the main finds we've seen:

Previous studies on the subject at the scale of our study are extremely scarce. Hierarchical relationships between business entities have been thoroughly studied but generally their geographic scope is global, regional or inter-metropolitan. There is a near complete lack of studies about those relationships at the intra-metropolitan scale.

In the domain of control and internationalization of the economy there are massive structural differences between economic branches, to the point where it is difficult to distinguish between structural and territorial effects in the evolution of the territorial structure of the economy.

In terms of evolution, there is an amount of functional disintegration happening, with more independent entities and less dependent ones than before. Disintegration affects above all strongly integrated domains, like industry. Conversely, functional integration progressed in disintegrated domains, like the high technologies and the professional services.

Economic crises play a major role in incepting major structural changes in the economic structure. The 1990s crisis helped spawn a significant disintegrative wave throughout the Swiss economy.

In geographical terms, the economy of centers is made up of more integrated businesses and entities than that of peripheral space. This is true of both locations and size classes. However, in the long run, this urban gradient is slowly eroding, and is being replaced by a dichotomy between central locations as a category, and edgeless space.

Urban centers still dominate the command and control structure of the economy, but they aren't as exclusive as they were. In particular, suburban centers have emerged as credible alternatives for headquarters location.

Territorial relations between company units show that the Swiss economy is transitioning from a predominantly vertical control structure where headquarters control subsidiaries close by or in smaller centers, to a more and more horizontal control pattern, where companies are active above all at the metropolitan level and let the lesser levels of the urban hierarchy go.

The preceding evolution allowed the very strong and evident rise of the big five superclusters as focal nodes of the new metropolitan structure of the country.

The way the international relations of the economy plays out in Switzerland also hints at the inception of a national metropolitan structure, covering most centers of the country regardless of their size.

The public sector is more integrated, more oriented on urban centers and more resilient to change than the private sector. As such it hasn't seen much of the aforementioned evolution, and serves as a witness of times past.

In all, this constitutes the strongest challenge to a Christallerian explanation of the economic territorial structure of Switzerland we have encountered.

8. Car accessibility and its many determinants

8.1. Introduction and literature review

8.1.1. Introduction and summary

In this chapter we aim at defining a measure of accessibility that we could attach to any place in Switzerland, at any moment. This measure must be numerical and continuous as to be useful when treating it statistically. First, we will study the literature pertaining to the definition of accessibility and the methods that have been proposed to answer that quest, with a strong emphasis on the probabilistic ways to define accessibility. Then, we will discuss the different parameters which are susceptible to modify accessibility, namely the evolution of travel time to work as time goes by, the evolving distribution of the active population, and the evolution in transportation network and means. As the definition we will give of accessibility combine all these aspects, we will then formally define and build our indicator for all periods under review, and then comment on the geographies revealed by the mapping of this indicator across several points of view – absolute accessibility, relative accessibility and finally competitive position in the communal mesh.

8.1.2. Accessibility in the literature

In the research world, the English term accessibility has primarily referred to the ability of disabled persons to reach or not a given destination – indeed, a literature research with accessibility as sole keyword does return a large majority of references pertaining to the subject of accessibility to buildings for disabled persons. Of course, this isn't what we have in mind.

Accessibility, as understood in the context of this work which is that of transportation research, is the quality of a place to be reached from the outside: a certain place will be deemed reachable by a certain number of interested people. As the notion isn't necessarily directional, accessibility can also mean that the location under review can give access to interested people and places (Rodrigue et al 2006, p. 30). In both cases, accessibility is understood as a measure of the potential of a place. In that respect, in the course of time several ways to compute such an indicator have been put into practice.

The first way to compute such an index is the geographical accessibility. According to John Q. Stewart (Stewart 1947), the geographical accessibility of a place is simply the sum of its distances with all other locations in a given territory; to normalize it, it can also be a function of the total number of locations divided by the sum of the distances to those locations, which would give more accessible places with a higher value than less accessible ones:

$$A_i = n \,/ \sum_{n} d_{ij}$$

Where A_i is the accessibility of location d_{ij} the distance between location i and object j, and n the total number of locations to be considered. Of course, this computing considers only the geographical position of locations regardless of their actual interest or mass. The idea to compute population potentials for a place, being a function of the population and of the distance between this population and the location to be evaluated can also be traced to Stewart (Stewart 1947). The family of applications derived from this approach is named the potential accessibility family, as opposed to the geographical accessibility (Rodrigue et al, op. cit, p. 30). As Stewart envisioned it, it derived directly from Newton's gravitation theory and the ensuing discoveries, which had notably resulted in the invention of the concept of gravitational potential of a location, being:

$$A_i = \sum_n p_j / d_{ij}$$

Where A_i is the accessibility, or population potential, of location i, p_j is the population of location i, d_{ij} the distance between location i and j, and n the total number of locations to be considered. In creating this, Stewart directly adapted the gravitational potential definition – mass divided by separation – by replacing mass by population, and considering all locations of a given space – for instance a large country or a continent. His population potential maps, especially of the United States, are very famous.

While the population potential is the ancestor of accessibility measures, those were developed per se by another seminal reference written by Walter G. Hansen (Hansen 1959), which defined accessibility very closely to the Stewart potential computation:

$$A_i = \sum_n p_j \, d_{ij}^{-\beta}$$

Where A_i is the accessibility of a location i, p_j the population of a location j, d_{ij} the distance between I and j, β an exponent expressing the decay function according to distance (*Chart 8-1*). By analogy with Newtonian gravitation theory, this exponent is often put to 2. One of the interests of the measure is that for the first time it is proposed to make the exponent β vary as to minimize the effect of long-distance relations, even if this was not explicitly stated. While Stewart was considering whole continents to build his potentials, Hansen clearly adapted his definitions to a local or regional context. Accordingly, the Hansen measure has been dominant ever since, despite the fact that it has two major drawbacks.

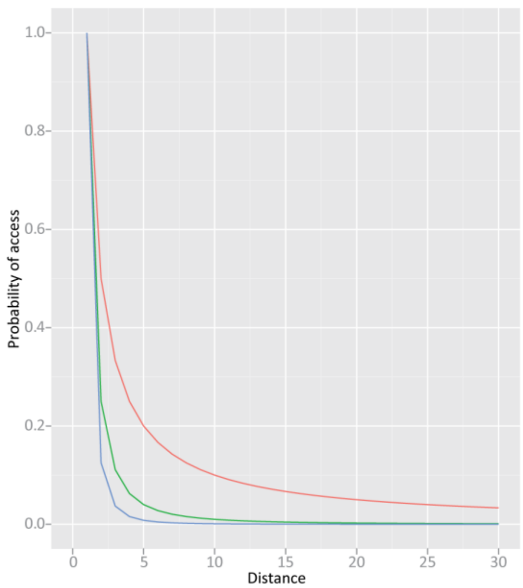


Chart 8-1: Three distance-decay curves from the Hansen family, with β = 1 (red), 2 (green), 3 (blue)

First, if the distance tends to zero, that is if there is population at location i, accessibility become infinite, as by the way the potential measure of Stewart, which is by the way a special case of the above function, with β equal to 1; in a more general manner, if the exponent is set too high, then the indicator is entirely dominated by locations nearby, especially very close-by ones, to the exclusion of every other ones. The second drawback is that conversely, if the exponent is too small, far-away locations become very important to the construction of the index, as compared to nearby ones. Nevertheless many researchers seem very happy to work with the Hansen measure, notwithstanding its drawbacks, or tweaking with them, notably by imposing a minimal distance between every couple of locations, including the distance of a location with itself.

Those drawbacks have been recognized by various authors and in particular alternative models were put into practice, notably the reverse exponential model family - see for a good review Miller 2005 and Weibull 1976:

$$A_i = \sum_{n} p_j \exp\left(-\beta\, d_{ij}\right)$$

Where all the symbols refer to the same meanings than for the preceding equation (*Chart 8-2*). The negative exponential function has definite qualities, first of which being the fact that it doesn't go awry when the distance becomes null. However, it still has the same problems than the classical gravity model, which is either a too strong effect of far-away locations in case of a too small β coefficient, or a too strong effect of very close locations if β is estimated too high.

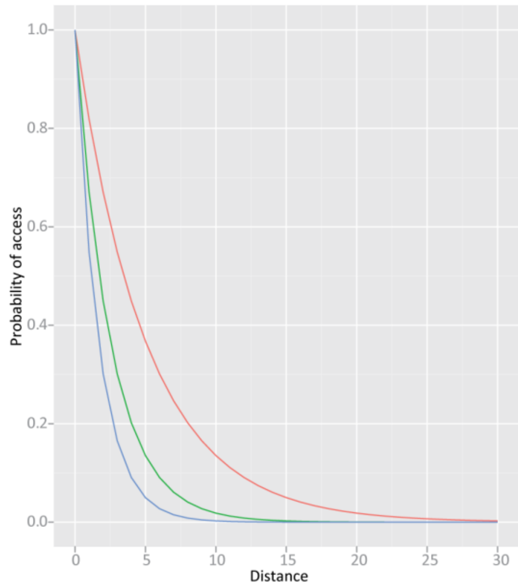


Chart 8-2: Three distance-decay curves from the reverse exponential family, with β = 2 (red), 4 (green), 6 (blue)

As D.R. Ingram recognized very early on (Ingram 1971), neither the gravity curve, nor the negative exponential one can be fitted on an observed commuter distance distribution as empirically observed. These distributions seemed instead to be fitted by a Gaussian distribution of the following form:

$$A_i = \sum_{n} p_j \exp\left(-\left(d_{ij}^2 / \gamma\right)\right)$$

Where all the symbols mean the same as before, and γ refers to a positive parameter (*Chart 8-3*). The major interest of a Gaussian form of the distance decay function is that it clearly states three facts:

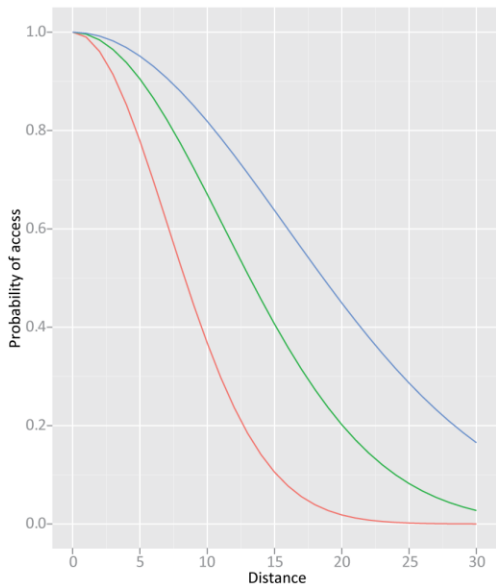


Chart 8-3: Three distance-decay curves from the Gaussian family, with γ = 100 (red), 200 (green), 500 (blue)

Within a certain range there is only a small distance decay. This takes into account a well known result of the literature since the work of Bruce W. Hamilton (Hamilton 1982, 1989), that within a given range, which is considered to be the acceptable commuting time by the actor, commuters do not discriminate between locations by distance.

Around this maximal range, the function rapidly decays, expressing the fact that we are indeed at values that are considered as limiting for most of the population. Thus, at those values, every increment in distance has a major effect of the probability of access of the population. Once the maximal range crossed, the probability assumes an asymptotic form towards zero, as to take into account only long-time commuters, which represent a small minority of the population.

Meanwhile, in the professional practice, accessibility and potential studies have been used under the form of isochrones computing, that is, areas within a given reach of a location would be built, then their population counted and the result attached at the location as potential. This can be formalized as follows:

$$A_i = \sum_n p_j\, f\left(t, d_{ij}\right), \qquad where:$$

$$f\left(t, d_{ij}\right) = \begin{cases} 1, & t > d_{ij} \\ 0, & t \leq d_{ij} \end{cases}$$

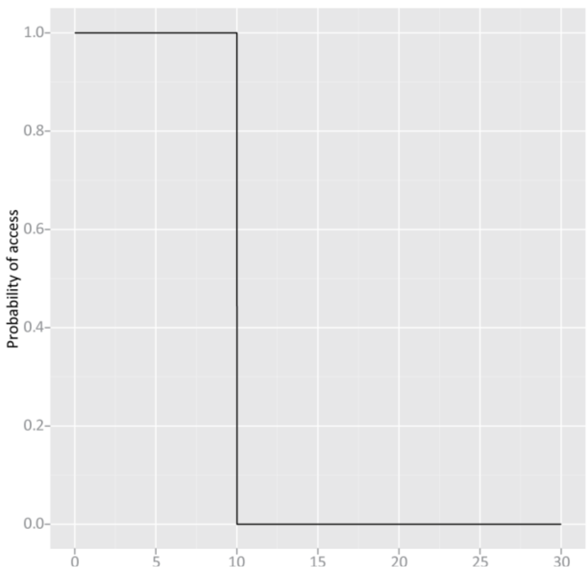


Chart 8-4: A distance-decay curve from the threshold family

Where all the symbols mean the same as before, and t refers to a distance threshold value (*Chart 8-4*). This approach was, and still is, widespread enough in the industry that it led to the development of GIS software and applications aimed at computing isochrones, and to this day this rather crude approach – everything is counted within the threshold, nothing outside – is very widely used in the industry.

There is thus a discrepancy between the professional and academic worlds. While the isochrones approach is totally dominant in the industry, it is practically absent from the literature, which prefers, by a wide margin, the Hansen measure corrected for the null distance problem, that is, the negative exponential measure. In Switzerland, the Institute for Transportation Planning and Transport Systems (IVT) of the Swiss Federal Institute of Technology in Zurich has been by far the most active place of research about accessibility as we understand it in this work (Axhausen et al 2004, Axhausen & Hurni 2005, Fröhlich & Axhausen 2002, Tschopp et al 2003, 2006, Tschopp 2007, etc…) – and it follows squarely that road.

There have been fairly few studies which have used the Gaussian approach to potential accessibility, two of the most interesting being those made by Florent Joerin (Joerin et al 2001, Joerin & Bozovic 2007), both studies very much linked to practical applications, and which introduced a curve based on the Weibull gamma function, chosen because it can be fitted easily on empiric travel time distributions – as shown in both articles. The Weibull gamma function, when integrated in an accessibility computing, looks like this:

$$A_i = \sum_n p_j \exp(-(d_{ij}/\lambda)^k)$$

Where all the symbols mean the same as before (*Chart 8-5*). The two positive numerals λ and k referring respectively to a scale factor and an exponent controlling the curve figure.

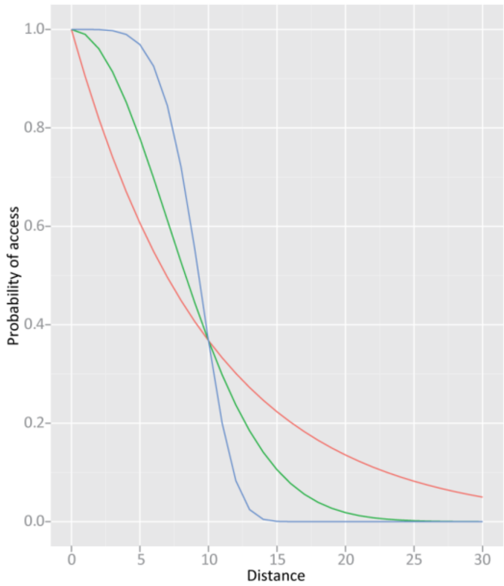


Chart 8-5: Three distance-decay curves from the Weibull family, with λ = 10 and k = 1 (red), 2 (green), 5 (blue)

Our long and ongoing involvement in professional practice leads us to prefer a Gaussian version of the accessibility curve. As we have already said, both the literature (Hamilton 1982, 1989) and the professional practice in geomarketing and retail location counseling points to the fact that there is a threshold effect in the way people see their commuting time, inside of which distance is not particularly important. Therefore, it seems to us very important to have a model which mimics the indifference of people towards distance within a limit which is proper to each person. Therefore, in our study, we will use such a function.

8.2. The definition of accessibility

8.2.1. The Gumbel distribution and its integration in a potential caluclus

Emil Julius Gumbel worked chiefly in the 1940s and 1950s (Gumbel 1954, 1958) about the statistical characteristics of the distribution of extreme values. Initially, this research pertained notably to the statistical evaluation of extreme climatic events, such as floods or rain events. However, while it remained the classical distribution model for such applications, its uses have largely spilled over to a very large array of domains. By 2000, apart from climatology and natural phenomena, it had found uses in most of engineering, as well as in such exotic domains as horse racing, track race records, and supermarket queue modeling. In all, the Gumbel function was found used in more than fifty different domains (Nadarajah & Kotz 2004). The Gumbel distribution is the most famous particular case of the generalized extreme values distribution. Its form, as a probability of occurrence, looks like this:

$$P = \left(1 - \exp\left(-\exp\left(\frac{\mu - d}{\beta}\right)\right)\right)$$

$$\begin{cases} \overline{m} = \mu + 0.5772\,\beta \\ \sigma = \beta\,\dfrac{\pi}{\sqrt{6}} \end{cases}$$

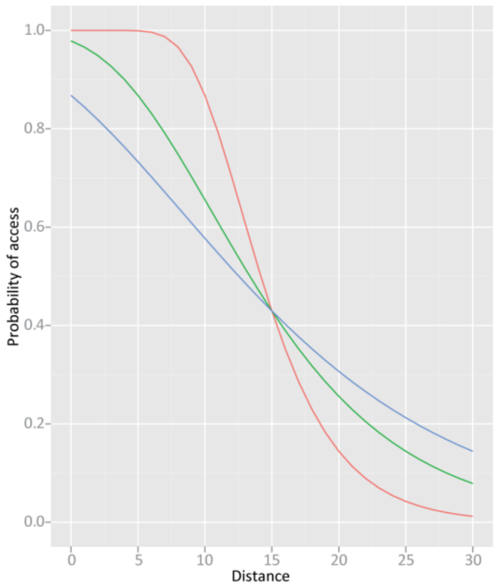


Chart 8-6: Three distance-decay curves from the Gumbel family, with $\overline{m}$ = 15 and σ = 5 (red), 10 (green), 15 (blue)

Where all symbols mean the same as before, and d represents the distance between the origin and the destination (*Chart 8-6*). The two positive numerals μ and β referring respectively to a location and a scale factor; μ and β can furthermore be related to a mean $\overline{m}$ and a standard deviation σ which can for instance be derived from theoretical considerations or empirical research. Suffice to say, it we have the mean and standard deviation of a given distribution and this distribution is one of extreme values – maximal or minimal expected values, then the Gumbel distribution will model accurately the distribution of these events.

8.2.2. The estimation of the maximal commuting time

The Gumbel or extreme value distribution has been extensively used in travel time evaluation and decision research, especially in choice modeling: see for instance Ben-Akiva 1985, Ben-Akiva & Bierlaire 1999, Jara-Díaz & Guevara 2003, Bhat 1998, besides many others. This illustrates the uses of this distribution outside its primary domain in climatology and natural phenomena modeling. However, to our knowledge, the Gumbel distribution hasn't been used to directly model the distribution of commuting times; the closest use we have found in the literature are the already mentioned efforts of Florent Joerin (Joerin et al 2001, Joerin & Bozovic 2007).

One could assume that the largest commuting time a person is ready to undergo is indeed an extreme value, as it would represent a maximum quantity. However, this maximal amount is clearly not reached for everybody. If we follow Bruce Hamilton (Hamilton 1982, 1989), we find that within their tolerance limit in terms of commuting time, people tend not to optimize their travel from home to work. As given in Hamilton 1982, in a set of major metropolitan areas of the United States, Hamilton showed that actual commuting distances were about 90% of what they would be if people and jobs were distributed randomly in the metropolitan area, and each job coupled to a person regardless of his distance to the job. That is to say, people do not choose their jobs according to distance as long as their maximum distance limit isn't reached.

This find allows us to make a second assumption. If we consider that within a given distance, people do not discriminate jobs by their distance, and if jobs are distributed randomly, then it statistically follows that the mean distance between home and jobs will be about $1/\sqrt{2}$ times the mean maximal distance, which is about 0.71 – if the maximal distance defines the radius of a circle, then a concentric circle of radius equal to $1/\sqrt{2}$ times the radius of the first circle will have exactly half of its area. In our case, this circle will contain exactly half of the job opportunities of the first circle, and thus split this original stock in two equal shares.

From the preceding assumptions it derives that the maximal distance considered by the actors should be about $\sqrt{2}$ times the median distance measured, which is about 1.4. That is to say we have a mean of linking an empirical distribution with a theoretical distribution of which we know the form.

The last parameter we have to take into account is the standard error of the mean. A strict application of the aforementioned principle would postulate that the standard error should also be multiplied by the same amount. However we surmise that there is a flaw in this reasoning, which is to consider that the relationship between actual and maximal times holds regardless of the actual travel time, whereas it is very probable that for small commuting times, the difference between actual and maximal commuting times is larger than in large commuting times, and that this difference is practically nil in very large commuting times. Thus, there is probably a continuous variation in the relationship between actual and maximal commuting times, which supposedly go closer as the actual commuting time. A way to mimic this relationship is to maintain the standard error as it is measured. Therefore, the correction factor we apply to the Gumbel distribution is a mere translation to the right, of a factor 1.4.

8.2.3. Accessibility literally defined

As we define it, the accessibility of a location is assimilated to the number of actives which are susceptible to commute to work at this location. It is, then, computed as follows:

The active population is attributed to locations, here the Swiss communes as they stood in 2000. Travel times are computed between all locations, for each of the eleven periods under review, taking into account the road and automobile conditions of the time. This allows us to compute a probability of access from each location to all other ones. This probability of access is computed according to the Gumbel distribution mentioned in the preceding section, and thus depends on the mean maximal travel time of the epoch and its standard deviation.

Once the probability of access from a given residential place to a given job place is known, it is multiplied with the active population of the residential location, to give an actual number of actives which are susceptible to commute to this job place: from the point of view of the job location, this is the number of accessible actives coming from the particular residential location. Accessible active numbers are then obtained for all residential locations with respect to the work location under investigation. This location's accessibility is the sum of accessible actives through all residential places.

Formally, accessibility is computed as follows:

$$A_i = \sum_n p_j \left(1 - \exp\left(-\exp\left(\frac{\mu - d_{ij}}{\beta}\right)\right)\right)$$

$$\begin{cases} \overline{m} = \mu + 0.5772\,\beta \\ \sigma = \beta\,\dfrac{\pi}{\sqrt{6}} \end{cases}$$

Where all symbols mean the same as before.

8.3. The four components of the accessibility measure

8.3.1. The evolution of the travel time to work

8.3.1.1. The empirical determination of commuting time

We benefit from two different data sources when encompassing travel time to work in Switzerland. The first and foremost is the population census. From 1970 on, questions were asked to respondents about the time they spent in their journey from home to the workplace. For the last four censuses up to 2000, we benefit from rather precise information about the time spent commuting to and from work. In parallel, there has been transport micro censuses held every five years since 1974 which also give information, albeit less precise for our scope, about travel times in Switzerland. We discussed those sources in chapter 2 – here we will only discuss the results their exploitation gave us.

The most precise source, for our study, are the population censuses as they allow us to compute not only travel means, but also standard deviations. The results are as follows, for all actives having to move to get to their job place:

Year	Mean Travel Time (minutes)	Standard Deviation (minutes)
1970	19.8	13.4
1980	19.8	13.4
1990	20.7	13.9
2000	22.9	17.2

Table 8-1: Commuter mean travel time and standard deviation, population census results, 1970-2000

As can be seen, at the beginning of the period under review there was great stability in the travel time reported by the actives. The figure started to climb a bit in the 1980s (+0.9 minutes). During the 1990s, though, a double move was seen, with a clear rise of the mean travel time, amounting to 2.2 minutes, and above all a strong rise of the standard deviation at +3.3 minutes. This double climb means that a strong rise was seen in the numbers of long-distance commuters – in fact, it could be hypothesized that most, if not all, of the rise seen can be attributed to them. The results for our second data source aren't as straightforward – as we have seen in chapter 2, methodologies in retrieving raw data varied wildly between micro censuses; in one case (1979), there were no data collected about travel times. In any case, here are the results:

Year	Mean Travel Time (minutes)
1974	17.6
1979	n/a
1984	20.4
1989	22.2
1994	18.4
2000	21.2
2005	20.2

Table 8-2: Commuter mean travel time, transportation microcensuses, 1974-2005

As can be seen the results are somewhat inconclusive in terms of general trend, as two of five possible inflection points trend downwards; it is possible, though, that the error margins of the series would suffice to explain most of the variations seen; the general trend seen in the data is a slowly growing one, of 0.06 minutes per year, or 0.63 per decade. In a very general way it does confirm the finds made on the four population censuses from 1970 to 2000. In all, we judge the population census data more reliable.

In any case, those results contradict the well-received idea that commuting times are stable in the long run: in the last decade of the 20th century in Switzerland, they weren't anymore. The fact that there is a trend towards growing commuting times in Switzerland is somewhat unexpected, as the literature generally points out to strong evidence of long-term stability of commuter time within a given territory (Gordon et al 1991, Levinson & Kumar 1994), a result also frequently given as true in Switzerland. Our data supports, up to a point, this interpretation and great stability is seen between 1970 and 1990, the turning point being clearly felt in the 1990s. Correspondingly, there is evidence that in other parts of the world such growth was also seen, for instance in the whole of North America (Vandersmissen et al 2003, Gordon et al 2004, Turcotte 2005). It seems, then, that something really global started to happen in metropolitan areas at the turn of the century, with commuter time, which were more or less stable till then, started to grow, as if the tradeoff between distance and time which was in effect till then started to crumble, the increase in distance being not compensated anymore by speed gains. In any case, the literature shows that what we observe in Switzerland, i.e. stable commuting times up to 1990, and growing ones since then, is largely encountered throughout the developed world.

In terms of actual commuting times, the figures found in Switzerland are globally in line with those found at varying times across varying places. It has been found that larger metropolitan areas boast larger commuting times, with world cities having the largest ones. Thus, U.S. metropolitan areas of population over 3 million people showed in 2001 average commuting times of 28.5 minutes, against only 17.6 minutes in areas with less than 250'000 inhabitants, and 22.4 minutes for metro areas with population between 1 and 3 million people (Gordon et al 2004). Likewise in Europe, with 1990 commuting times ordered neatly by metropolitan size between 20 minutes for the smallest metropolises (Zurich) and 35 minutes in the largest ones, Paris and London (Schwanen 2002). As we can see the commuting times we get by analyzing Swiss censuses are commensurate with these results.

8.3.1.2. Maximal travel time estimation

In the preceding sections, we found several results which can help us place parameters for our accessibility measure. The first is that by and large, mean travel time for commuting was relatively stable between 1970 and 1980 at practically 20 minutes, with a standard deviation of 13.5 minutes. This figure slowly started to grow, to reach 21 +- 14 minutes by 1990, and then jumped to 23 +- 17 minutes for 2000 (*Chart 8-7*).

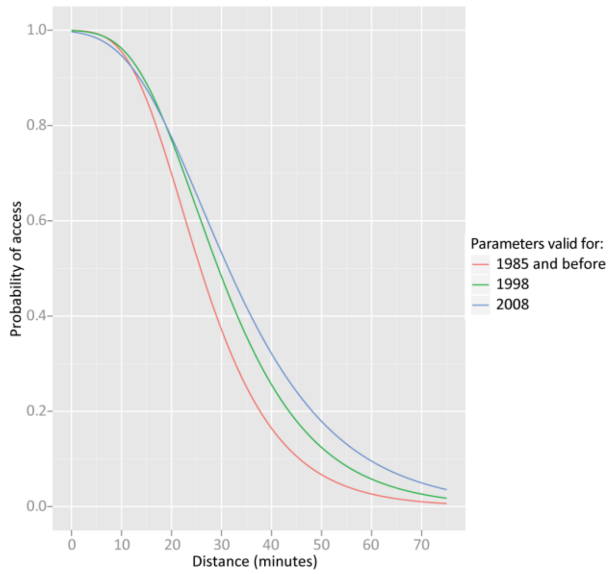


Chart 8-7: Actual Gumbel distance-decay curves for three selected years

There is a complete lack of data for periods leading to 1970 – however, commuting times were very stable before 1985 and the literature points to commuting time stability for periods leading to it. We could estimate that for earlier periods, commuting times were probably not very different than that they were by 1970. While the literature is relatively mute about the evolutions after 2000, and for good reason as there is no data available for later developments, there is some anecdotal evidence to the furthering of the late trends seen, most notably of the rise in long-distance commuter numbers. For these reasons it is reasonable to postulate that the sudden rise in commuter times seen in the 1990s have probably furthered in the 2000s. We could then estimate that the average commuter times by 2010 are likely to hover around 24.5 +- 19 minutes.

As we assumed earlier, there is a relatively straight relationship between mean commuting time and maximal commuting time acceptable by the commuters. Taking into account the determinations of earlier sections, this gives us the following table of determinants of maximal commuting times and standard deviations for the 11 business censuses we consider.

Year	Mean Travel Time (minutes)	Maximal Travel Time (minutes)	Standard Deviation (minutes)
1939	20.0	28.0	13.5
1955	20.0	28.0	13.5
1965	20.0	28.0	13.5
1975	20.0	28.0	13.5
1985	20.0	28.0	13.5
1991	21.0	29.5	14.0
1995	22.0	31.0	15.0
1998	23.0	32.0	16.0
2001	23.0	33.0	17.0
2005	24.0	34.0	18.0
2008	24.5	34.5	19.0

Table 8-3: Mean and maximal commuting times and standard deviations entered in the model, 1939-2008

This means that while for a rather long period of time, the workers space-time remained relatively unchanged, from 1991 on, people started to consider job opportunities further and further away. In terms of accessibility, such a move should reinforce larger metropolitan areas further away rather than smaller job centers nearby. As a whole, in geographical terms, job places were gaining a larger job pool in the last period of our study.

8.3.2. The evolution and distribution of the active population

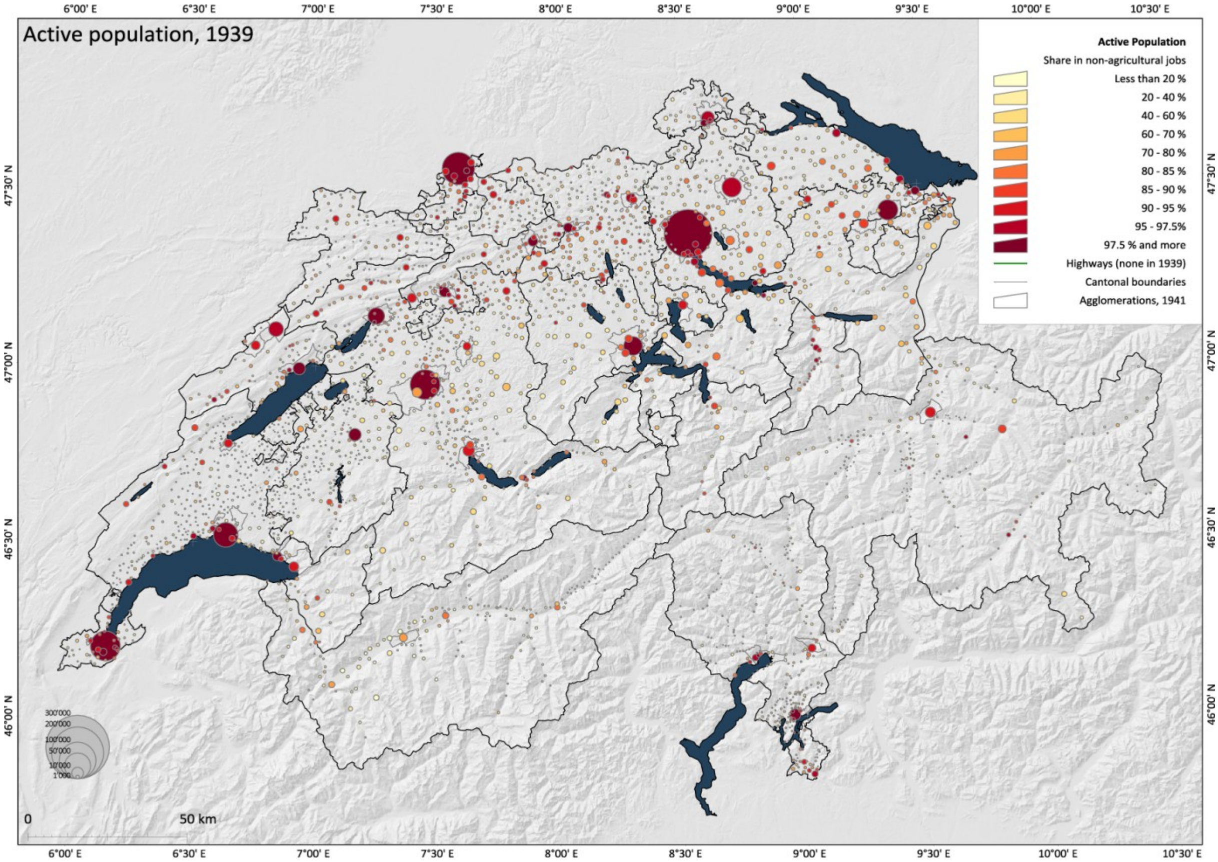
8.3.2.1. Introduction and the three-period analysis

The second variable which has an impact on accessibility is the availability of the workforce. We already explained in chapter 2 the modifications that were made to the seven population censuses we took the data from to build the database of the active population, recomputed to match the dates of the business censuses, as well as the extrapolations which were necessary to estimate the active population after 2000, date of the last available population census.

The history of the population distribution in Switzerland has been widely studied, most notably by Martin Schuler (Schuler 1984, 1992, Schuler et al 1985, 1997, 2002, 2006), also by various other important authors, like Rossi 1982, Bassand et al 1988, Frey 1990, Racine & Raffestin 1990. Those studies are critical to our subject as, by and large and with some variations, but of second order, the active population distribution is strongly similar to the distribution of the population as a whole. Our goal here isn't to describe precisely the way this distribution evolved with time, as we refer the interested reader to those studies. But we will point to some general phenomena which happened to the active population distribution since 1939.

The first find is that there is a strong temporal correlation between what happened in the economic geographical distributions, and the active population geography. Careful examination of the data series for the 1939-2008 period shows that as for business geography, active population geographical evolution is best studied in three periods, which are the same, i.e. with cutting dates places on the 1965 and 1991 results. Thus, the active population geography can be resumed in four instants: at the start of our period of study, that is, in 1939, and then at the end of three different periods, which correspond to the business censuses of 1965, 1991 and 2008.

8.3.2.2. 1939: Centrality

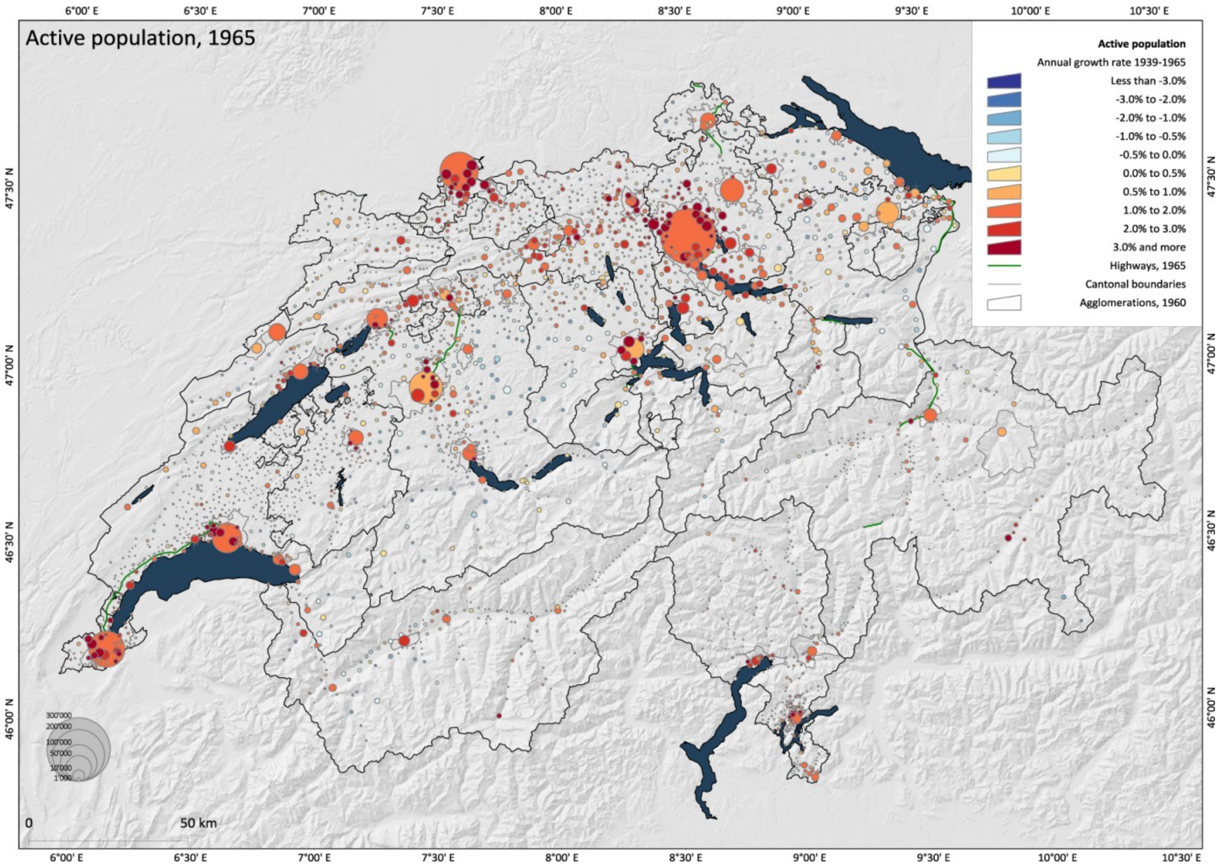


Map 8-1: Active popuolation distribution and share of non-agricultural employment, 1939

The 1939 map of the active population distribution showed two major distributions (*Map 8-1*). The first one was a blanket distribution across all accessible places of the country, a rural substrate, showing a remarkable homogeneity from Geneva to St-Gallen. It showed also that this relatively strong workforce was above all devolved to agriculture – very few rural localities exhibited a majority of their workforce in alternate activities, and those were predominantly situated in very select regions, along the Aare valley and in corridors in Eastern Switzerland. Superimposed on this structure were the centers per se, where most of the non-agricultural workforce was concentrated. The general picture was that of a rather sparse urban network, units which were clearly standing out being rather far away from one another, in a classical Christallerian fashion.

Between town and country, not much. Suburban belts existed, but in embryonic form. Only around Zurich and Basle did they take some importance. First around Lake Zurich, where both shores were urbanizing fast, then around Basle, along the Birs and the Ergolz, in addition to the first ring of suburban communes from Allschwil to Birsfelden and Riehen. Berne, Lausanne and Geneva showed much less suburban development. In fact, those developments were more evident around lesser centers lying in the industrial heartland – here, centers like Solothurn, Olten, Aarau, Baden, Reinach or Schaffhausen exhibited clear suburbanization signs as was, surprisingly, Lucerne, while similarly sized cities, like Biel, Fribourg, Winterthur or St-Gallen, did not. It is as if suburbanization started in the heartland, around lesser centers than the big ones. But those few suburban areas could not really disturb the dichotomy between centers and rural areas.

8.3.2.3. 1965: Urbanization



Map 8-2: Active population distribution, 1965, and evolution, 1939-1965

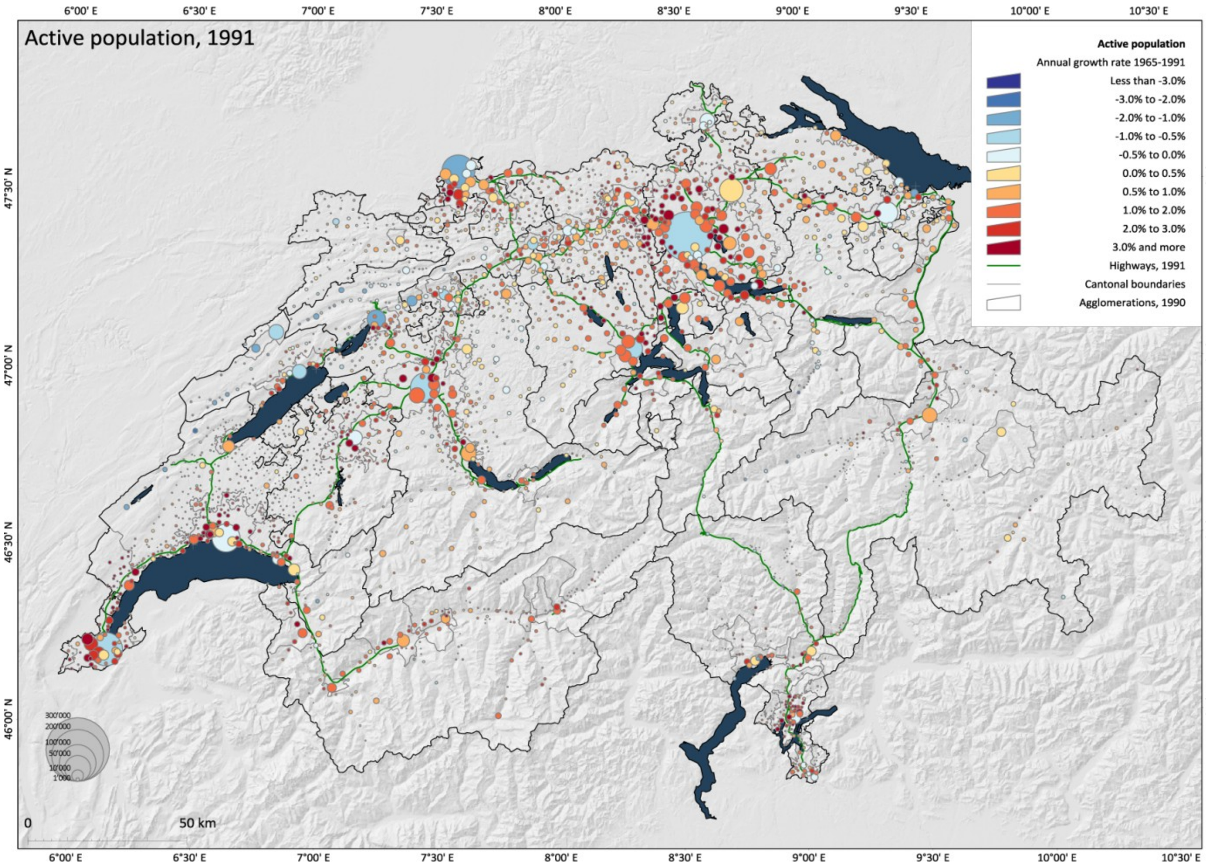
The 1965 map of the active population shows the distribution of the active population as well as its evolution since 1939. Since 1939, the active population distribution had radically evolved, along three axes (*Map 8-2*).

Firstly, as a whole it had grown very much, gaining one million people at 2.54 million actives in 1965. This growth, in absolute terms, benefited first and foremost to urban centers, which grew accordingly. It has to be noted than as a whole, as residential centers this growth was quite homogenous on the whole of Switzerland, and across size classes, small cities growing like larger ones, and without distinction between central and peripheral areas, as far as cities were concerned. This growth also allowed some smaller center to take some importance in the network, a result opposite to that of business censuses where the overall development of the economy was made at the expense of the smallest Christallerian centers, showing that while losing their edge as activity centers, they maintained it as residential ones. In any case, the residential urban system reinforced during the 26 years under review.

Secondly, suburban belts had greatly progressed during this period, clearly more than their parent centers, although their share was still rather small. In Zurich, the Glattal and Limmattal had erupted into view, as had the whole Basle suburban area. In Berne, the Ostring area, in Lausanne and Geneva their respective western sides were now adorned by powerful residential suburbs which were progressing fast. The same phenomenon was seen in Aargau where some suburban belts were already joining to form a ribbon of continuous urbanization, a phenomenon visible in the Biel-Solothurn corridor, the Olten-Aarau region, the Zurich Oberland area.

Lastly, but perhaps most importantly, rural villages and areas were steady depopulating. This third phenomenon was happening about everywhere save the Basle-Aargau-Zurich areas, and often right next door to strongly progressing cities and suburbs. While cities and suburbs were growing, the land was losing its substance and thus creating, in terms of residential structure, a more polarized space, between bursting cities and emptying campaigns. At this point all suggests that the land was urbanizing, deriving all its residential growth from cities and suburbs, while the rural world was losing imposrtance in absolute as in relative numbers.

8.3.2.4. 1991: Suburbanization



Map 8-3: Active population distribution, 1991, and evolution, 1965-1991

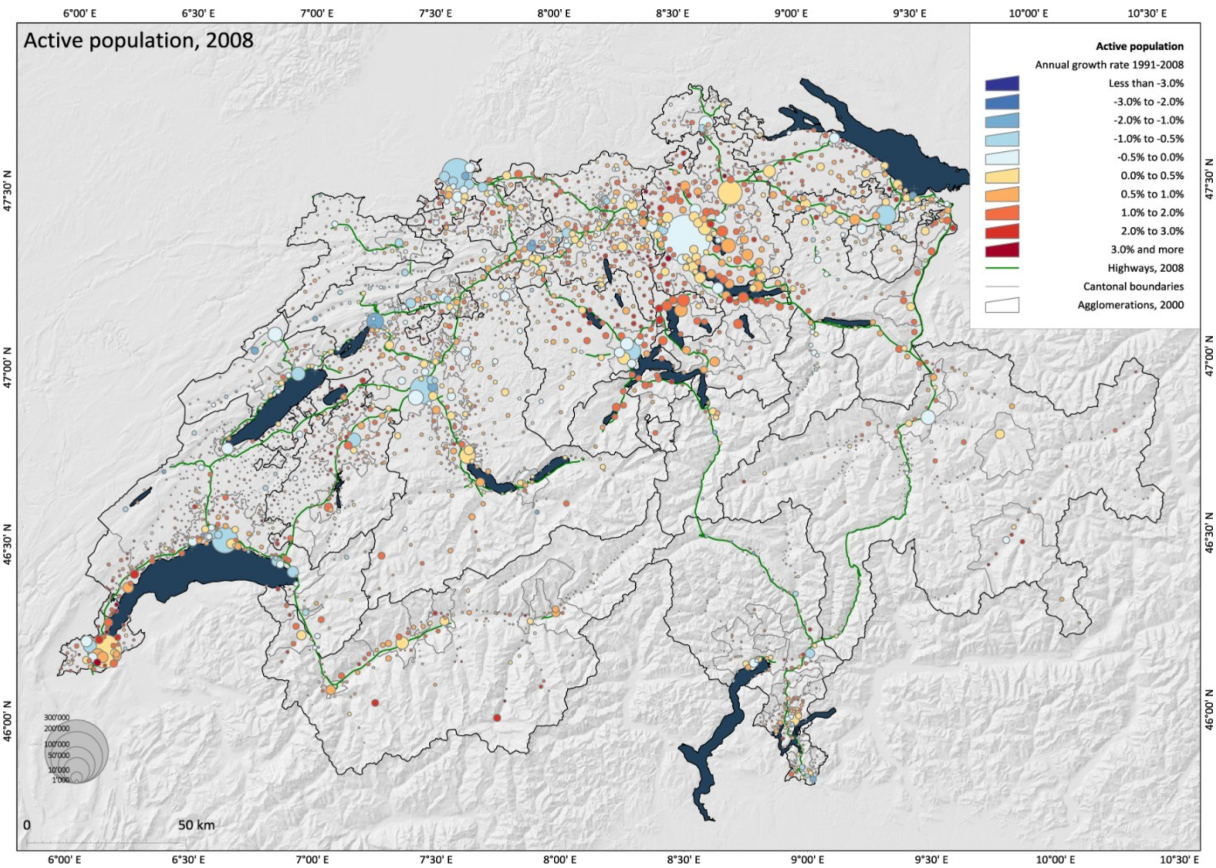
Between 1965 and 1991, the active population gained a bit less than 600'000 actives at 3.12 million, a severely reduced growth rate when compared to the preceding period (*Map 8-3*). For all this, the territorial changes experienced during those 26 years were at least as spectacular as the ones of the preceding era. As for the period leading to 1965, they can be resumed in three main traits.

The first one is the interruption of growth experienced by most urban centers. In terms of residential places, cities had reached their apex in the 1960s and 1970s, and had lost steadily active residents since then. By 1991, most cities were exhibiting absolute losses of active population, and the ones which weren't were tellingly situated in rather peripheral areas, like Yverdon, Thun, or in Eastern Switzerland. In economically dynamical areas, all centers had lost population, as if actives were being driven out of them to make space for more lucrative jobs.

In parallel, suburban belts, everywhere, had undergone massive growth and formed now – and this was a new feature, gained since 1965 – a very significant part of the active population of the growing agglomerations. This growth was particularly spectacular around the big five with a clear advantage to the Zurich area which seemed to command growth in a much larger area than its competitors, from Olten to Lucerne to the Upper Lake to the lower Glattal and back, a feat which no other urban area could match. That being said, each major urban area had remarkable examples of suburban growth areas, and many places started to experience the oil slick like growth patterns shown in full in the larger Zurich area.

Meanwhile, general rural depopulation was replaced by regional patterns of growth and decline. In many areas of the Swiss lowlands, depopulation had been reversed, especially around the major urban areas of the country. Thus, from Vaud to Fribourg, to Lucerne to Thurgau, villages were seeing their active population grow again, after decades of decline. However this pattern was not general and in selected peripheral areas depopulation went on, most notably in the Jura arc, in the Prealps of Eastern Switzerland and in many remote valleys of the Alps. Thus, a general center-periphery dichotomy had been replaced, in residential terms, by a dichotomy of winning regions, against losing ones.

8.3.2.5. 2008: Metropolization



Map 8-4: Active population distribution, 2008, and evolution, 1991-2008

In the 17 years separating 1991 from 2008, the active population gained only 200'000 people to 3.32 million actives, a rather surprising result given the fact that Switzerland had gained about three quarters of a million people during the same time span, a testimony at the same time of an ageing population, a retardation of the age at which young people enter active life, and of the growing job share taken by cross-border workers (*Map 8-4*). This relatively anemic growth, and above all general population ageing, had rather profound geographical consequences for the active population distribution. Three traits, again, can be discussed.

The first, very general trait, is that as a whole, in terms of residential distribution of the active population, the years leading to 2008 were in continuation of the ones preceding 1991, only less so. Cities continued to lose active population, but at a somewhat lesser rate than before – clearly, the residential flight which had happened during the 1970s and the 1980s had abated. More significantly, the ageing had started to hit the most established residential suburban communes: in all major agglomerations, major suburban communes had lost, sometimes heavily, active population, from Vernier, Meyrin, Onex to most of Lausanne western side, from the Berne Ostring to, the whole inner suburban belt of Basle, to Emmen and Littau, to Schlieren, Dietikon, Kloten. It was not so much a residential flight than the ageing of their once young population which was to blame for their loss of residential substance but in any case, here is a strong signal for the rest of the country. This had also a far reaching geographical consequence, which is that now extensive central areas were losing active population, and not just the centers.

Further away from the centers, in extensive outer suburban and so-called periurban areas, growth had remained, if somewhat weaker than before, with the consequence than the metropolitan areas they contributed to form and develop were becoming more and more powerful, as well as more and more extensive, and also more and more diffuse as their centers tended to deflate. Residential growth was, more than ever, oil slick like, concerning whole areas, like Central Switzerland, the Aargau area, the Zurich canton, the Lake Geneva crescent. We had already seen this phenomenon when discussing the latest economical developments, but in the economy, at least, polarities seem to remain even if acting as groups. In residential terms, everything had turned centerless, dissolving structures in a sea of small, undifferentiated periurban space. Edgeless space.

At least, the development of extensive metropolitan periurban areas helped put to rest any remaining fear of rural depopulation by 2008. Even if the national growth rate was far less of what it had been in the 1950s and the 1960s, it was positively felt in rural space. Or should we say former rural space, as these areas started to grow again by way of their transformation into something else, i.e. residential metropolitan space, which now extended way back into the countryside, with strong growth noted in such far-out regions as central Thurgau, western Lucerne, or the middle Broye valley, and the same healthy growth were seen in some mountainous areas, such as Valais in general or the whole Rhine valley downstream from Chur. In any case, lowlands rural areas were not retreating anymore, nor were most peripheral areas, except one, always the same one, the Jura Mountains.

8.3.2.6. Conclusion: dispersion, unabated

As for spatial economics, the seventy years separating 1939 from 2008 can be split into three distinct periods, from a starting point which was clearly Christallerian in structure, with a network of cities superimposed on a uniform rural substrate. The first period, lasting a quarter of a century to 1965, was marked by strong growth and concentration: strong overall growth, with, at the end of the period, about two thirds more active population than at the start of the period, a growth which benefited exclusively the urban domain, as most rural localities actually lost active population during this period, expressing thus a move of massive urban growth and sensible rural decline: a classical concentration process. Suburbanization was already starting to appear, with suburbs growing the most amongst all categories, but their importance was still rather secondary.

The second period also lasted a quarter of a century, to 1991, and was marked by a weakening growth and a very strong suburbanization of the urban population. The period thus marked the major wave of suburbanization with centers displaying notable losses. Suburbs, in contrast, progressed very strongly, expressing, after the concentration period of the 1950s and the 1960s, a big wave of population dispersion. This dispersion wave, while decreasing, was still active in 2008, only it had reached further away from centers, in large patches, especially in periurban space which saw its active population grew strongly. Meanwhile, urban centers were still losing population, a phenomenon which had spilled over on the most internal parts of the suburban belts. What had started as a strong growth mostly concentrated on urban centers had become a shockwave which was reaching further and further away, while the centers were slowly retreating.

In the context of this work, this means that as time went by, the geography of the active population at its residence slowly evolved, in differing directions, first of growth and concentration, until 1965, then of slow but steady, powerful and relentless dispersion in larger and larger areas. In terms of accessibility, space became more discriminated from 1939 to 1965, with a strong bonus given to dense areas, while since then accessibility disparities between town, suburban and countryside have tended to abate. Thus a double move in accessibility is forecasted: a polarizing one up to 1965, followed by slow but steady return to indiscriminate space afterwards, during the two last periods under study.

8.3.3. The evolution of the transportation network

8.3.3.1. Introduction

The third component of our accessibility measure is the state of the transportation network. In this study this will be limited to the road network as the car became the main commuter mean of transportation during the period under review, thus having a major structural effect. The road network allows access to all of the inhabited territory, and thus allows accessibility to be computed everywhere. Lastly, in terms of commuter times, car has been until very recently at least the quickest way to get from a point to another. For these reasons we think that car accessibility plays the most structuring role in defining general accessibility.

The data used to build the state of the Swiss network at different points in time has been described in chapter 2; here we will only delve about the actual history of the road network, from 1939 to 2008.

8.3.3.2. Before the highway act

In 1939, the road network had essentially the same extent than fifty years before, as can be seen by comparing maps of 1916 with ones of the mid 1950s: see the General map of Switzerland at 1:200’000 in 4 sheets, 1916, and the Road map of Switzerland at 1:200’000 in 4 sheets, 1953/1956. This network was taking a strong rise in traffic since the end of WWI and the advent of trucks which started then to compete with the almighty railways. Most of the work happening in the network was directed towards betterment of existing axes instead of creation of new ones, mainly towards road surfacing. As the responsibility for these public works was residing exclusively with the cantons, the situation varied widely across the country, with rich cantons having most of their roads asphalted by 1939 while the poorer cantons lagged behind: in some areas of the country, notably in the mountains, some communes were not linked by surfaced roads until the 1970s.

In terms of network completion, those were above all happening in the mountainous regions, where the major pass openings of the late 19th and early 20th centuries somewhat lived on with the commissioning of all weather roads on some secondary axes, such as in the Jura Mountains the Passwang (SO) in 1933, and in the Alps the Susten pass (BE-UR) during WWII, and the Forclaz (VS), Glaubenbielen, Glaubenberg (both LU-OW) and Schwägalp (SG-AR) passes just after the war. The last such example was the commission of the Nufenen pass (VS-TI) which opened as late as 1969. All those roads were situated in remote or very remote areas, quite far away from population and activity centers, and clearly their commissioning responded to a logic of network completion. Some were openly built for strategic reasons, like the Susten link, and maybe the Nufenen one.

Apart from these changes, up to the end of the 1950s, very few network completions were undertaken in Switzerland: we have found only 23 visible changes at the 1:200'000 scale to the network between 1930 and 1960, including the cases given above. Thus, by 1960, the road network had not evolved to take into account the major changes under way in terms of demographical and economical growth. This was not lost on the federal and cantonal authorities, which were monitoring impressive traffic rises throughout the country and especially in the major centers and their agglomerations, and were looking at the solutions the outside world offered to these problems. By 1955 it seemed evident that just patching up the existing network was not going to solve all problems, especially given the projected growth of the country. A new approach was needed to respond to the generalization of car transportation in the country. This would provide the basis for the first involvement of the federal state in transport politics since the creation of the federal railways in 1903: the Confederation launched a program of national highways. For the first time, road planning would be made at the federal level.

8.3.3.3. The highway act of 1960 and its evolution

The history of the highway act has been thoroughly studied by Bassand et al 1986, and we refer to this work for readers interested. Our goal here is just to give several indications on the logics of the network and to give some indications as to its spatial and temporal developments.

The network which was planned through the 1960 highway act resulted from a compromise between two conceptions of what should be the highway network of Switzerland. The first conception was a maximalist one, which aimed at creating direct communications between all major centers of the country – of which there were fourteen: Geneva, Lausanne, Fribourg, Neuchâtel, Berne, Biel, Basle, Lucerne, Zurich, Winterthur and St-Gallen as major centers, with Vevey, Lugano and Chur as smaller but regionally important ones. The second conception can be deemed as minimalist and envisioned only a "federal cross", one highway on the east-west axis between Geneva and St-Gallen through Lausanne, Berne and Zurich, and another one on the north-south axis between Basle and Chiasso through Olten and Lucerne. In the end, the resulting network was closer to the maximalist view than to the minimalist one, with 12 dedicated highways crisscrossing the Swiss territory. That being said the highway act abandoned some highways options that could have been viable: for instance, a link Between Berne, Lucerne and St-Gallen, another one between Biel, Basle and Winterthur, and four north-south links in the Seeland area: Neuchâtel – Fribourg, Neuchâtel – Berne, Biel – Fribourg and Biel – Berne. Furthermore, highways had to have an inter cantonal interest, so that even interesting and major relationships occurring inside a given canton were rejected – this was the argumentation to reject a Biel – Berne link, a Neuchâtel – La Chaux-de-Fonds one, or a Berne – Delémont – Delle link, which was at the time entirely inside the Canton of Berne.

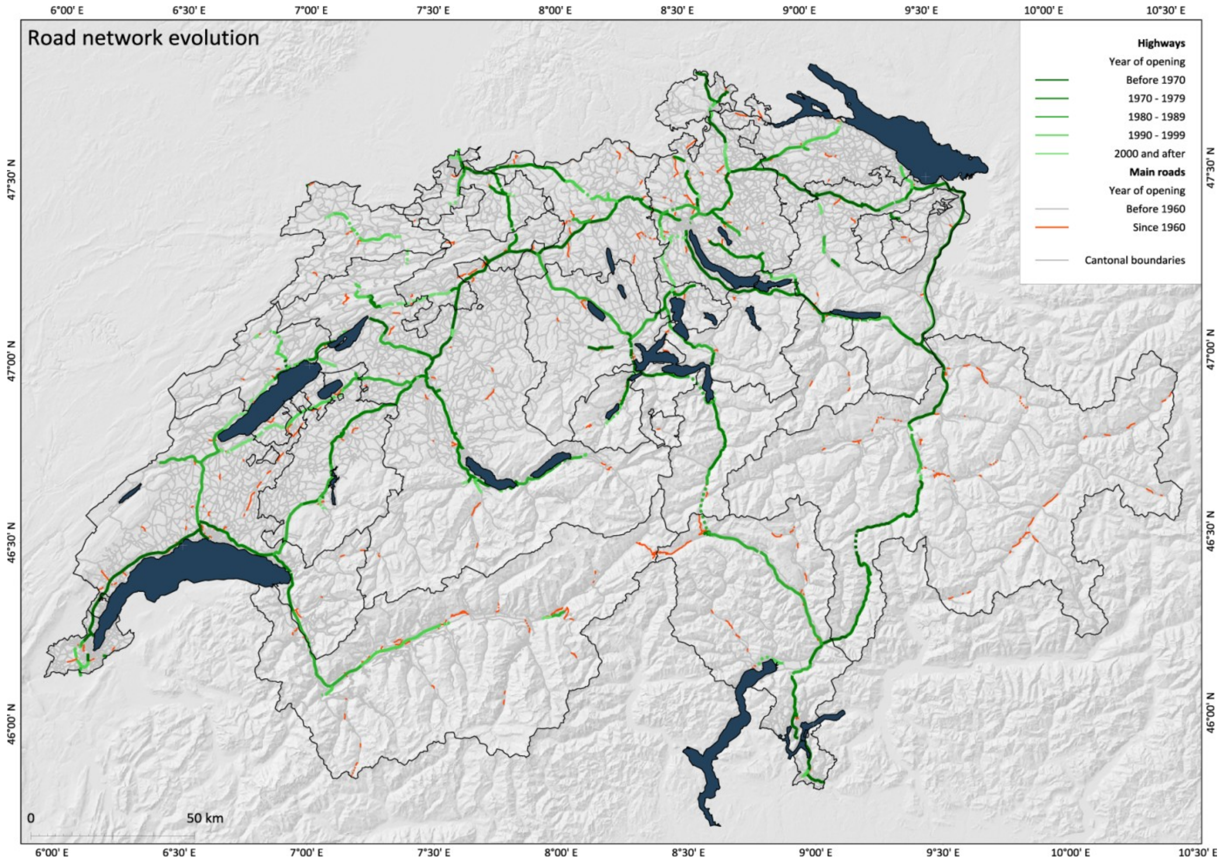
At the urban level, the philosophy of the network was to link centers to centers, and inside the agglomerations, the downtowns to the downtowns. In the first draft, then, highways would go through urban centers instead of around it, with several such urban highways planned, in Lausanne, Neuchâtel, Basle, Zurich, Schaffhausen or St-Gallen. However, very soon in the process it became apparent that in many cases through-center highways were contested and that other solutions, like the construction of highways which would bypass or encircle the major cities instead of traversing them, were on offer. In most cases such bypasses weren't planned in the original highway act – the first major revision of which tackled this problem by designating such bypasses, most notably in Geneva, Lausanne and Zurich. In other cases, though, through highways have been built, in Basle, St-Gallen, Neuchâtel, and Schaffhausen, and such projects are still planned in Zurich and Biel.

At the regional level, there were three major evolutions from the original highway act. The first was that most highways were upgraded to full, four-lanes, divided highways before being built, even if the original plan planned many of them as second-class, two-lanes highways without separation, a formula which resisted only in some alpine segments, mainly the A8 and A13 highways through Obwald and Graubunden. The second evolution concerned major changes to the national highway network, in 1984 with the adjunction to the network of a new A16 highway between Biel and the French border near Porrentruy following the inception of the Jura canton in the late 1970s, and, in 1986, the formal abandonment of the A6 highway between Spiez-Wimmis and Sion, which deprived central and upper Valais of a direct all-season road link to Berne and German-speaking Switzerland.

The addition to the network in 1999 of the main road from Landquart to Davos heralded a major revision of the network philosophy, a philosophy more strongly affirmed in 2009 with the planned inclusion of no less than 19 such segments throughout the country. For the time being, these inclusions do not mean that the corresponding roads will be upgraded as highways, but merely that their maintenance will now depend on federal rather than cantonal financing. That being said, it is interesting to see that among those segments, seven were discussed for formal inclusion into the 1960 highway act: Neuchâtel – La Chaux-de-Fonds, Neuchâtel – Murten, Biel – Berne, the ramps to the Lötschberg tunnel as a replacement for the abandoned A6, Delémont – Basle, Zug – Wädenswil and Kreuzlingen – Arbon. Thus, there is a sense that when the Confederation will have finished with its modified original network, it may want to complete it by reinstating some of the segments it had discarded in 1960. Another indication of this is given by the fact that the new federal network philosophy states that all cantonal capitals should be linked to the national highway network – this explains four more additions in the network to link Aarau, Liestal, Glarus, Herisau and Appenzell (SFRO 2010).

Lastly, it is to note that several cantons, being deprived of federal highway segments they judged necessary, decided to build them outside the federal network system. Those cantonal highways are particularly present in Zurich, with three different segments (Bülach – Wallisellen, Illnau – Uster and Zürich – Hinwil), St-Gallen (various segments along the Toggenburg valley and the Hinwil – Rapperswil – Reichenburg highway), Aargau (Aarau-Aarau Ost), Berne (Biel-Berne), Neuchâtel (Neuchâtel – La Chaux-de-Fonds) and Ticino (Bellinzona – Locarno), most of which segments were commissioned in the 1980s and the 1990s. Zurich still has a very lively cantonal highway program (see Tiefbauamt ZH 2000, 2002).

8.3.3.4. The implementation of highways from 1960 on



Map 8-5: Road network evolution, 1940-2010

Once decided, the highway network saw immediate and rapid development (*Map 8-5*). The first big highway segment opened in 1964 between Lausanne and Geneva, followed shortly by segments in the Berne region. By 1970, the three main German-speaking cities of Berne, Basle and Zurich were interconnected, as were Zurich, Winterthur ans St-Gallen, and the left shore of Lake Zurich. The construction program went on with speed during the 1970s, which saw the copmpletion of the lemanic highways from Geneva to Aigle, the connection of Berne with Fribourg and Thun, the interconnection of Bellinzona with the Sottoceneri and the San Bernardino road. By 1982, the interconnection between western Switzerland and Berne was realized through the completion of the A12 highway between Fribourg and Vevey; the same year, the Gothard highway tunnel opened and insured a year-round link between Ticino and Lucerne, which was the same year directly linked to Basle. By 1985, the fundamental armature of the network, the “federal cross”, was completed with the last openings of the Zurich bypass and the St-Gallen through-highway along the A1 and the Leventina segments of the A2.

From then on, though, the building rhythm went sharply down – it had taken less than 20 years to build about three quarters of the network, but it would take another 35 years to complete it, as major additions to the network were rescheduled, and rescheduled again, as the political priorities of the Confederation shifted from the national highway network to the upgrading of the railway infrastructure. Thus, the A1 bypass of Geneva waited till 1993 to enter into service, the A1 was only completed in 2001 between Yverdon and Murten, and from Neuchâtel and Biel major sections of the A5 waited 2000 to be opened towards Zurich, and 2005 towards Lausanne. In German-speaking Switzerland, the segments which weren't opened by 1985 suffered the same delays, with the incredible fact that the direct link between the two biggest cities of the country wasn't completed until 1995 with the belated opening of the A3 between Brugg and Frick, while the Lucerne-Zurich link waited until 2009. In other parts of the country the delaying was intentional in order to minimize the magnitude of the public works involved and thus letting small regional companies to bid on the contracts. Such approaches explain the very low progression rates of the A9 in Valais and the A16 in the Jura arc, and also explains why those two particular highways are still awaiting completion in 2010 – both are scheduled to be completed by 2016, the last link remaining to be open after that being the Biel through highway, slated for 2020, while the Biel eastern bypass should open in 2014.

As we can see, the implementation of the Swiss highway network can be separated in two very different periods: a first period from about 1964 to about 1985 which showed a rapid development of the principal armature of the network and the interconnection of all regions of the country except the Jura mountains, a period which ended about 1985, and then a far longer period of small increments made to the network, mainly, but not only, in relatively peripheral parts of the country.

8.3.3.5. The upgrading of the main road network since 1960

The trend we noted about the rapidity with which the highway network principal armature was put into place from the mid-1960s to the mid-1980s is mirrored when looking at the upgrades the road network received outside the development of the national highway network system. In all, from 1939 to 2010, we have found 314 visible changes at the 1:200'000 scale. Of those, only 17 were recorded before 1960, concerning mostly mountain roads.

Then, the pace of changes upped dramatically. 91 changes to the network were recorded in the 1960s, and this flurry of activity went on in the 1970s, where we recorded 73 visible changes, the majority of which occurring in the first half of the decade – there was a clear slowing of openings in the wake of the economical crisis. The first half of the 1980s saw 28 such changes, a rate a bit lower than the one observed in the 1970s, then there was a clear rupture, with only 16 visible changes happening in the latter half of the decade, as if the sudden slowing of highway building which happened then was mimicked by a similar downwards trend in the main road network restructuration. Since then, the rate have held about steady, at half the 1960s values, with 39 changes in the 1990s and 42 in the 2000s.

Major operations went along in particular on the main alpine roads, which were thoroughly upgraded, from the Gd-St-Bernard to the Simplon and Gothard passes and the Engadine valley. In the lowlands, extensive restructuration were made on the Lausanne-Berne main road, transforming it into a second-class highway without the name, in the Gäu region west of Olten, the Suhretal south of Aarau, and in the Zurich Unterland around Kloten and Bülach. Many of these changes, and most of the smaller ones, were implementations of locality bypasses, which aimed to allow both the traffic to move more swiftly, and to ease the localities of the traffic going through them. Many changes were also linked to the network restructuration following the commissioning of highway segments, a trend which still lasts, and will as long as there will be highway segments to put into service.

In short, in our time span there were three major phases: a first one which was above all concerned by the upgrading and the surfacing of the existing network, then, starting around 1960 and lasting about 25 years, a period of major activity and restructuring of the network itself, and finally, from 1985 on, a calmer period where changes were made in an incremental manner, without the big operations of the two preceding decades.

8.3.3.6. Conclusion: two decades which changed the face of the road network

In all, there is strong evidence that both the highway network and the principal road network evolved concomitantly, in three stages. Firstly, from 1939 to 1965, there was a period of very few changes made to the overall network, with most of the betterment directed towards getting the existing network into better shape and more adapted to the rising number of cars it had to deal with.

Change was prepared from the mid-1950s, when the authorities took the view that this policy wasn't going to be enough to cope with the explosive rise of the population and of the economy at a time when rising living standards were making the car accessible to a rising majority of the population. Thus, a period of very strong modifications made to the network, both by the inception of a national highway program, which was voted in 1960, and which highways were commissioned from 1964 on, and by major modifications made to the existing network, with the upgrading of certain major routes and the building of many locality bypasses. This period lasted until about 1985, date at which the principal highway network was completed, with continuous highway links from Geneva to St-Gallen and from Basle to Chiasso. In about two decades, about 80% of the planned national highway network had been opened to traffic and it was expected that the remaining 20% would be opened by the end of the century.

However, from 1985 on a new period opened, with changes made to the network suddenly becoming far less numerous, both for new highways, where the commissioning of new segments fell by at least two thirds after 1985, and for the existing network which saw a change reduction of about one half. It is probable that political reasons played a major role in that dramatic and quite sudden reduction, with valuation of road transportation turning negative at that point, highways being contested as such – for instance, four segments were successfully stalled for years by a referendum proposition against them which was finally voted down in 1991. It is certain that the green movement, which took a strong importance in the 1980s, dramatically slowed down the pace at which highways were built from the mid-1980s on, while making their cost explode by the multiple new requests of landscape and ecological integration they had now to cope with. In parallel, a new emphasis was made on the development of the railways as an alternative to car transportation. In any case, we had passed from a period where urbanism and land management had been geared towards easing car travel, seen as a benefit and as a right, to one where car travel was devalued and hindered, a period in which we still live. This, of course, had a major impact on the road network evolution. What had been, for twenty years, a relentless evolution became, from 1985 on, an implemental development of an otherwise stable again network.

8.3.4. The evolution of the commercial speeds of automobiles

8.3.4.1. Introduction: MicroGIS and the IVT

The last component of accessibility is the actual speed - the distance an actor is actually able to do in any given time. In our case the promble at hand is twofold – first, we need to estimate credible speeds on the different road types which exist in Switzerland, and then, we have to estimate how those speeds have evolved from 1939 to 2008. Fortunately, the history of the commercial speeds of individual automobiles in Switzerland has been thoroughly studied by the IVT Lab from the ETHZ. For the concern of this particular part, the following publications are of particular importance. A first implementation of generalized commercial speeds was proposed in Fröhlich & Axhausen 2002. This work is particularly important to us as it was implemented on the same network and along the same logic than the one we used, as there was, at the beginning of the years 2000, fruitful data exchanges between the IVT, at the time searching for a viable road network for Switzerland, ans MicroGIS Ltd. Which had developed such a network under our direction. Speeds implemented empirically by MicroGIS when developing the MicroDrive network were taken as basis by the IVT researchers, which sought afterwards to make them evolve and founded their results on numerous studies of which Erath & Fröhlich 2004 give a major overview.

8.3.4.2. The IVT commercial speeds

Both the MicroDrive and the modified IVT model split roads in several broad categories which are taken as representative for their class. The interest of this conjoint model is that it allows for separation between urban, plain and mountain roads, a feat not found in most market products which emphasize instead official classification schemes. The speeds used by and given in Fröhlich & Axhausen 2002 are as follows, along with the values implemented by MicroGIS Ltd. in its current product:

	1950	1960	1970	1980	1990	2000	MicroGIS
Road type							
Highway, 120 km/h limitation	85	95	110	112	114	114	110
Highway, 100 km/h limitation	85	95	90	92	94	94	90
Highway, 80 km/h limitation	85	95	75	77	79	79	75
Highway access	30	30	30	30	30	30	30
Main road	40	45	55	65	70	70	70
Connecting road	25	40	50	60	60	60	60
Collecting road	30	35	45	50	50	50	45
Access road	25	25	35	40	40	40	30
Mountain transit road	35	40	50	60	60	60	60
Mountain main road	30	35	45	50	50	50	50
Mountain collection road	25	25	35	40	40	40	35
Mountain access road	15	20	25	30	30	30	20
Urban main road	22	22	22	22	22	22	22
Urban collection road	17	17	17	17	17	17	17

Table 8-4: Commercial speeds on different road types, 1950-2000

As stated by the authors, those values are issued from their own calculations, based on data found in the Highway Capacity Manual from the US Transportation Department and from a study by Dietrich et al 1988, both extensively cited in Erath & Fröhlich 2004.

As can be readily seen, the values for 2000 are very close to the MicroGIS values. Differences arise in two domains; first, a systematic difference of 4 km/h on highways, which is seemingly based of extensive research done by Erath & Fröhlich 2004 and the results of mean speeds on Swiss highways since the 1980s. The second difference, more marked, is seen on local roads where the MicroGIS speeds are again lower than those of the IVT. We justify those two sets of differences on the following manner. Both aforementioned IVT studies took into account speeds in free flow traffic, whereas MicroGIS, without taking into account true traffic jams, evaluated the impact that casual slowdowns have on the general mean speed, which correspond to the 4 km/h difference. The local roads were initially assigned the speeds seen in the IVT table, but were later reevaluated by MicroGIS to take into account inside-locality speeds as well as outside locality ones, as the segments aren't discriminated enough to allow specific speeds. Furthermore, in the course of the years the network was completed by more and more very small roads which prompted the reevaluation of the general mean speed possible on those roads.

Fröhlich & Axhausen 2002 generally show a steady growth of average speeds through time, particularly between 1950 and about 1975. Those were confirmed by Erath & Fröhlich 2004 work, which empirically shows such progression in speeds which can be attributed first to the wider and better surfaced roads, and then to the more powerful and versatile cars. Then, the progresses are clearly incremental. The oil shock provoked an abrupt stop to power and volume growth of the car motors which were actually marketed in an effort to curb gas consumption. Ten years after, general speeds limits were lowered, first in built-up areas – from 60 km/h to 50 km/h, then outside the localities, with a 10 km/h reduction on highways to 120 km/h, and a 20 km/h reduction, to 80 km/h, on roads outside localities. However, to the IVT researchers, those limitations were still offset by general vehicle and road progress and, if only incrementally, the average speeds continued to grow.

8.3.4.3. The MicroGIS commercial speeds

In order to estimate the historic speeds, we largely inspired ourselves from the groundbreaking work at the IVT and many speeds we use are indeed the speeds given by Fröhlich & Axhausen 2002, which have been somewhat extended back towards 1939, and forth towards 2008. However, several important departures from the IVT model have been implemented. Here are those changes.

Firstly, we believe that the slowing of the network growth from 1985 on was real enough that it couldn't cope entirely with the subsequent rise in vehicle numbers. There were in 1985 some 2,685 million private cars in Switzerland, double the figure of 1970, but very far from the 2008 figure of 3,990 million cars (SFSO 2010a). This means that from 1985 on a slowly growing network had to bear more and more cars – in fact, one and a half as much cars in 2008 as it had to cope with in 1985. While before 1985 the massive rise in car numbers were more or less matched by corresponding investments aimed at facilitating car transportation no matter what, this link decoupled around this date, so that subsequent rises in car numbers weren't followed by adaptations in infrastructure. As a logical consequence, congestion problems are way worse now than they were in 1985, and this, we believe, have profound repercussions, also in the average speeds one can expect to reach while travelling by car on the Swiss road network. We believe that in urban areas and in highways in general, the combination of lower speed limits and rising congestion problems are incrementally slowing down traffic. We implemented such changes in our model, up to have differences of more than 10 km/h between our speed values for 2008 and those of the IVT for 2000.

In a similar vein, the IVT teams have postulated a stable commercial speed in urbanized areas, advances in technology compensating rises in congestion. For our part we think that urban congestion problems have progressed more rapidly than advances in technology, such as the average speed in urban areas was probably higher in times past than now, albeit not by very much. Therefore we have implemented slightly higher speeds in urban areas for 1939 and 1955, which we made decrease up until about 1995. Since then we have considered it to be stable as congestion problems tended to generalize to other areas then the urban centers. The changes we just mentioned are of course quite empirical, if not outright speculative; but in the absence of literature about the subject we have to rely on empirical means, in this case personal experience, and common knowledge. For example, the commercial speed of public transportation is about the same than the commercial speed of cars since about 20 years in our cities, and that it has remained stable on the same period.

The last change we implemented to the IVT model concerned the rate at which speeds grew in the beginning of our period of study. We observed that IVT mean speeds weren't affected by the speed limit changes which happened first in the 1970s with the imposition of speed limits, and then in the 1980s with their lowering both in and outside localities. We think that those limitations had an impact on the mean speeds registered when the changes occurred, especially since they were rather important, with a reduction of 20% of the speed limit in and outside localities, in speed ranges which were already easily attained by the vehicles of the time. Thus, if for the periods after the speed limit correction the mean speeds we use are correct, then there must have been a period before the implementation when those speeds were somewhat greater. We have implemented those changes, which elevated mean speeds before 1980, always taking into account the maximal speeds reasonably possible at the time, which we used for highway mean speeds adhering strictly to Fröhlich & Axhausen 2002.

Concerning the highway mean speeds, the speed limitations which were put into place in the 1970s and the 1980s were quite higher than the mean speeds recorded at the time, and even the lowering of the speed limit from 130 km/h to 120 km/h in the 1980s did not close completely the gap between mean speed and speed limit. Thus, to the contrary of the mean speeds on the principal road network, there was no adaptation on the highway mean speed for cause of speed limit promulgation.

Here is the table of mean speeds per year and per road class that we used to compute the matrices between the communes of Switzerland.

	1939	1955	1965	1975	1985	1991	1995	1998	2001	2005	2008
Road type											
Highway, 120 km/h	80	90	105	110	115	110	108	106	104	102	100
Highway, 100 km/h	80	90	95	100	95	90	89	88	87	86	85
Highway, 80 km/h	80	80	80	80	75	75	75	75	75	75	75
Highway access	30	30	30	30	30	30	30	30	30	30	30
Main road	50	60	70	80	70	70	70	70	70	70	70
Connecting road	35	50	60	70	60	60	60	60	60	60	60
Collecting road	35	45	55	50	45	45	45	45	45	45	45
Access road	20	25	30	35	30	30	30	30	30	30	30
Mountain transit road	30	35	40	50	60	60	60	60	60	60	60
Mountain main road	30	35	40	50	50	50	50	50	50	50	50
Mountain collection road	20	25	30	35	35	35	35	35	35	35	35
Mountain access road	15	20	25	25	20	20	20	20	20	20	20
Urban main road	30	30	30	28	26	24	22	22	22	22	22
Urban collection road	30	30	25	23	21	19	17	17	17	17	17

Table 8-5: Commercial speeds on different road types applied to the model, 1939-2008

8.3.4.4. Conclusion: commercial speeds going up, then down

As for the determinants of accessibility, commercial speeds along roads seem to have a history in three periods. First, a period of concomitant ameliorations both in road and car technology allowed mean speeds to progress about everywhere, save in cities where very soon, congestion had an impact on the actual speeds the vehicles could make. This period of worsening conditions in urban settings against bettering conditions elsewhere culminated around 1980 with the maximal means recorded about then.

Afterwards, technology advances went partly away from performance and towards safety and gas consumption. In parallel, the state started to impose more stringent speed limits on roads while redirecting its transportation policy priorities from road and highway infrastructure towards railroads. At the same time the numbers of cars continued to climb, and traffic congestion slowly developed and migrated out of the cities where the situation somewhat stabilized, and towards the highways which weren't designed to handle such car numbers. In the countryside, along main and local roads the effects of speed limitation were seen in the 1980s, then mean speeds stabilized. In highways, congestion slowly crept in, which decreased, and still decreases, mean speeds.

8.3.5. A combined history of the four components of accessibility

If we take together the evolution of all four determinants, we can broadly recreate a three-part history of those determinants and their interplay.

The first period, broadly from 1939 to 1965, is essentially marked by the active population growth and redistribution, with far more actives in 1965 than in 1939, and in a clearly more concentrated fashion. In parallel, technology advances made the 1965 cars far more performing than their 1939 counterparts, while the roads had become way better. Those changes happened while the behavior of workers towards space-time had probably remained the same, as did the road network, at least in its structures. Nevertheless, the advent of faster cars on faster roads made the spatial range of workers and jobs larger, that at a time when cars were becoming available to the greater part of the active population, which was steadily growing and concentrating on urban centers. All those facts would postulate massive rises in accessibility, for the combination of a rising population, and far larger numbers of people able to afford cars than before and therefore extending their range massively. In cities, the effects of the traffic congestion started to be felt

The second period, running from 1965 to the late 1980s, was one of massive changes happening in the structures of the road network with the advent and completion of the fundamental parts of the highway network and the commissioning of highway bypasses in and along all major centers of Switzerland and most medium ones. During the same time, there was a massive dispersal of a still rising active population towards the suburban belts of the agglomerations. For their part, technological advances and the state of the network had made the speeds culminate outside the agglomerations towards the end of the period, while in built-up areas, especially urban centers, those speeds had gone down throughout the period. Behavior towards travel time seems to have remained stable on the period. One would then expect in those conditions accessibility to have remained stable in the urban centers and a strong rise of it in the suburban belts, especially along highways.

The third period started in the late 1980s and is probably still on course. It is marked by a general stabilization of the system, with an active population far more stable than before, albeit still dispersing, and a network which was now completed at a far slower rate than before, while still progressing. At the same time, travel conditions had slowly deteriorated on highways while remaining stable elsewhere, which should contribute to qualify the advantage to be located on a highway. Finally, the major change of the third period could well be the changing of attitude of the population towards commuting time. Stable until then, the mean commuting times started to rise, probably in response to changing and worsening travel conditions. Thus, by their behavior workers were compensating the shrinking of their range by extending the time they would allocate to travel. In all, accessibilities should have remained rather stable throughout the period, with a bonus to periurban places, and all places that were just marginal before and which the range extension included now in the metropolitan space – which the varying accessibility had probably been a big determinant in creating.

8.4. The accessibility components complex interplay

8.4.1. Introduction: the relative importance of the components of accessibility

Accessibility as we defined it stands on four parameters: the active population numbers and distribution, the maximal travel time allowed by the actors, the state of the road network, and the commercial speeds attainable on this network. What we don't know is the way those four parameters interact in order to form accessibility. Furthermore, as we just have shown, all four parameters exhibit significant variation over time. Before looking at the combined results of those variations under the guise of accessibility, we need to assess how a given variation in a given parameter impacts accessibility as we defined it. Two of the four parameters involved in our definition of accessibility strongly depend on spatial constraints:, active population distribution and state of the transportation network. Those parameters are not reducible to simple variables which would be easy to describe analytically. Therefore, only exploratory analysis can be conduced on accessibility.

The goal of this section is to test for the sensibility of accessibility to variations of its parameters – to establish if there is a hierarchy in parameter variation. To this aim, we will compute accessibility for 2008, and then check for the impact of parameter variation by replacing a given 2008 parameter with its 1939 version. This method will allow us to determine if some parameters are of more importance than others in making accessibility vary. The study gives results at a global stage under the form of a mean national accessibility, as well as at the local level, assigning accessibility to each commune.

Accessibility spatial variations can be expressed in thematic maps. For accessibility at a given time, three different maps can be constructed: First, absolute values are useful when constructing time series. Secondly, the use of indexed values allows showing spatial variations around the national mean, which remains fixed. Lastly, communal rankings can be mapped, which illustrates the position of any commune with regards to the others. Furthermore, all three methods allow differential mapping, i.e. the mapping of differences between two sets of accessibilities, a possibility that we will use in the assessment of accessibility sensibility to changes in its parameters, as well as in the description of accessibility's history since 1939.

8.4.2. Global effects of parameter changes on accessibility

Accessibility is defined by a combination of active population, road network, commercial speeds and maximal acceptable travel times. We have information for those parameters for 1939 as well as for 2001. We can summarize this information as follows.

In 1939 there were, according to our estimation, 2'131'919 actives in Switzerland. This represents about 61.7% of the 3'454'477 actives we estimated for 2008. Besides this major size difference, differences were also present in population distribution. In 1939, strong centers were superimposed on a relatively populated and unvarying rural substrate, whereas in 2008 the centers had partly diluted in large metro areas with variations being more regional than center-periphery. The road network of 1939 had one major difference with the 2008 network, which are the highways – in terms of topology, a mere 10%, at most, in variation – however their impact of global relations is likely to be major. Nevertheless, it has to be said that of the four parameters, the road network is probably the one which exhibits the least variation of all, at least in topological terms. As it stands, the commercial speeds we used show relatively few variations. The unweighted speed mean for all our road categories in 1939 is 35.00 km/h, 75.9% of the 46.08 km/h obtained in 2008. Put in the other way round, speeds were about 1.32 times higher in 2008 than in 1939, which in theory should lead to a reachable area 1.73 times larger. Lastly, the travel times have grown with time, from 28 minutes in 1939 to 34.5 in 2009, a 23% rise which theoretically should translate to a reachable area about 52% bigger.

In brief, we would expect the accessibility to vary most with the active population parameter since we expect the 2008 active population at about 1.62 times the 1939 one. Behind active population, the travel times should have a slightly lower impact, as in theory reachable areas and people in 2008 were about 1.52 times larger than in 1939. The third component is constituted by the mean speeds, which define a theoretical area in 2008 about 1.52 times larger than in 1939. Lastly, we would expect the road network to have the slightest impact of all, at about 1.08 to 1.17. Here are the results:

Parameter affected	Mean Potential	Actual measured ratio	Theoretical expected ratio
	(reachable actives)	(2008/1939)	(2008/1939)
None (actual conditions)	258'974	1	1
Active population	156'886	1.65	1.62
Road network	151'102	1.71	1.08 - 1.17
Commercial speeds	182'843	1.42	1.73
Travel times	157'383	1.64	1.52

Table 8-6: Influence of four parameters on accessibility

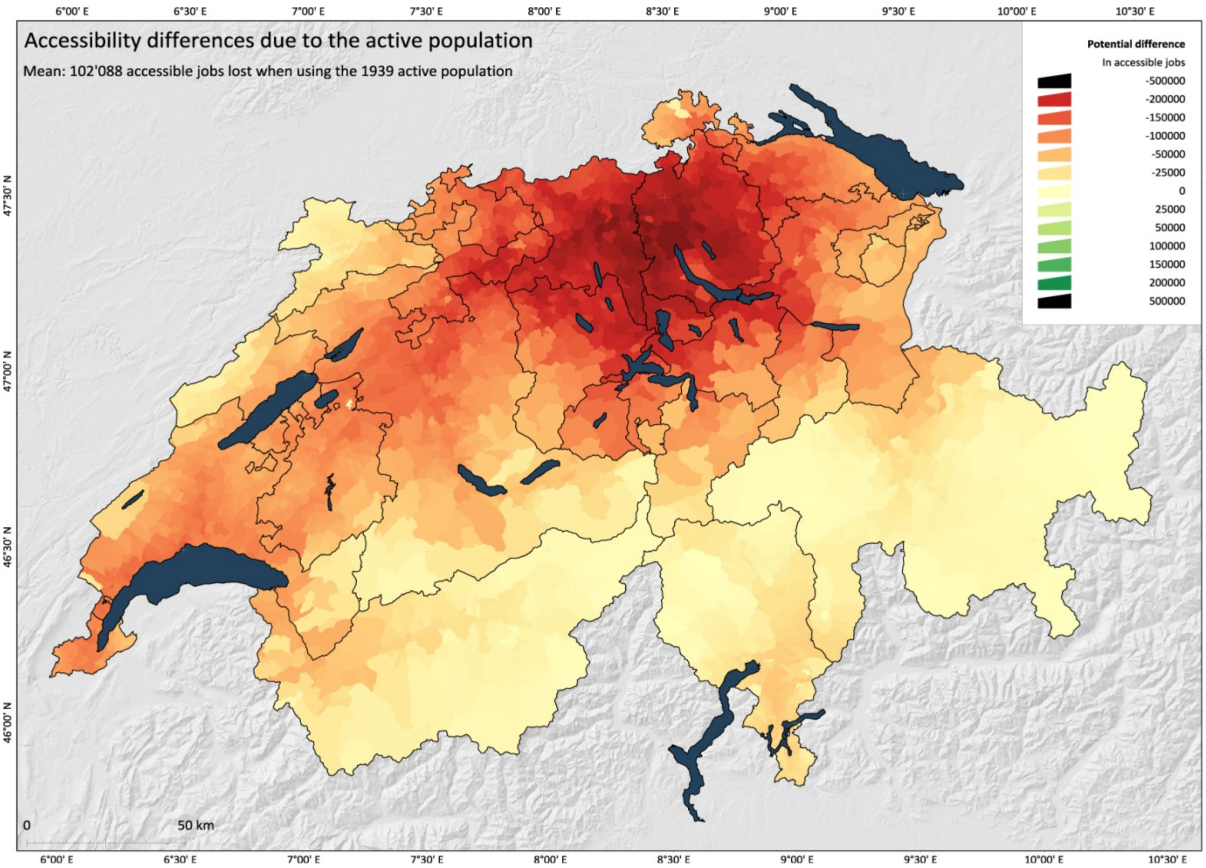
The conclusions are as follows. First, commercial speeds variations fail to translate fully into accessibility: less than 60% of the expected effect of speed variation on accessibility is actually measured. This 40% undershoot may well be due to the fact that speed changes varied a lot according to road class, with speeds doubling on some road types while nearly halving on others. The bulk of the speed progresses were made on country and mountain roads, which cover long distances but connect few people, while the urban roads, with far less mileage but which concern the majority of the population, saw their commercial speeds stagnate at best. This discrepancy is then found when computing accessibility: the effects of speed changes are muted. A 31% increase in mean speeds translates only to a 42% increase of accessibility while according to theory it should be around 73%.

Globally, accessibility reacts almost exactly as expected theoretically with respect to variations in active population. For its part, accessibility shows a tendency to amplify variations in travel time, which can be explained by the fact that we computed the ratio with a threshold method, while we used the Gumbel curve to compute our accessibilities. With such a distribution, the expansion of the travel times has the most impact in the long-tail section, which concerns longer distances – and those long-tail areas, when translated spatially, cover larger areas than the proximal parts of the distribution. We believe the 20% overshoot we measured to be essentially due to this phenomenon. Nevertheless, even if it is readily explainable, it is quite a find to discover that in all, a growth of 23% of the time people dedicate to travel translates to a 64% growth in accessibility.

But the real find of this small study is the enormous impact changes in the road network topology have when compared to the other changes. Here, a mere adjunction in a mature road network, adding at most 10% of new road, results in adding 72% more accessibility. Admittedly, the contribution of the highway network to the overall road network of Switzerland is difficult to quantify – and admittedly a kilometer of highway has more impact than a kilometer of local road. That being said, it remains that Switzerland has built less than 2'000 km of highways out of a more than 68'000 km of other asphalted roads, of which 26'084 km are represented in the road network model we used to compute accessibilities. This is to say that a carefully planned enhancement of the transportation infrastructure has enormous multiplicative effects on global accessibility. Here, the ratio between the enhancement of the network and its effects is between three and seven times the actual enhancement. At the national stage, accessibility depends very strongly on the quality and completion of the road network, with highway networks having a major role in it.

8.4.3. Spatial effects of parameter changes on accessibility

8.4.3.1. Changes in the active population

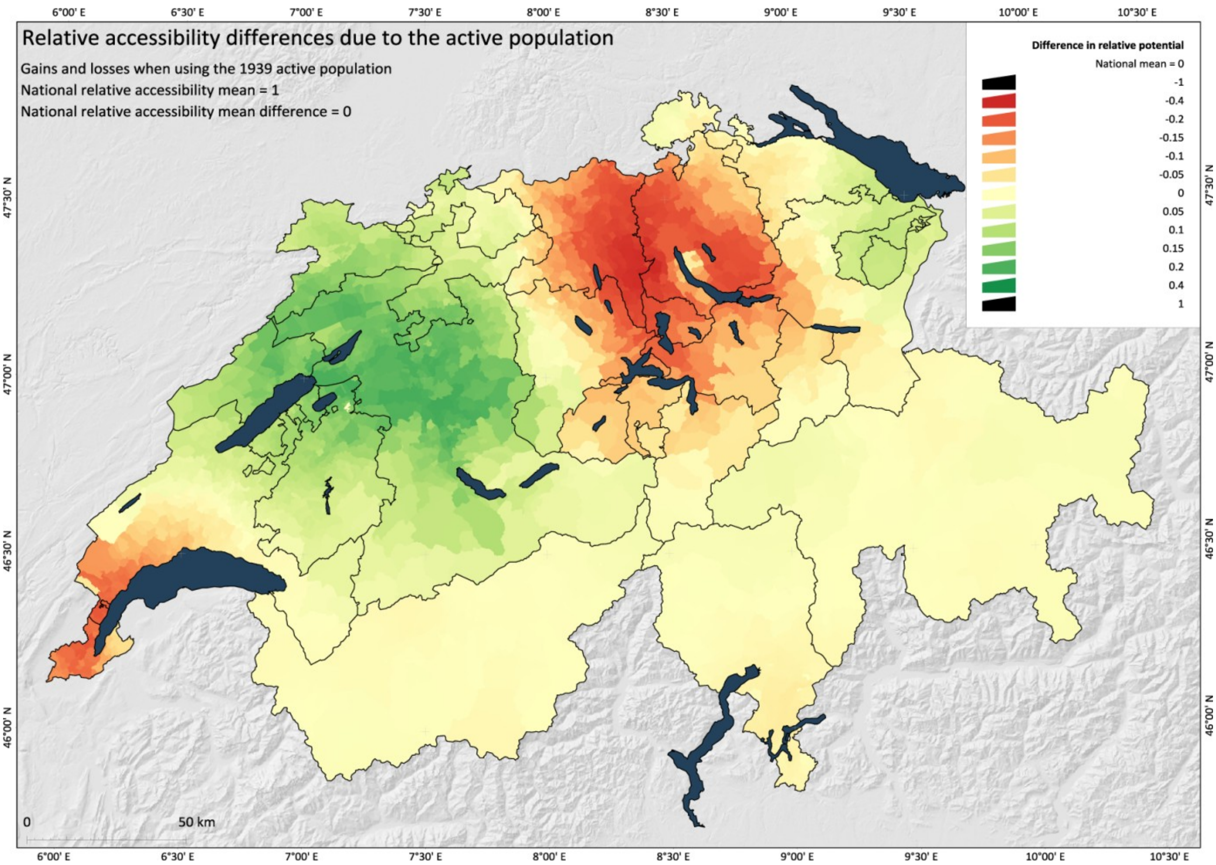


Map 8-6: Accessibility difference due to the active population

As we have seen, variations in active population translate almost linearly to accessibility. Thus, the global changes are explained directly. We will here examine whether those global changes translate equally across space or if those changes entail a spatial component.

All locations suffered a loss of accessibility with the switch of active population (*Map 8-6*). Furthermore, the loss seems globally to be most acute where accessibility was highest. It seems that there is a strong correlation between the accessibility level and the accessibility loss provoked by the active population switch. Thus, there seems to be a general accessibility loss but no major change in the accessibility profile, as if the hierarchies had not moved with the loss of accessibility.

However, looking at the difference between indexed accessibilities, which remove the general size effect, or differences in rankings reveal that hierarchical changes are indeed observed (M*ap 8-7*). Granted, the changes observed are quite subtle and show a very long wavelength, with quite smooth transitions. That being said, replacing the 2008 active population by the 1939 one is detrimental to the metropolitan areas of the Greater Zurich and the Lake Geneva region, while it is beneficial to a "super-Mittelland" region around Berne and of a second region centered around St-Gallen. About the same pattern is seen when looking at the ranking changes induced by the switch, which show strong losses induced in suburban and exurban parts of the greater Zurich metropolitan area, as well as for the whole of the Lake Geneva area.



Map 8-7: Indexed accessibility changes due to active population changes

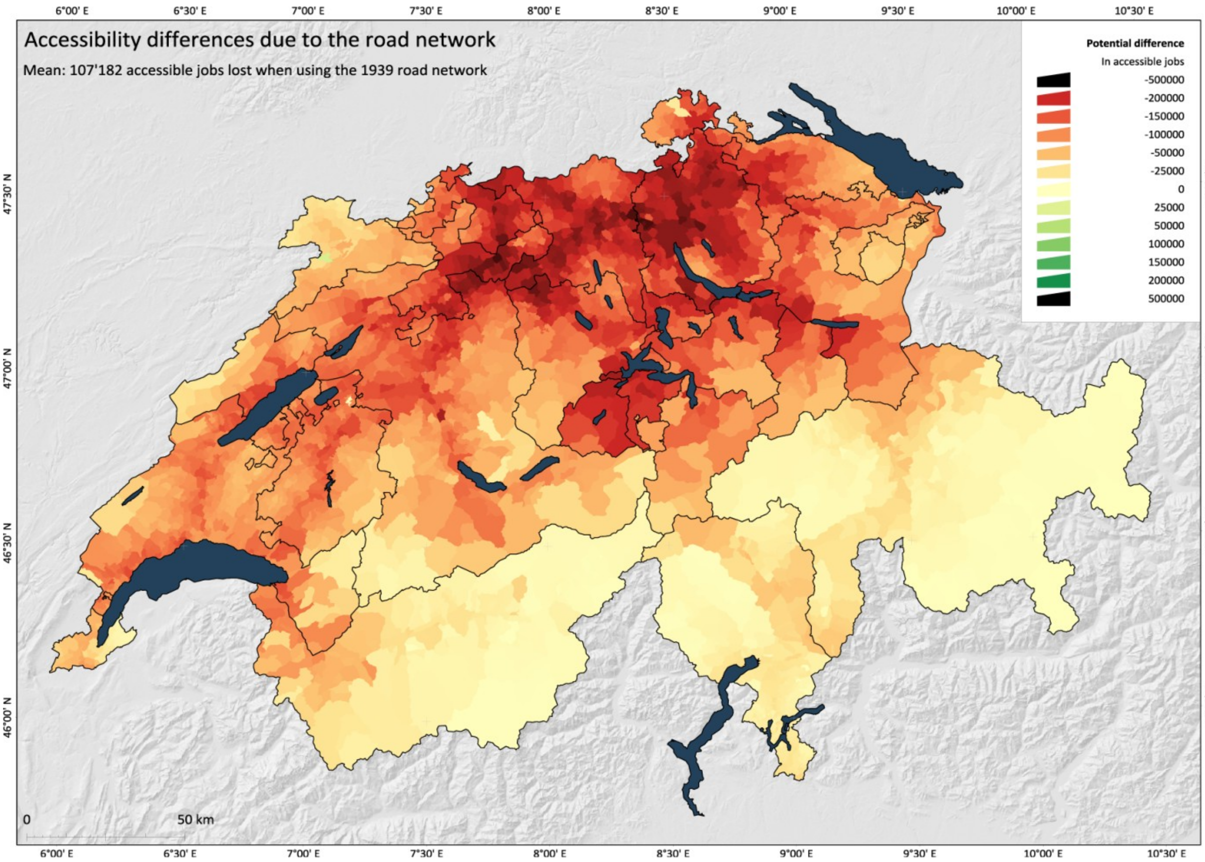
At a more general level, this means also that changes in active population distribution since 1939 have tended to reinforce the metropolitan areas as a whole and especially their outer parts, against the Bernese domain and parts of Eastern Switzerland. As time went by, population redistribution were favoring in particular Central Switzerland, the lower Rhine valley areas, and the Geneva-Lausanne axis.

8.4.3.2. Changes in the road network

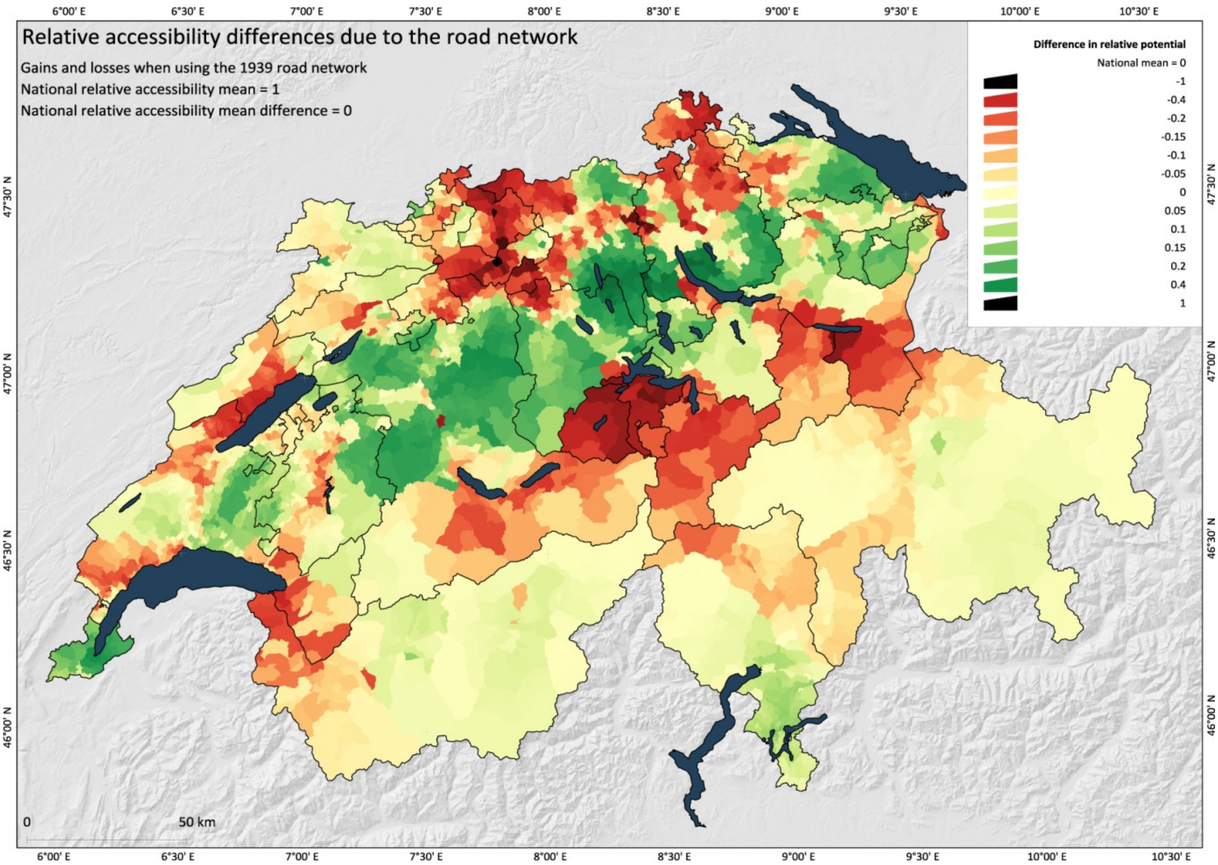
As we have seen, variations in the road network tend to have a massive effect on accessibility, which seems to hint that those changes have probably massive regional variations.

And indeed such changes are seen when we remove all additions made to the network since 1939 (*Map 8-8*). First of all, the variation pattern is way rougher than for active population variations, with big changes happening in several kilometers. Apart from a general loss, the map shows distinct corridors of especially high losses which correspond to the principal highways of the country. Regions of maximal losses encompass the Gäu complex around Olten and the lower Limmattal valley between Zurich and Baden. The triangle A1-A2-A3 is also very much visible on the map, but such effects are readily seen on every highway corridor of the country.

Removing the general size effect by looking at the differences between indexed accessibilities reveal a patchwork geography with very stringent borders and very few transition zones (*Map 8-9*). The inception of the highway network favored some areas and penalized others. Regions concerned were also far smaller that the large scale variations seen when looking at the active population maps: road network changes have major but very localized effects.



Map 8-8: Accessibility difference due to the road network



Map 8-9: Indexed accessibility changes due to road network changes

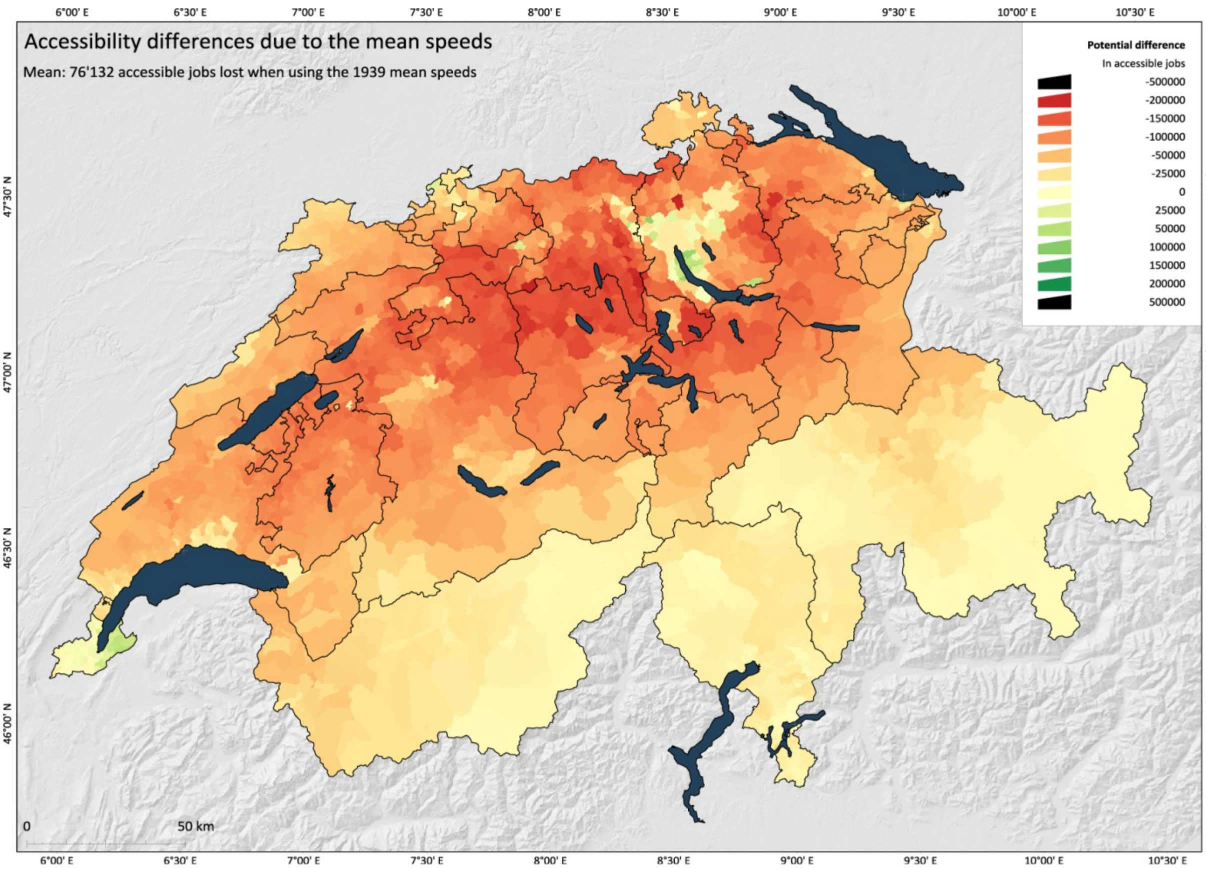
Areas which were dredged up the most by the inception of the highway network are the A2 axis between Basle and the Gäu complex, Unterwalden in general, the Zurich Unterland, Weinland and Schaffhausen, the Walensee axis, the Neuchâtel Littoral region, the A12 axis in Fribourg and the Geneva-Lausanne axis. Conversely, the big losers were the Geneva area, the Seetal-Albis region southwest of Zurich, the right bank of lake Zurich, and at a lesser rate the bernese Mittelland, the Broye Valley, the Upper Töss Valley in Zurich Oberland, and the Lake Constance coast. In all network changes provoke major accessibility changes and significant hierarchical ones. However on the face of it the patchwork geography thus revealed is to be linked to evolutions in job concentrations remain to be seen.

8.4.3.3. Changes in the commercial speeds

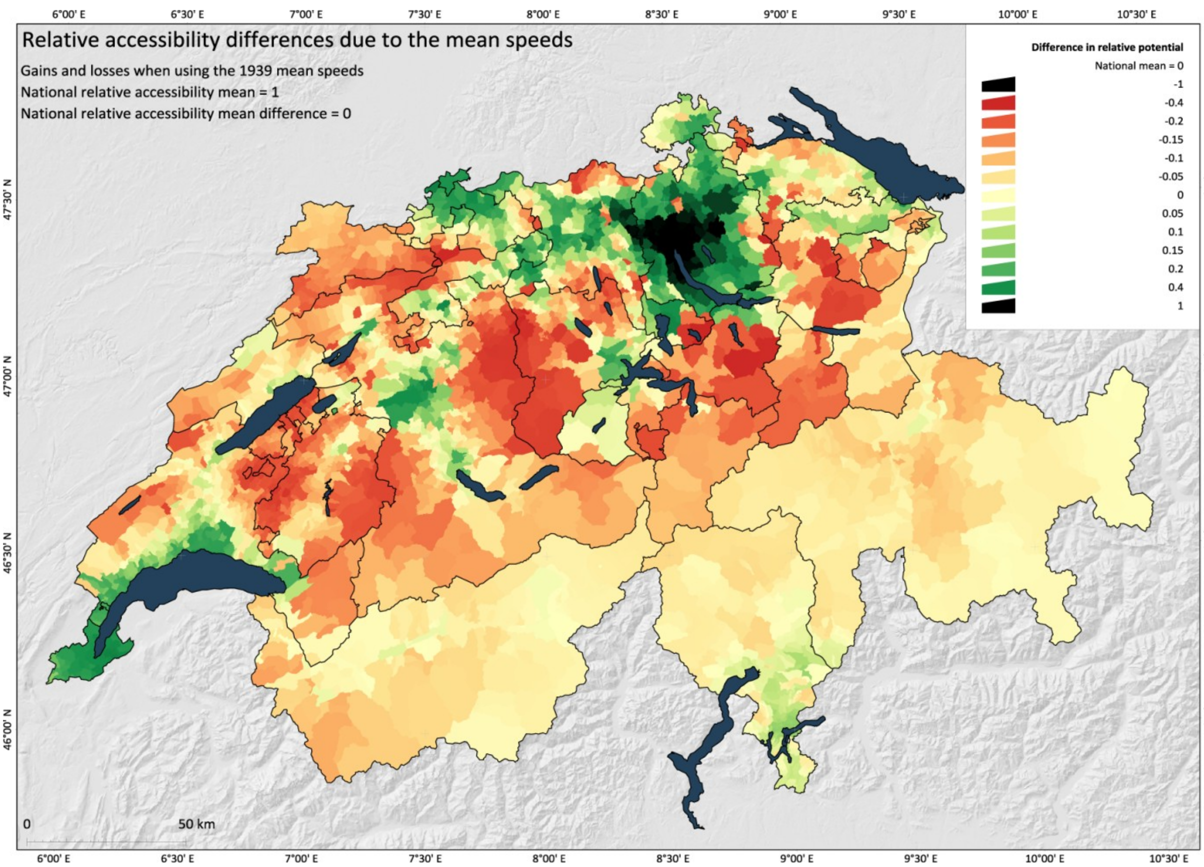
As we have seen, variations in the commercial speeds seem to have a rather low impact on accessibility, which we attributed to the fact that differing variations of speeds on differing road types blurred the picture.

The map of the difference in absolute accessibility is unique amongst the four under review here in that it shows locations actually gaining from the reversion to 1939 mean commercial speeds (*Map 8-10*). Zurich and Geneva, in particular, are places which have lost the most due to the evolution of mean speeds, because their roads saw speed declines since 1939 whereas most everywhere else speeds increased. In fact there is, then, a strong difference between the innermost areas of the metropolitan areas – Geneva and Zurich above all, but also Lausanne, Basle and Bern, and the rest of the country, particularly the suburban and rural areas situated between Berne, Basle and Zurich. But as a first confirmation, speeds variations are globally blurred because there is a strong opposition in its effects on centers and peripheries respectively.

Removing the general size effect by looking at the differences between indexed accessibilities confirms in general the finds made above (*Map 8-11*). Metropolitan areas, in particular the Zurich one, and in general all of them, were hampered, in the long run, by the commercial speed variations. This is only half surprising as those dense areas were naturally the first casualties of urban and traffic congestion, and the map highlights such areas, and opposes them to peripheral regions. As such, it then seems that mean commercial speeds acts as a negative feedback factor, as it somewhat slow the development of the most favored areas of the country. This evolution, if left alone to act, favors systematically the peripheral regions – the Jura Mountains, the Broye Valley, upper Sarine and Sense Valleys, the Napfgebiet, Innerschwyz, the Toggenburg – against the central ones – the Lake Geneva shores, the Bern agglomeration, the Basle area, the Aargau corridor, the whole Zurich agglomeration. Very peripheral areas aren't affected much though, even if their mean speeds were the most affected: in the Alps, are only slightly affected by the speed changes – they are just too far away to really benefit.



Map 8-10: Accessibility difference due to the mean commercial speeds



Map 8-11: Indexed accessibility changes due to commercial mean speeds changes

8.4.3.4. Changes in the maximal travel times

As we have seen, changes in the travel times seem to have a definite impact on accessibility, which amplifies its variations.

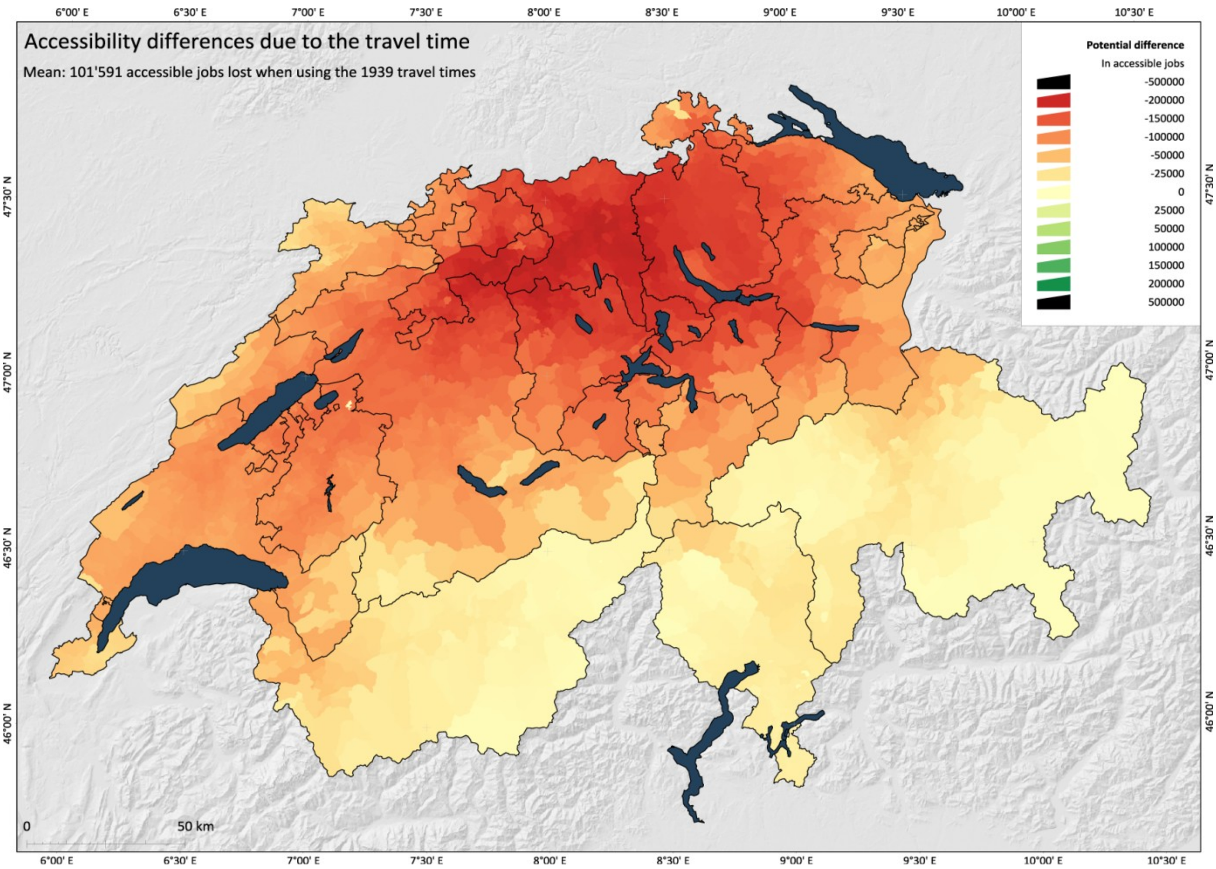
At first sight the accessibility differences have definite similarities with the difference maps according to active population and mean speed switches. Asa for active population the effect seems above all to be one with a large wavelength, with variations being more regional than local (*Map 8-12*). At this scale, the region extending west of Zurich to Basle and Solothurn seem to have benefited the most from the extension of travel times from 1939 to 2008. As for the active population, there seems to be a correlation with the absolute accessibility level in 2008 and the magnitude of the loss incurred by reverting to 1939-1985 travel times.

Removing the general size effect by looking at the differences between indexed accessibilities reveals long range oscillations which are in favor of the outermost parts of metropolitan areas influence zones, and detrimental to the inner regions of said metropolitan areas (*Map 8-13*): the Geneva Lake area as a whole, the Berne, Basle, Lucerne and St-Gallen agglomerations, and of course the larger Zurich area. The areas which are favorably affected by the extension of time travel are all the other lowland areas, organized in big aureoles around the aforementioned metro centers, at about 45 minutes driving time. What is very noticeable is that those aureoles are joining: the very big circle around Zurich confounds, in the west, with those of Basle and Berne, which themselves are merging with the big aureole surrounding Lausanne and Geneva, which seem joined as a single metro area – as are, indeed, Zurich and St-Gallen. The fact is that as described by this indicator variation, the whole of the lower lying areas of Switzerland appear as either in metro areas which are already formed, or in interstitial areas which are very much favored by the new behavior of the population, and which may well soon join them. The Swiss Mittelland, from Geneva to St-Gallen, has no truly peripheral areas anymore. Only the Alps display a true peripheral reaction to the indicator, by keeping approximately the same values, at least in relative terms.

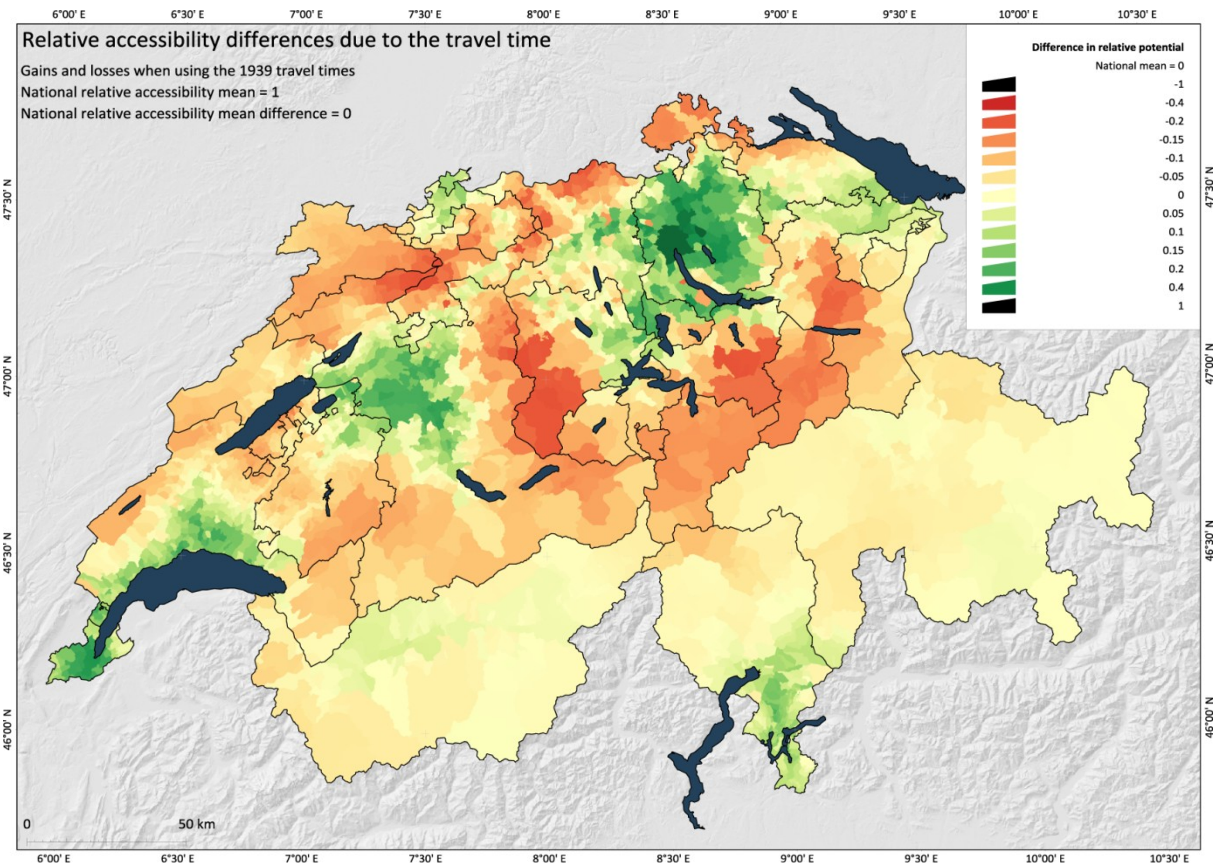
8.4.4. Conclusion: a complex spatial interplay between negative and positive feedbacks

While it is relatively straightforward to assess the interplay the four components of accessibility display at the global level, the spatial variation they display are far harder to encompass. The spatial patterns they display highlight the differing play and effects each of the component variations have on overall accessibility.

Two of the four components – active population and time travel – show some neutrality towards their spatial patterns, that is, they do not change the hierarchy of places much when they vary in absolute values. In those two cases, strong variations in accessibility are correlated with strong accessibility as a whole, and the departures which are measured from this central tendency have a very large bandwidth, to the order of hundreds of kilometers for active population, and tens of kilometers for the mean speeds. However, the variations between those two parameters tend to cancel out – active population variations favored strongly the metropolitan areas as a whole, while travel time variations favor former peripheral regions.



Map 8-12: Accessibility difference due to the commuter travel time



Map 8-13: Indexed accessibility changes due to commuter travel time changes

The two other parameters are quite different – firstly, they do show strong departure from a neutral role even at the global scale, with accessibility dampening strongly the effects of mean speed changes, while decupling the ones of network modifications. At the spatial level, both those parameters variations have a sharply lower bandwidth than before, to the order of the kilometer. The mean speeds tend to separate between metropolitan areas and peripheral ones, with a clear advantage of the peripheral ones – mean speeds tend to have grown more easily in those areas than in more central ones. In that characteristic the spatial patterns of variation of mean speeds joins those shown by variations in travel time: both long-term evolutions tend to favor outlying areas over central ones.

The last parameter, the variations in road network, is probably the most important of them as its effects on accessibility are major when observed at the global level, and because its spatial variations can be severe over very short distances – in short, variations in the road network are likely to have profound effects on accessibility and those effects are far more likely to be felt on very short distances. In short, changing network conditions have probably major spatial effects. As it is, the spatial patterns revealed by the changes in the road network since 1939 show a patchwork geography which, in general, favor certain sections of metropolitan spaces, generally at mid to large distance from metro centers, over certain others, generally the metro centers themselves and sections of their agglomerations which are not served by highways – namely, the rich residential areas.

In all, one can see that metropolitan cores have been on the long run adversely affected by evolutions in the parameters of accessibility, except globally by the evolution of the active population distribution. Conversely, parameters variations since 1939 seem to advantage more and more outlying metropolitan areas. Most inner suburban belts, though not all, are favored by active population and often by network effects; outer suburban belts are systematically favored by evolutions in active population, travel times and often network effects, and exurban spaces are now favored by all four parameters. In all, the 1939-2008 evolution of active population, road network, mean speeds and travel times point to a tendency towards dispersion that gains of accessibility seem to allow.

8.5. A history of accessibility in Switzerland, 1939-2008

8.5.1. Introduction and general remarks

Up until now we have exclusively considered accessibility by automobile. However, the ubiquity of the car is a relatively recent phenomenon, which happened during our period of study (*Chart 8-8*). In 1939, there were less than 66’000 cars registered in Switzerland, which means that only about 3% of the active population could benefit directly from a car. In 1955, there were 280’000 cars on the Swiss roads, about 11% of the active population, and by 1965, 919’000 cars were at the disposal of a third of the active population. By 1975 essentially every active who wanted a car had one, there were about 1’800’000 cars on the roads, which covered about 60% of the active population, more than the actual commuting by car population (all figures from SFSO 2000, 2010).

For our study, this means that out hypothesis which states that only accessibility by car should be considered need to be qualified for periods before 1975 – for 1975 and afterwards we consider that access to cars is essentially guaranteed. For the first three censuses we’re working on, though, such is not really the case, especially for the two first censuses. In both cases we can safely assume that leading professionals would have a far larger access to cars than most workers would have, and that companies would tend to take into account their commuting patterns more than others, but still it wouldn't account for all the difference. For those three censuses, we have to take into account somehow the large population which had no access to a car to commute to a remote workplace. For them, transportation to work was on foot, by bicycle or by public transportation. This effectively removed the rural workforce to commute mostly anywhere – those were basically stuck on the land. For this category of people which commute by alternate means than by car, we created what we called a bicycle matrix, with the mean speed on flat conditions put at 15 km/h, and in mountainous areas at 10 km/h. The resulting matrix was then used in the model, which can accommodate for several matrices to be taken into account to compute a combined accessibility, created by weighting several sets of parameters and matrices which can run in parallel.

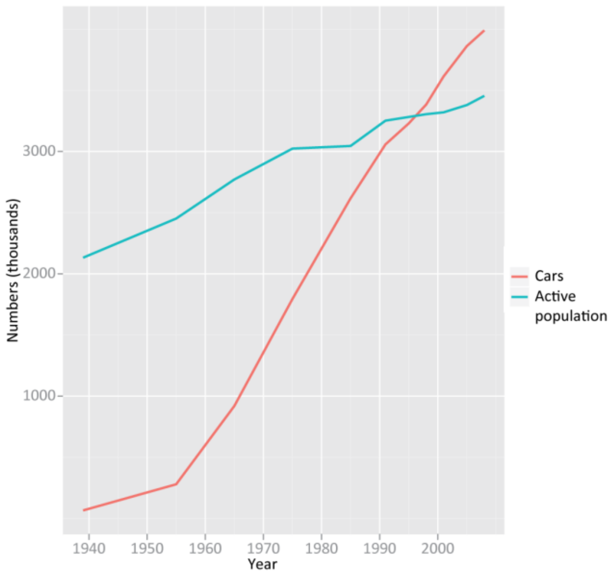


Chart 8-8: Active population and car numbers evolution, 1940-2008

From 1975 on, we only used automobile accessibility, but for preceding years, we mixed automobile accessibility with bike accessibility. For 1939, automobile accessibility was weighted at 10% of the total, and bicycle accessibility was weighted at 90%. For 1955, a 35% auto, 65% bicycle distribution model was used, and for 1965 automobile accessibility was weighted at 75% of the total against 25% for bicycle accessibility. While there is no definite rule as to how we fixed those shares, they correspond at about three times the share car owners represent in the active population, with the assumption that those were more affluent, influent and desirable for companies. To keep comparisons between the models, pure automobile accessibilities were also computed for the three first censuses, up to and including 1965. At the other end of the time span, another set of accessibilities have been computed with constant time travel as to ascertain the influence of travel time inflation since 1985.

8.5.2. Accessibility global evolution, 1939-2008

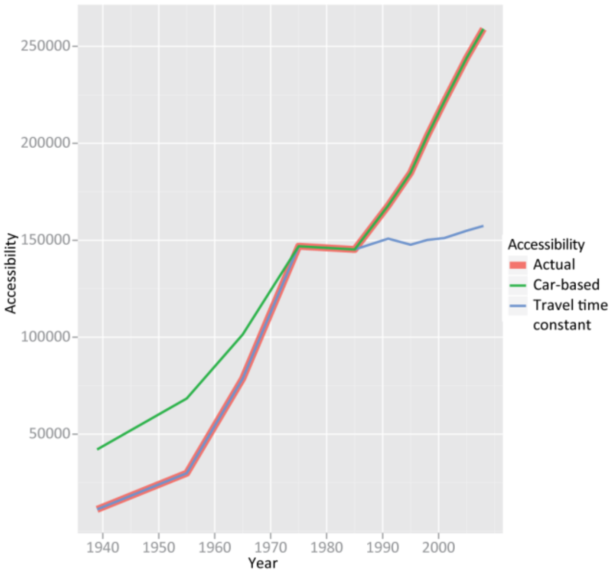


Chart 8-9: Mean accessibility evolution, 1939-2008

The goal of this section is to describe the evolution of accessibility at the national level through time. In short, accessibility showed relentless growth throughout the period under review, and by 2008, the mean communal accessibility in Switzerland was about twenty times what it had been in 1939. This means that by 2008 the average Swiss workplace had access to a workforce pool twenty times bigger than in 1939, which would go a long way towards explaining the diversification of the economy (*Chart 8-9*).

In terms of relative levels most of the changes happened early in our period of study – by 1975, accessibility was close to fifteen times what it had been in 1939, while the second period would see only a 75% rise. Those changes can rather easily be linked to the generalization of the automobile as an adequate means of transportation. By 1975 we consider that essentially everybody who needed a car had one and thus accessibility was computed solely on this basis, while in 1939 we considered that most workers had no access to a car and thus had to revert to other means of transportation to go to work, most of the time walking or cycling to it with a substantial part of public transportation in cities.

However, when we compute accessibility based exclusively on car accessibility for 1939, we find that a very significant raise is still happening. 1939 car accessibility is still 3.5 times lower than 1975 car accessibility, while being about 3.5 times higher than actual 1939 accessibility. This indicates that from 1939 to 1975 accessibility evolved about as much as by getting the car into everybody's hands as by getting better cars rolling on better and more numerous roads.

1975 marked a very clear rupture in the way accessibility evolved. From 1975 to 1985 the relentless progress of actual accessibility was suddenly stopped and the 1985 numbers are actually slightly lower than their 1975 counterparts. This sudden stop can be linked to the fact that while up until 1975 everything concurred to amplify accessibility, by 1985 all those effects had reverted. Up to 1975, the motorization rate was growing between each census, to reach an apex in 1975 from which it could not go further. At the same time, cars had essentially attained their current performance, in terms of power and speed if not in terms of gas consumption. By 1975 the most important highways had been built, although important segments would be added later on, especially bypasses and cross-mountain and cross-country sections. On top of those facts, speed limits were imposed on roads during the early 1980s, which together with traffic congestion had profound effects on mean commercial speeds on some road types, mainly in urban settings and on country roads. For all these reasons it seems that the late 1970s and the early 1980s proved a turning point. This is furthered by the fact that when travel times are taken constant after 1975, accessibility remains essentially stable between 1975 and 2008.

After 1985 though, accessibility resumed its growth. This can easily be linked to the evolving behavior of the active population towards the time it spends commuting. As we have seen, statistical evidence shows a gradual lengthening of the mean time spent commuting. This only fact accounts for the resuming of accessibility growth from 1985 on. It is responsible for the 75% accessibility growth noted between 1985 and 2008.

In short, global accessibility evolution can be described as follows. It is essentially the tale of two periods, separated by a rupture. From 1939 to 1975, generalization of car ownership, automobile technological advances and development of a highway network all concurred to make accessibility explode, which it did, passing from a bit more than 11'000 accessible workers in 1939 to about 147'000 in 1975. But those favorable factors ceased to play a role by 1985, provoking an accessibility growth crisis with a sudden stop. Then, conditions remained globally the same but the active population started to take upon itself and give more time to commuting, which accounted for all the growth measured by 2008, when mean national accessibility was estimated at about 259'000 accessible workers.

8.5.3. Accessibility evolution and general spatial patterns: the rank-size curves, 1939-2008

In this section we will shortly delve upon general characteristics noted in the way accessibility is generally spread, by looking at the allure of the rank-size curves displayed by communal accessibility.

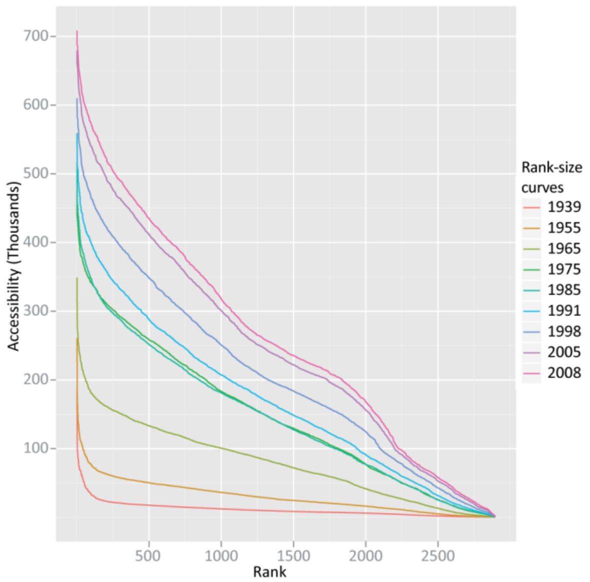


Chart 8-10: Accessibility rank-size curves for selected years

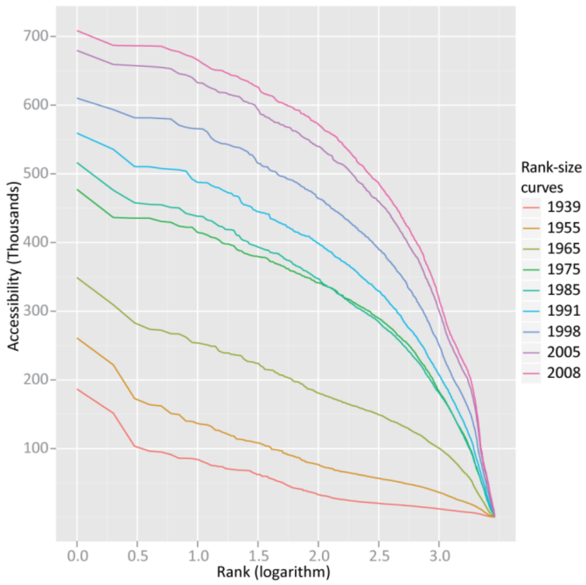


Chart 8-11: Log rank-size curves for selected years

Accessibility growth was above all supported by mid-placed localities, while most accessible places and least accessible ones evolved less (*Chart 8-10*). In general, accessibility progressed through all periods, except the 1975-1985 hiatus where accessibility stayed essentially put. After 1985, a significant bump developed towards the 2'000th rank which wasn't present before and which may be linked to the progressive lengthening of the maximal commuting time and the beneficial effect it has on corresponding peripheral locations.

The corresponding log-linear chart (*Chart 8-11*) clearly shows that in 1939 the rank-size distribution mostly displayed a logarithmic distribution with an overshoot, which by and large reinforces the link with the Christaller theory. This overall form was more or less maintained until 1965, with the reduction of the first ranks bump, and the apparition of an accessibility hole at the tail end of the distribution. By 1975, though, the curve displayed a clear concavity, meaning that it was evolving from a logarithmic relationship to a linear one, meaning that localities in the middle of the curve were gaining in relative accessibility compared to both first and last ranked localities. Accessibility was spreading more evenly as time advanced.

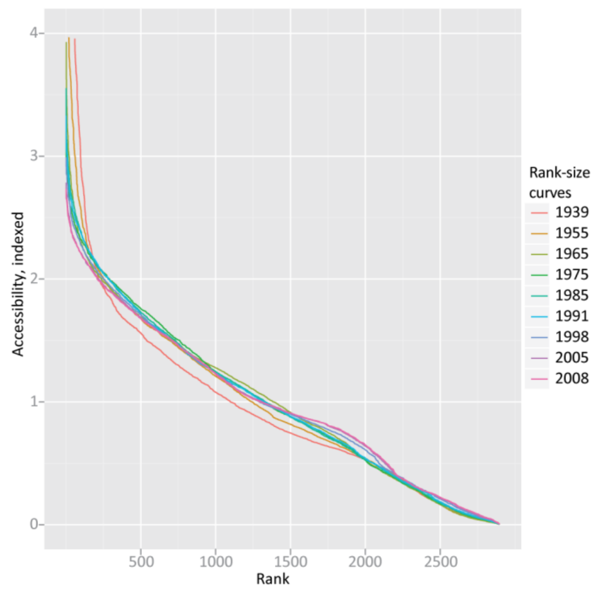


Chart 8-12: Relative accessibility rank-size curves for selected years

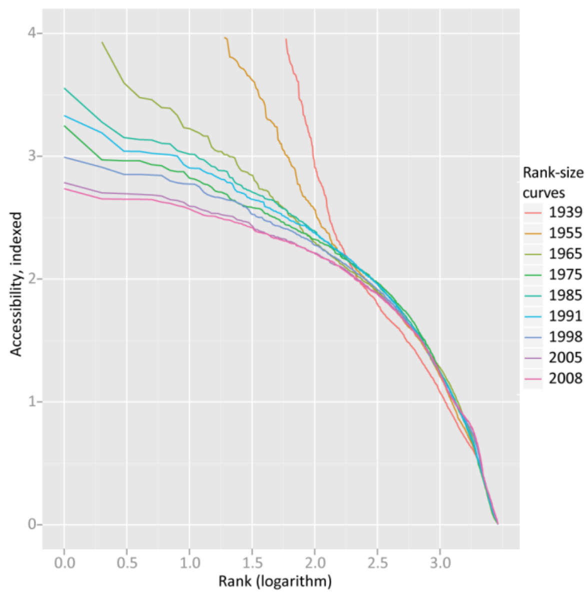


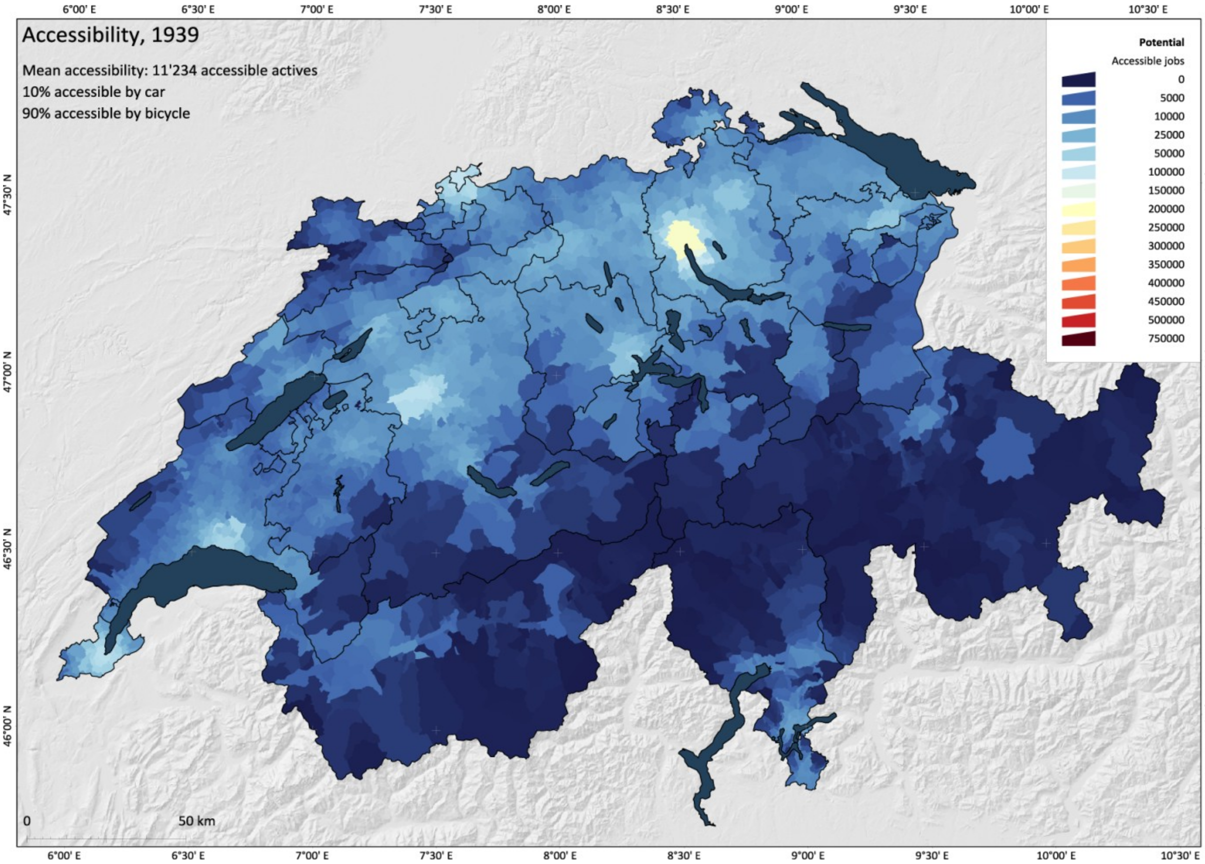
Chart 8-13: Relative log rank-size curves for selected years

In relative terms, the most original of all the curves was the 1939 one, which showed both a very strong accessibility coming from the very best locations, as well as a depressed accessibility from the very first ranks to about the 2000th one (*Charts 8-12 & 8-13*). Thus, the 1939 curve extremely overshoots all other ones at its head, and then significantly undershoots them up until the last thousand communities. Compared to the 1939 curve, all other curves look distinctly more similar and differ only by the gradual and almost continuous loss of importance of the most accessible places as compared to the general distribution, concerning about the 100 to 200 best ranked localities. In contrast, the 2'000 rank bulge developed from 1995 on, which depressed somewhat the head of the curve for latter years. However, those moves were less important than the depression of relative accessibility noted for best ranked localities through time. What it meant, in all, is that in a context of rising accessibility, differences between places gradually faded as local patterns of sharply different accessibilities dissolved into more and more regional ones.

8.5.4. Accessibility and territory: a history

8.5.4.1. 1939: accessibility already threatening Christaller

As we have seen, in 1939 accessibility seemed to display a very strong hierarchy between a few major centers where accessibility was very high and a countryside where it was both very low and undifferentiated. Zurich had the best accessibility of the country with 16.5 times the national mean, Basle ranked 5th, Bern 10th, Geneva 11th and Lausanne 39th. In between them, communes from the already formed, closest suburban belts around the aforementioned centers, such as Zollikon in 2nd place, Binningen in 7th, Carouge in 13th, Ostermundingen in 15th or Pully in 48th. Everywhere, agglomeration centers were first, although very close suburban communes were usually not far behind. As early as 1939 then, urban centers accessibility was dredging suburban communes up. On the other side of the distribution, most alpine communities displayed extremely low accessibilities, especially those situated at the heqad or high on the flanks of long valleys. Greich VS, Hinterrhein and Braggio GR, for instance, showed accessibilities 200 times lower than the national mean – isolation took there its true signification.

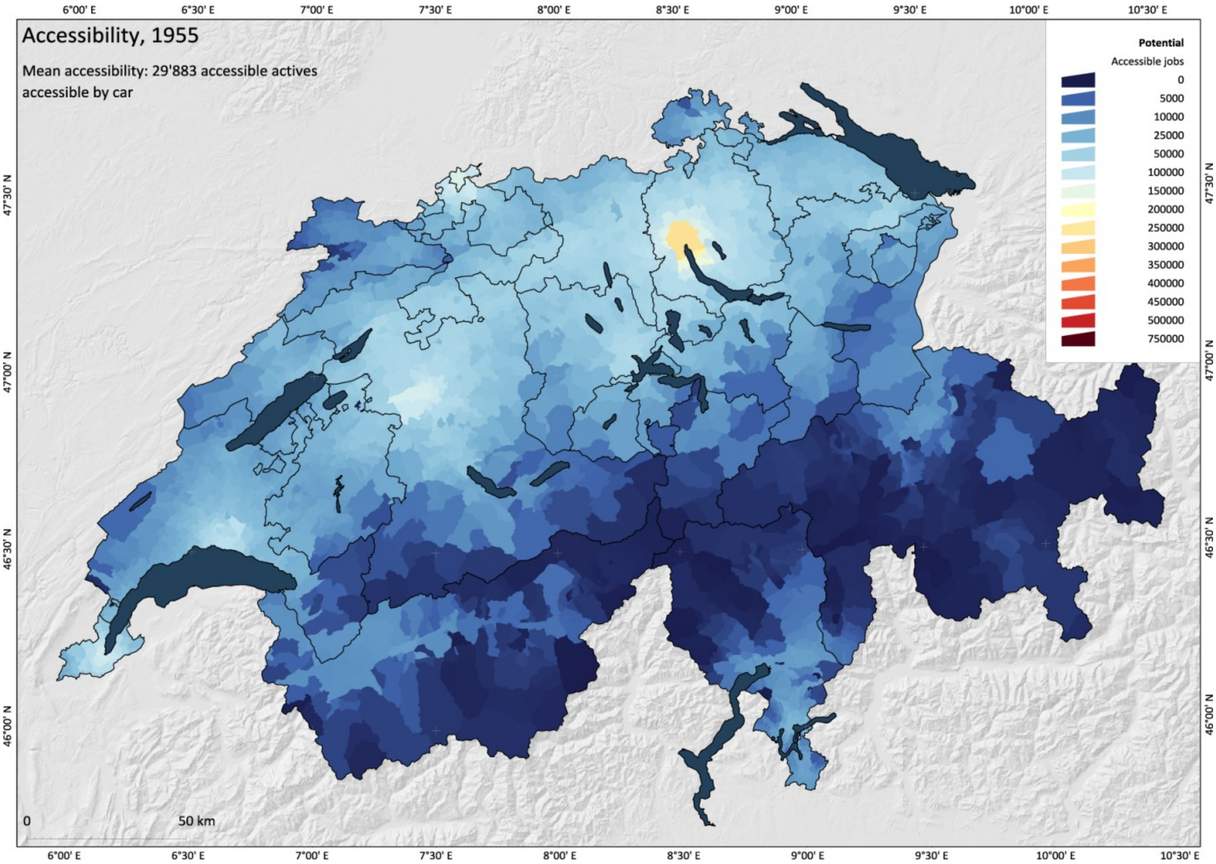


Map 8-14: Accessibility, 1939

The 1939 accessibility maps lets appear a clear urban network in which the five aforementioned centers share the Swiss territory with numerous less important but still accessible centers, which can be grouped in two very distinct categories (*Map 8-14*). First, the regional centers in the true Christallerian sense, islands of accessibility amidst a rural or mountainous sea, like La Chaux-de-Fonds, Neuchâtel, Fribourg, Lucrene, Schaffhausen, St-Gallen, and Lugano, and secondly the centers close to a major one and which seem already part of something bigger. Thus, in Aargau there was already a continuous band of high accessibility locations from which it was rather difficult to isolate bona fide centers like Aarau, Baden, Brugg or Lenzburg. Around Zurich only Winterthur managed to emerge as a clear secondary center while most other district seats were already engulfed in the accessibility ring of Zurich. Between Winterthur and St-Gallen a second corridor was showing up. Around this high accessibility zone, transition stages were evident in the regions of Solothurn, Biel, Berne and Thun, where secondary centers were easier to find but which were already linked between themselves. In short, while 1939 accessibility was still very much centered on urban centers it already displayed clear signs of accessibility regionalization and dilution patterns.

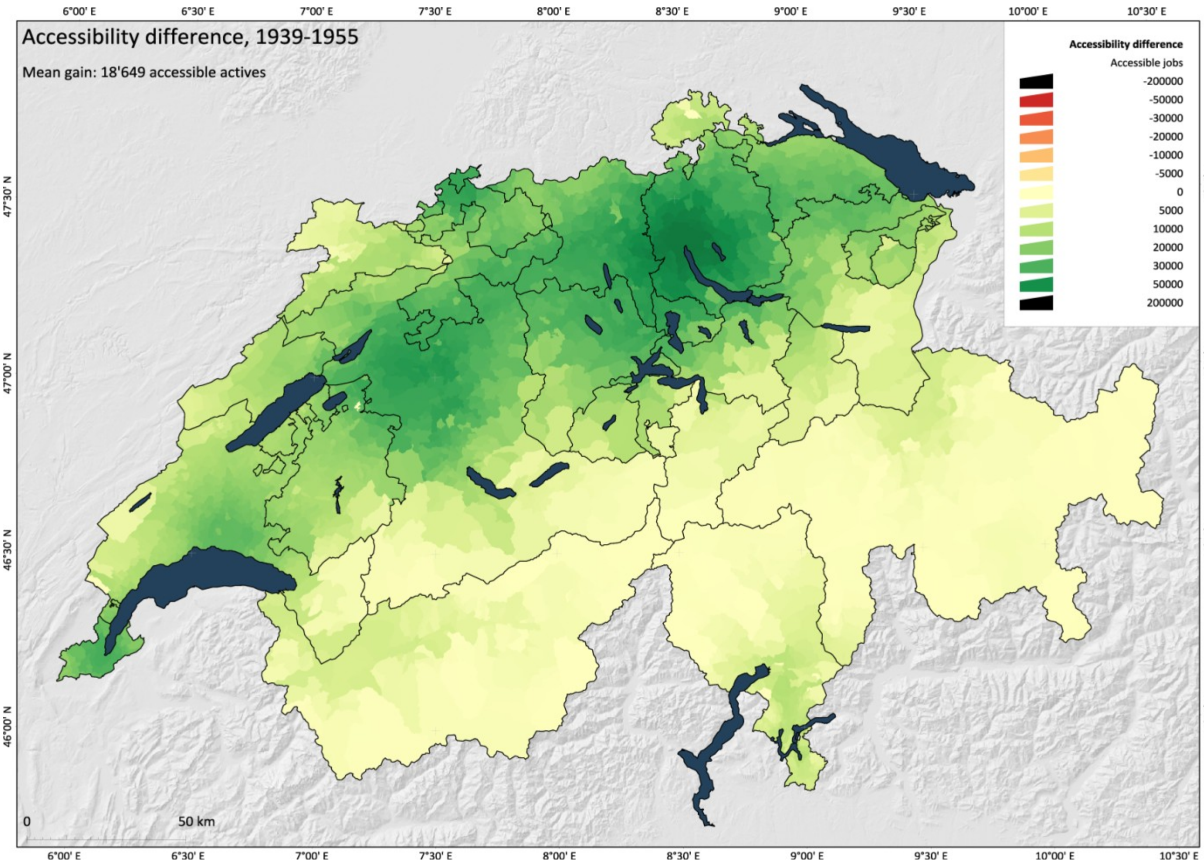
8.5.4.2. 1955: the rise of regional accessibility

The period leading to 1955 was marked by massive developments in accessibility, which nearly trebled in national terms. This massive rise was above all felt by mid-ranked localities and the top urban centers were less dominant than in 1939. Zurich still topped the rankings, but with a reduced 8.7 times the national mean, against more than 15 times in 1939. All other major centers retrograded, Basle to 14th place, Berne to 18th, Geneva to 24th, and Lausanne to 74th. In between came a lot more suburban communes than before, meaning that while urban centers saw their relative accessibility decline, suburban belts saw theirs increase. At the tail end of the distributions were found the same communities than in 1939, with even lower relative accessibilities than before. Thus, 1955 was a time of conflicting evolutions: suburbs grew closer to their centers in accessibility while peripheral areas sunk even deeper.



Map 8-15: Accessibility, 1955

The 1955 accessibility maps show that the definite urban hierarchy seen in 1939 had more or less dissolved except for the big five centers (*Map 8-15*). All five were now engulfed in regions of higher accessibility which were far larger than in 1939 and which had especially profound consequences for suburban communes, where accessibility exploded in the years leading to 1955. Areas of better accessibility were now larger than before and started to differentiate between rural areas, with all rural areas situated within the Berne-Basle-Zurich showing definitely better accessibilities than other rural areas, especially in Western Switzerland. Thus, a continuum of higher accessibility regions formed in the aforementioned triangle, which also extended to the Lake Constance shores. This accessibility patch all but eliminated local accessibility islands which were present in 1939. Thus the Aargau centers disappeared from view – their accessibility was now no better than those of their neighbors. In a less spectacular fashion, this was true of all regions. Outside the high accessibility zone of northern Switzerland, regional centers weren't as legible as in 1939.

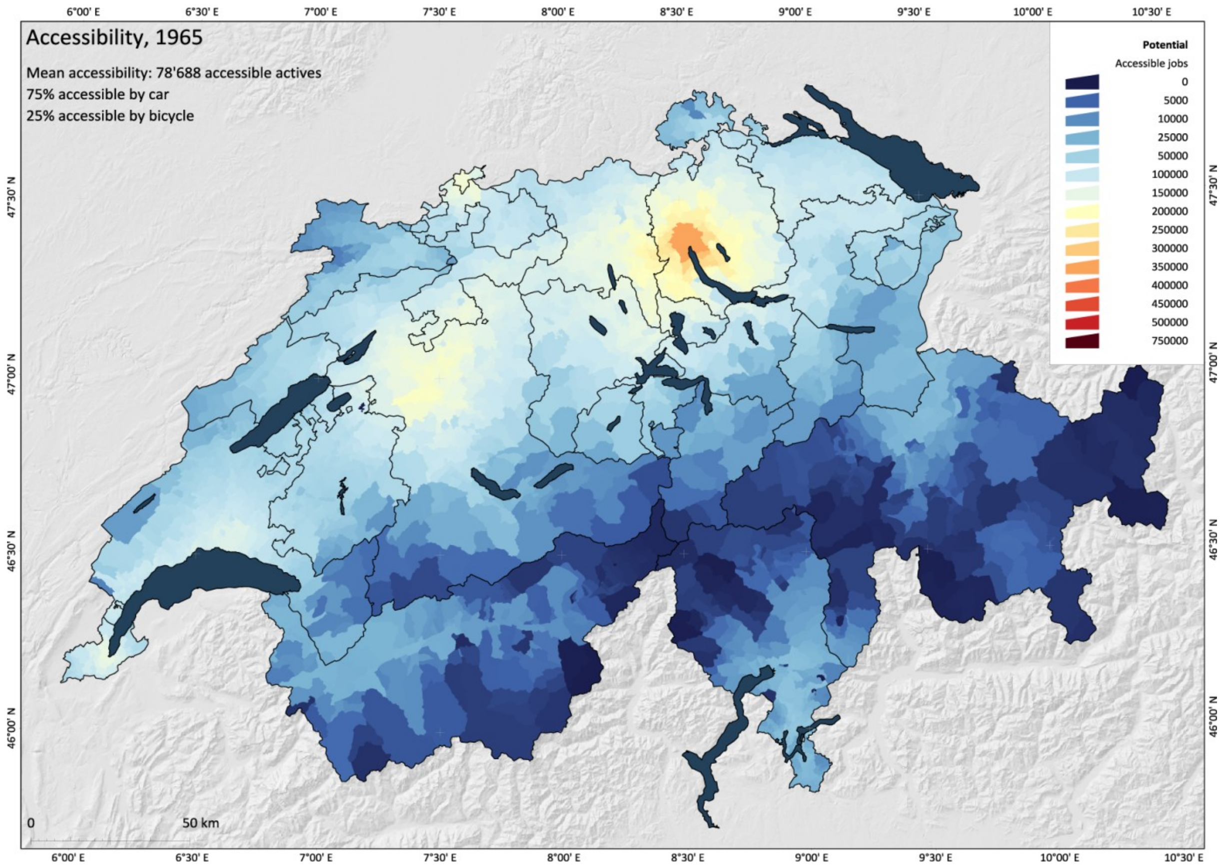


Map 8-16: Accessibility evolution, 1939-1955

The evolution maps confirm the above finds (*Map 8-16*). Accessibility grew about everywhere, but it grew most in select places: the Zurich agglomeration, already engulfing some eastern Aargau regions, and the Berne suburban belts. In relative terms all central urban areas of the country lost heavily and correspondingly to their absolute size, while the suburban and periurban belts gained strongly, especially around Zurich and Berne, in general throughout German-speaking Switzerland. Lastly, in the Alps most areas lost, albeit slightly, in relative accessibility, even if those differential losses could mean progress in rankings – thus a rather patchy map in terms of differential rankings.

8.5.4.3. 1965: the advent of the highway

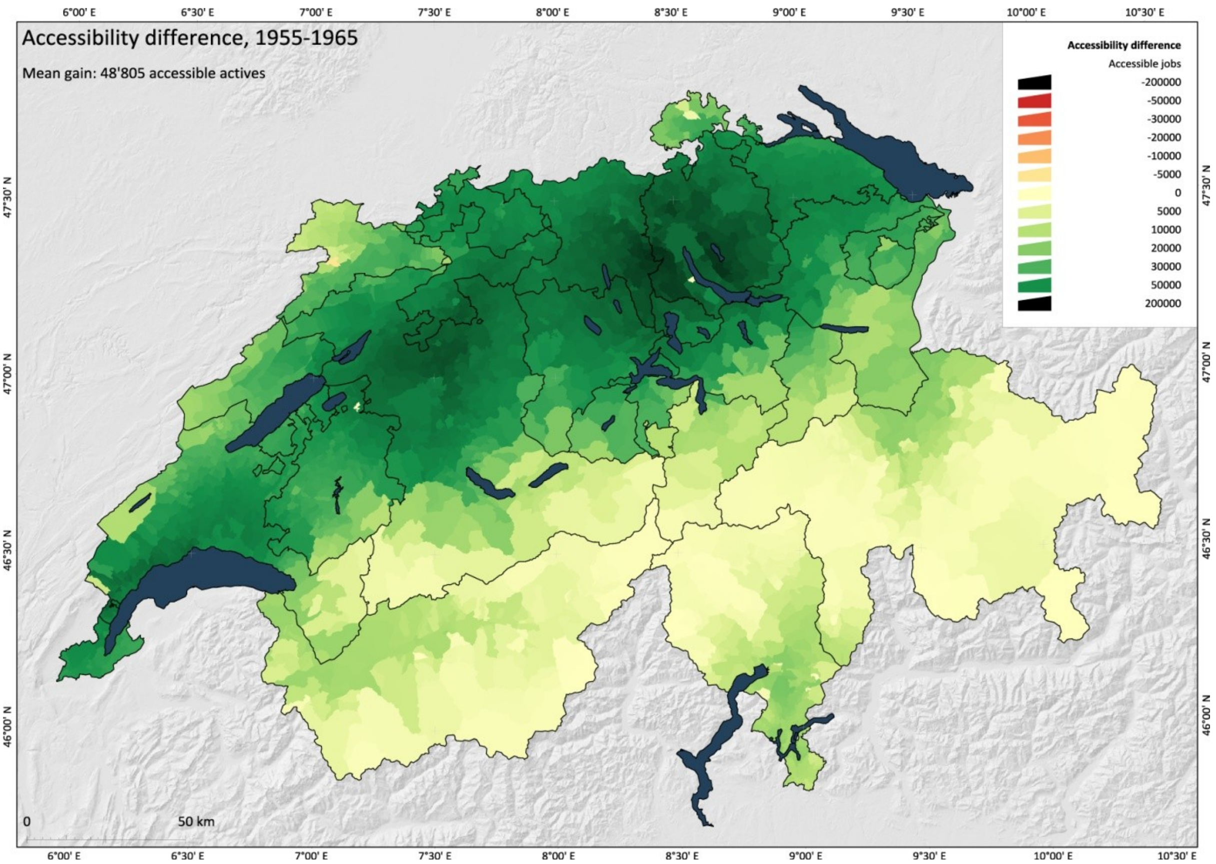
As the preceding one, the period leading to 1965 was marked above all by massive increases in accessibility that can be linked to the generalization of the car throughout society. As a consequence in just ten years, mean national accessibility was multiplied again by 2.5. And again, the general growth was marked by a relative decline in urban centers to the profit of other locality types. Zurich was still ranked first, with accessibility 4.4 times the national mean, again sharply down from the preceding figures. Bern now superseded Basle but only in 78th position, Basle retrograded to 143rd, Geneva to 249th and Lausanne all the way down to 487th. Thus, by 1975, being a major center did not guarantee anymore a prime position in terms of accessibility. Furthermore, and more importantly, by 1975 the 76 most accessible communities of Switzerland were all situated in the Zurich agglomeration, and several district seats engulfed in the agglomeration actually displayed a better accessibility than Berne: Bremgarten AG (37th), Thalwil (40th), Uster (56th), Dietikon (62th), Dielsdorf (65th) and Muri AG (71st), although the best locations in 1965 besides Zurich were still located very close by, like Zollikon, Adliswil, Kilchberg and Dübendorf. In all this was potent testimony that accessibility was becoming more and more regional, and that at this game the entire Zurich region profited. On the other side of the distribution, the former valley heads had been replaced by outpost locations: in 1965, the least accessible community of the country was Zwischbergen VS, on the international Simplon road but isolated on the southern side of the pass, along with the somewhat larger village of Simplon VS – similar localities were Samnaun GR and the communes of Val Müstair and Val Bregaglia GR. Alpine depopulation in the southern side of the Alps meant that many Ticino valley heads were now amongst the least accessible places of Switzerland, like Fusio, Bosco/Gurin and Campo (Vallemaggia). All those locations displayed accessibilities less than one hundredth the national mean. If accessibility was diluting the positions of the most accessible places, this wasn't having any effect on the accessibility of the most peripheral zones of the country.



Map 8-17: Accessibility, 1965

The 1965 accessibility maps confirm that the definite urban hierarchy seen in 1939 had more or less dissolved into larger regional accessibility areas, anchored by their major centers (*Map 8-17*): Zurich still showed up very much as the accessibility center of Switzerland, but with an accessibility area which covered the whole of German-speaking Switzerland's Mittelland, from Fribourg to St-Gallen, with only the Basle area somewhat isolated from the rest. Notable also was the clear strengthening of the Bernese position as compared to Basle – and in fact of all central locations as compared to the peripheral ones. A second, largely less potent high accessibility area appeared along the shores of Lake Geneva. Everywhere else, accessibility was below par, at least in relative terms, as most of those areas still experienced substantial gains in absolute accessibility.

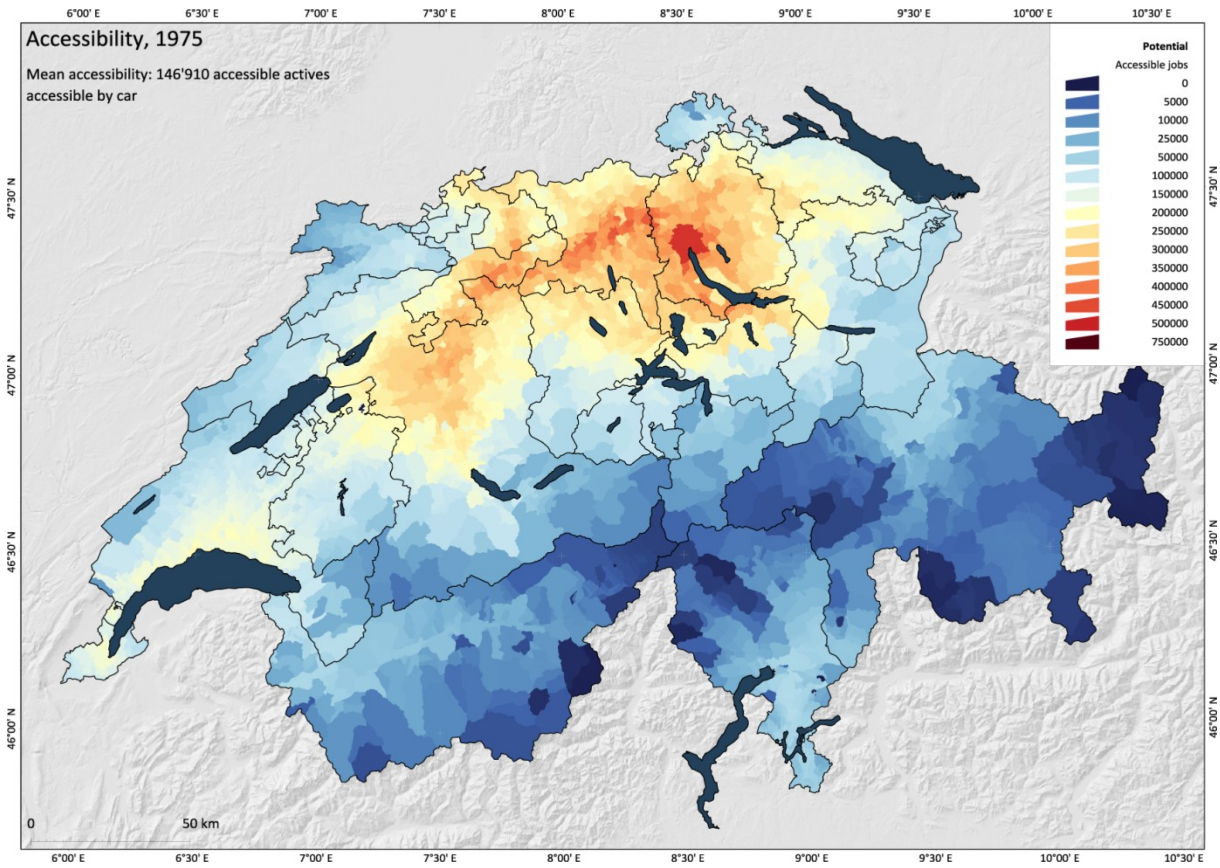
This is confirmed by the evolution maps (*Map 8-18*). At the absolute levels, the whole of the Swiss Mittelland, from Geneva to St-Gallen, gained heavily. Progression was noted in particular in three areas: the Zurich suburbs, which was expected, and two particular areas, the sector situated north of Berne towards Solothurn, and the Geneva-Lausanne axis. Those two regions benefited clearly from the fact that they hosted the first major highway segments of the country, which boosted their accessibility. In relative terms, by far the biggest gains were made in Western Vaud, in rural areas that were suddenly made far more accessible by the opening of the Geneva-Lausanne highway. Elsewhere, the evolution patterns already seen in 1955 were still in action in 1965 with relative losses for centers, which now spilled over on their innermost suburban belts, and their periurban belts. It is to be noted that only substantial centers were still losing in relative importance, as centers of lesser importance had been now thoroughly caught up by their neighbors. In the alpine regions, absolute progresses were rather small, and in relative terms the area was still losing on the Mittelland. In all, accessibility evolution tended to replace a center-periphery pattern at the local scale which was replicated throughout the country to a geography of central and peripheral regions. On top of that strong local effects due to highway and road openings were clearly seen. This prefigures what will be seen in subsequent periods: dissolution of local structures in regional ones and local competition and upheaval due largely to the evolution of the road network.



Map 8-18: Accessibility evolution, 1955-1965

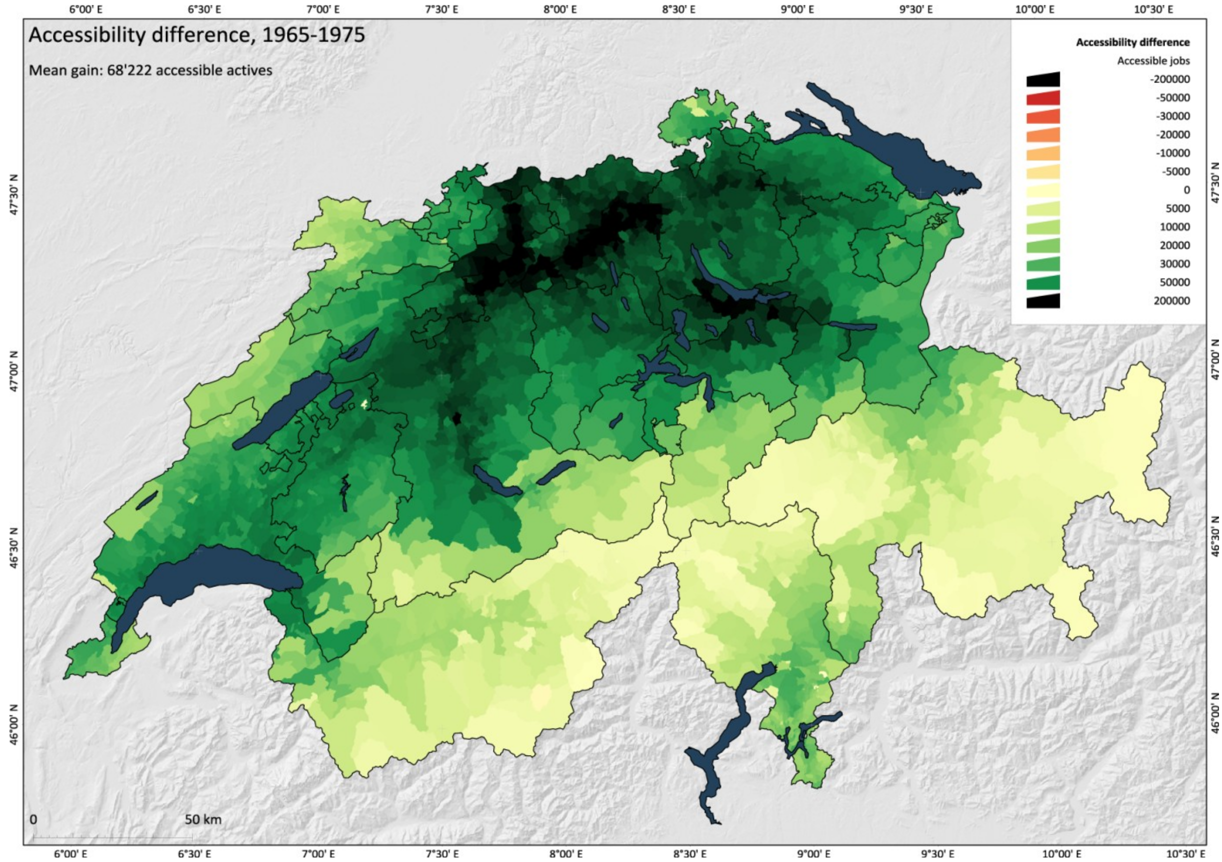
8.5.4.4. 1975: The magnificence of the highway

For the last time, accessibility progressed massively during the decade leading to 1975, with a near doubling of the mean national accessibility, which represented the largest progress ever made in absolute terms. Mean accessibility went up 68’000 accessible workers in one decade against 49’000 during the preceding decade and less than 20’000 between 1939 and 1955. In that sense the period leading to 1975 was the last one showing major upheavals. Zurich stayed in first position, while its relative accessibility continued to decline at now about 3.25 times the national mean, against 4.43 ten years earlier. Likewise, major centers went down massively: Berne to 331st, Basle to 609th, Lausanne to 1051st, Geneva to 1055th. In the two latter cases, fully a third of all Swiss communes had now a better accessibility than them. Down the ladder went also the inner suburban communities, although not as spectacularly than the major centers. They were replaced by a new breed of communes strategically placed along the newly built highway corridors: hence Oetwil an der Limmat ZH (2nd), Brunegg , Mägenwil, Othmarsingen, Würenlos and Fislisbach, all in Aargau, from 3rd to 7th place. Such notable changes weren’t seen at the very bottom of the distribution, with essentially the same valleys and communities ranked last in 1975 than in 1965: Samnaun, Val Müstair, the southern side of the Simplon pass, the heads of the Ticinese valleys, more generally all valleys abutting national borders: Bregaglia, Poschiavo, Lower Engadine.



Map 8-19: Accessibility, 1975

The 1975 accessibility maps show the clear development of accessibility corridors which were pretty much non-existent before (*Map 8-19*). Such corridors extended in particular west of Zurich towards Olten, Solothurn and Berne, as well as linking the greater Olten area to Basle. Such a structure was also visible northeast of Zurich towards Winterthur. The emergence of those corridors pretty much killed off remnants of localized accessibility centers – only Zurich showed up indisputably as an accessibility pole. In relative terms the corridors were less obvious but accessibility seemed more regional than before and did not show any locally centric patterns. In terms of accessibility, 1975 marked the end of an evolution started in 1939 or before, which made accessibility evolve from a Christallerian, central places pattern towards regional concentric ones, centered on major cities, and then towards a linear form of accessibility where most accessible places were arranged along corridors.



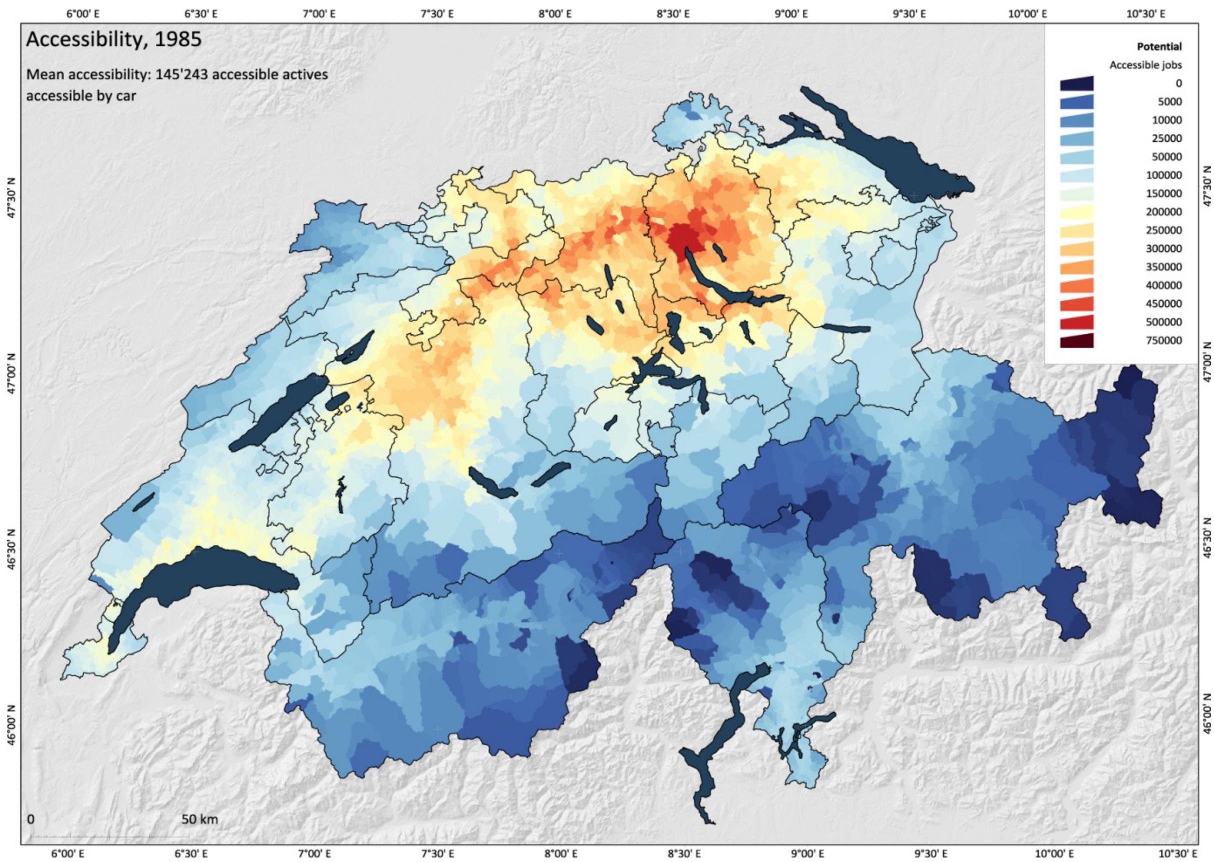
Map 8-20: Accessibility evolution, 1965-1975

This is confirmed by the evolution maps (*Map 8-20*). In absolute terms, places which gained the most were situated along the highway corridors that had opened since 1965, essentially between Berne, Basle and Zurich, and along the left bank of Lake Zurich. Those areas displayed the biggest accessibility gains ever made in Switzerland, underlining the power of the thrust which made them pass, in ten years, from small industrial villages or rural communities to the status of most accessible places. In relative terms gains were made above all in Aargau, Solothurn and Baselbiet, with a second but less powerful winning area situated along the A3 between Zurich and Sargans. Losses – that is, absolute gains but below the national average – were recorded throughout Western Switzerland, especially in centers and their immediate surroundings but also along the Geneva-Lausanne highway corridor, which had lost in the decade its exceptional status as the only Swiss highway. Losses were also spectacular in the southern half or the Zurich agglomeration, the one not served by highways, and more generally in all centers of notable size. The development of the highways, supposedly helping to connect the centers, were above all beneficial to the hinterland regions concerned, as long as they were not too far removed from population and work centers – thus the progresses also noted in Thurgau, Fribourg and Lake

Geneva Riviera areas. In all, the massive changes which marked Switzerland during the 1965-1975 decade, with the laying of the major components of the highway system, provoked massive upheavals in accessibility throughout the country which were best seen in differential rankings, with regions either gaining or losing massively and with sharp transition zones – a patchwork first noted in 1965 and which would be the mark of subsequent evolution, with regions alternatively springing into view or folding back according to the vagaries of highway development patterns.

8.5.4.5. 1985: The paradigm change

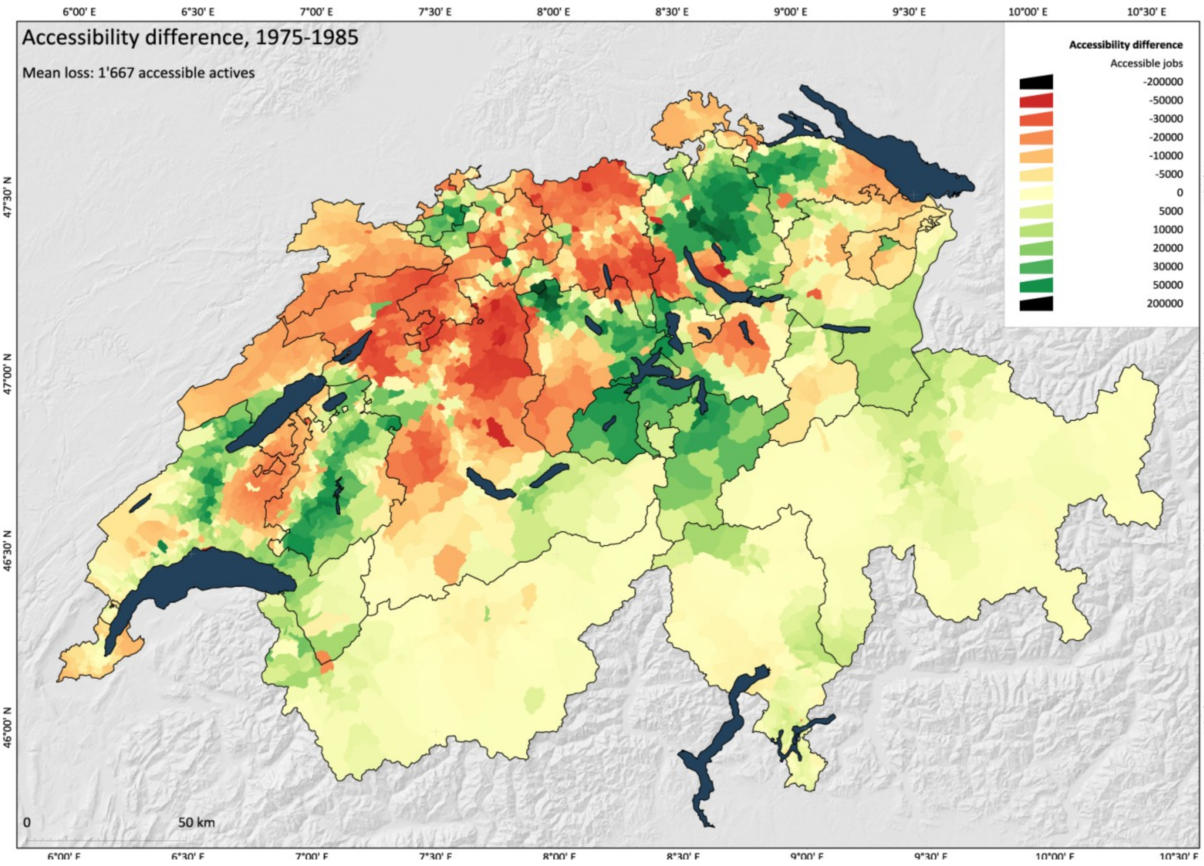
1985 marked a complete change in the way accessibility was developing in the country, as accessibility development was abruptly stopped during the 1975-1985 decade, even declining slightly. This evolution was probably due to several concurring factors, such as the generalization of urban congestion, the fact that major highways were now finished with the highway network now developing above all in peripheral areas, and the varying speed reductions which were imposed at the time in and outside built-up areas, of which we thing the 20 km/h reduction on country roads had the most impact. In parallel, population growth abated during the period under review while technological advances had no effect anymore on the commercial speeds people could expect. In all, accessibility suddenly sputtered. The freeze into place of accessibility, the fact that the accessible range somewhat decreased provoked some return towards hierarchy. Zurich was still in first position, but with an increased relative accessibility of 3.56 times the national mean, up from 3.24 in 1975. Other major centers likewise stayed approximately at the same spot than in 1975, save Bern which progressed significantly. As expected, new highway openings modified the structure at the top, with the Glattal communes gaining massively from



Map 8-21: Accessibility, 1985

the opening of the Zurich northern bypass highway. Those changes did not affect the very least accessible communes of all, which remained the same valley heads and suspended valleys of Valais, Ticino and Graubunden.

The 1985 accessibility maps are quite close, in structure, to the 1975 ones: a great central region of higher accessibility crisscrossed by noticeable corridors of higher accessibility corresponding to highways (*Map 8-21*). Since 1975 some new corridors have been added to the fundamental structure already in place in 1975, most notably the Olten-Lucerne one and a second one between Fribourg and Vevey, both of which correspond to newly opened segments of the highway network. With the addition of more and more such corridors of higher accessibility, the accessibility pattern of Switzerland assumed more and more the form of a net, and less and less that of massive and diffuse regional spots which it had tended to be around 1965. This is especially apparent when considering communal rankings.

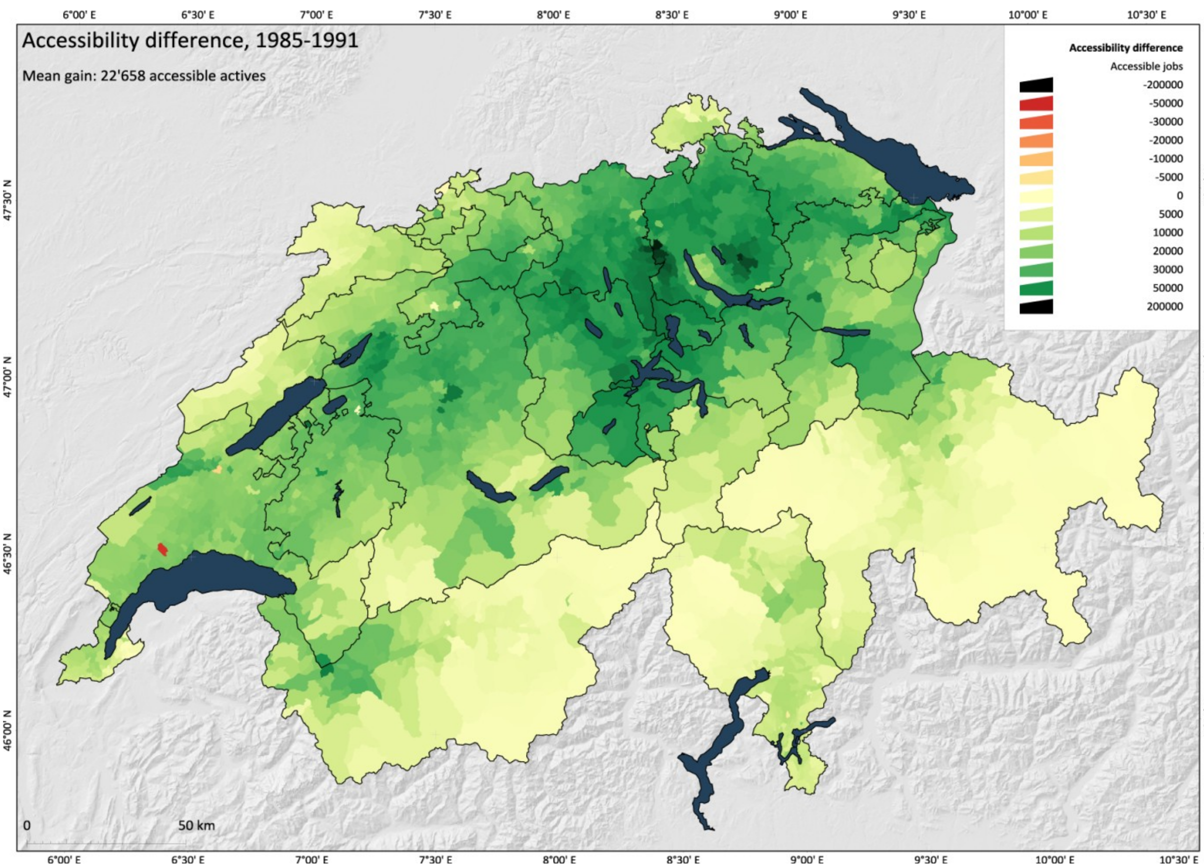


Map 8-22: Accessibility evolution, 1975-1985

This is confirmed by the evolution maps (*Map 8-22*). In absolute terms, places which gained the most were all situated at or around newly opened highways. Several regions thus appeared: The Lausanne-Yverdon-Neuchâtel axis and most of the Canton of Fribourg in Western Switzerland, the Olten-Lucerne and Lucerne-Zug axes. The completion of the Gotthard highway benefited massively the whole of Central Switzerland and especially the cantons directly served, Unterwalden and Uri. Similarly, the opening of the Zurich north bypass and of segments of the Zurich Oberland highway and of the A7 towards Kreuzlingen benefited the whole northern half of the Canton of Zurich and had positive effects up to Kreuzlingen. Also, for the first time the alpine region as a whole seemed to benefit from greater accessibility, at least in some places, such as the Rhone valley downstream from Sion, the Leventina in Ticino and the Mittelbunden region south and southwest from Chur. Those progresses were paid for by the retreat of other regions, mostly already very well deserved regions such as Aargau, Solothurn and northern Berne, and also regions left isolated by the development of the highway network, such as the Broye valley in Western Switzerland, the Goldküste southeast of Zurich, Einsiedeln in Central Switzerland, Appenzell in Eastern Switzerland. Still, an impression of patchwork dominated the map, but it is worthy of note that both in absolute and in relative terms the evolutions, by 1985, had started to tame: they were less impressive than in preceding decades.

8.5.4.6. 1991: Growth by default

1991 marked the opening of the third and last stage in the development of accessibility since 1939 in Switzerland. In short, accessibility growth resumed – here, a healthy 22’000 accessible workers mean gain in six years, but for different causes than highway development and technological advances: this time, it developed mainly because people had started to change their commuting habits, accepting progressively longer times to go to and return from work. In parallel, the trends seen in periods of accessibility growth returned. Zurich was still in 1st place but again its relative accessibility decreased to 3.33 in 1991 from 3.55 in 1985, while the other major centers resumed their downward fall, especially in border areas. Unlike preceding times however, hierarchies moved far less than before – as we had noted for 1985, moves were taming down. Major moves were still linked to highway commissioning, this time especially the partial opening or the western bypass of Zurich and the furthering of the Oberland highway east of Zurich.

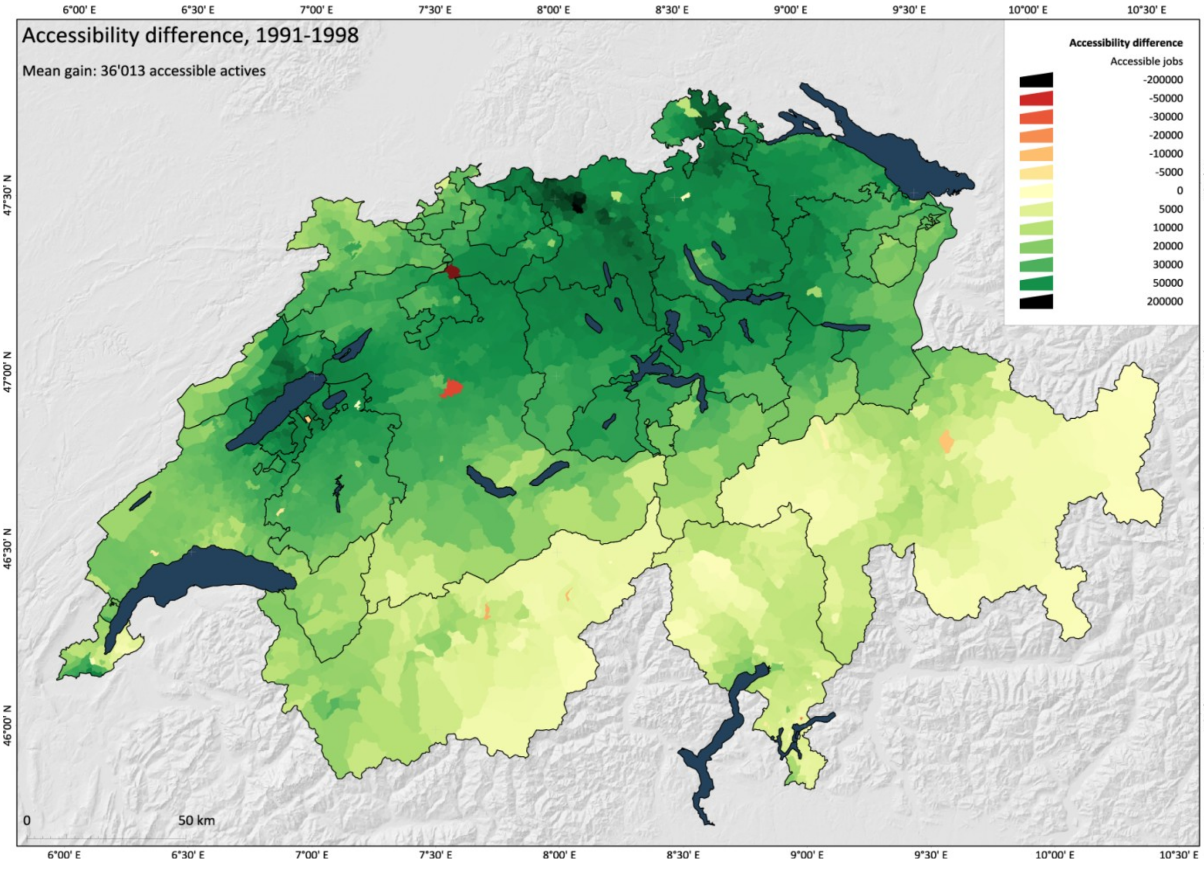


Map 8-23: Accessibility evolution, 1985-1991

As most changes grew more subtle after 1985, accessibility maps for subsequent years look distinctly the same, and moves can only be seen clearly by looking at the evolution maps; from now on we will comment only on those.

The rise in travel time resulted in enhanced accessibility which effects were general (*Map 8-23*): most areas of the country gained in accessibility during this time, and the regionally densest areas of the country – the greater Zurich area – gained most. The two areas we mentioned in the preceding paragraph did indeed show the greatest gains, along with several other small areas which gains can be linked to new highways, from west to east the Orbe-Vallorbe axis in Vaud, the Aarberg-Lyss area and the Kandertal in Berne, the St-Gallen area where the underpass was completed. Moreover, though, other, far larger areas exhibited gains which weren't so much linked with infrastructure novelties but with the fact that the extending time travel would progressively put them up with more and more active residents – thus the strong progression noted in most of Central Switzerland and to a point in interstitial areas between Zurich and St-Gallen. Thus, the evolution which had been dominated by highway openings since 1965 started to give way to a returning form of the regional principle. The net effect started to bear less heavily on the spatial structure of accessibility, which started a return to more regionally concentric forms.

8.5.4.7. 1998: A slow return to regional preeminence



Map 8-24: Accessibility evolution, 1991-1998

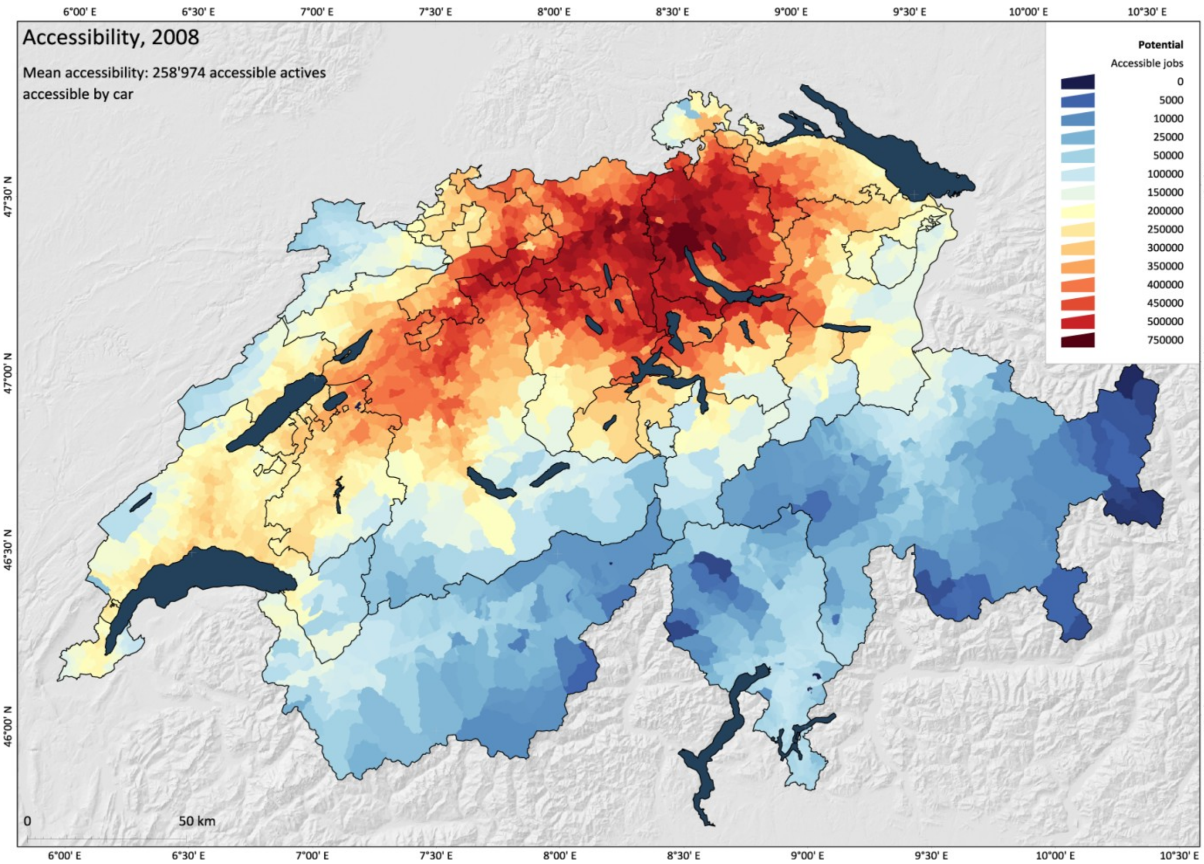
Most of the remarks made for 1991 still applied in 1998: accessibility as a whole gained, in fact relatively strongly at a further 36'000 more accessible workers in seven years, dsepite a strong economic crisis. As for 1991 those gains were solely made through the further lengthening of the commuting time – and since the same reasons produce the same effects, the tendencies seen in

1991 were also seen in 1998. Zurich saw its relative accessibility drop rather strongly from 3.33 times the national mean to 2.99, the general hierarchies were staying more stable than before.

The general rise in accessibility also showed a more and more pronounced regional pattern, always centered on the major metro area of the country, and which spatial variations were rather ample. In that large sea of progress several regions progressed more than the rest, and as usual those were linked to highway openings (*Map 8-24*): the Fricktal in Aargau, the lower Broye Valley, the Val-de-Ruz area, and Schaffhausen. But apart from those rather particular cases, the real news behind accessibility evolution is that it evolves less and less at a local level, as revealed by the relative accessibility variations , which show very little movement since 1991 and except in the small aforementioned areas. It is as if the changes in commuting ranges were just dragging the whole country along without changing much at the relative accessibilities. Correspondingly, the same effects were noted in differential rankings. It is as if a new equilibrium was slowly taking form, perturbed only by less and less frequent, more and more anecdotal highway openings. In that sense, 1998 was already very far away from 1985.

8.5.4.8. 2008: Towards the metropolization of accessibility

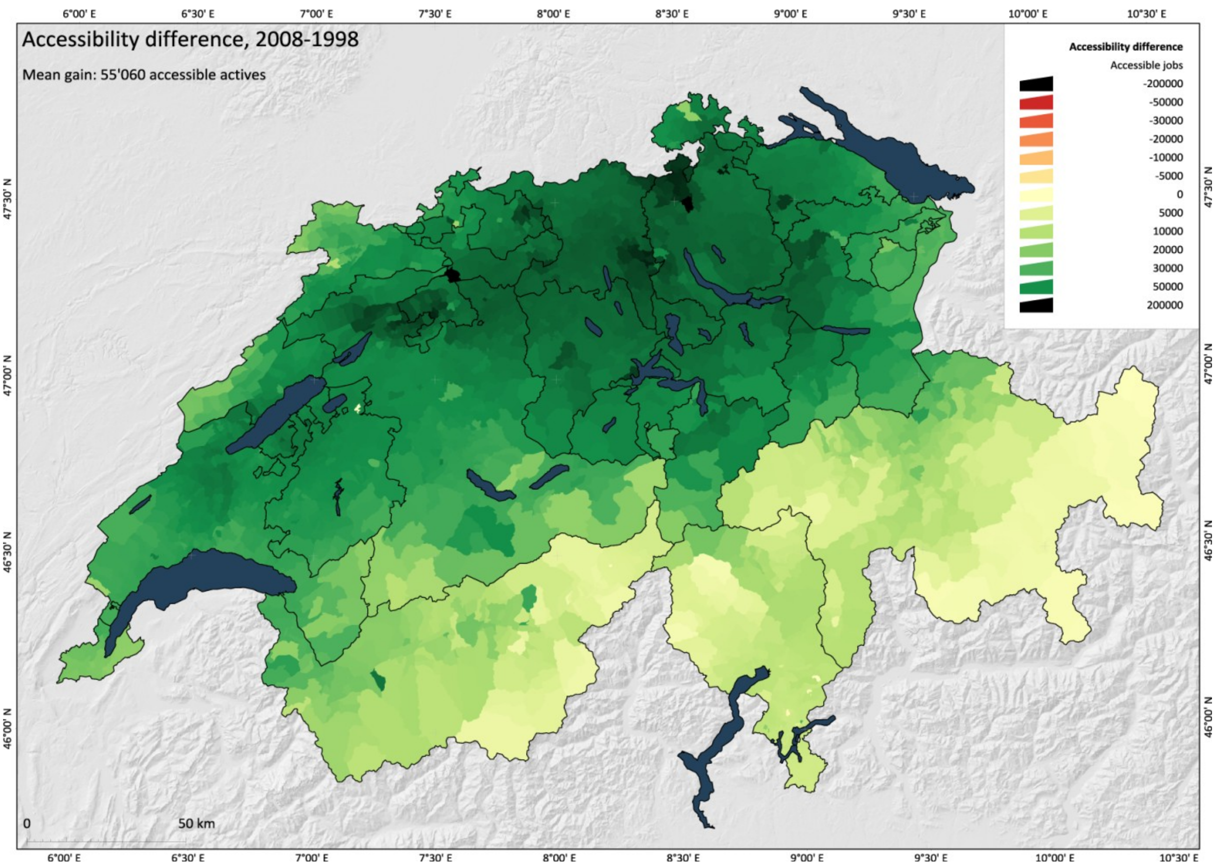
As already said, the evolution after 1985 were more linear than before and changes were less spectacular – however change was still happening, under the form of accessibility growth by enlargement of commuting range. Between 1998 and 2008, the mean accessibility gained a further 55’000 accessible workers, through extension of the commuting range. As expected, the position of the most accessible places declined in relative terms, Zurich still leading with 2.74 times the mean accessibility, against 2.99 seven years earlier. As expected also, there were less



Map 8-25: Accessibility, 2008

and less spectacular accessibility changes. As in 1998, major changes did not happen anymore in accessibility, only very gradual ones (*Map 8-25*).

Absolute gains in accessibility were displaying a very broad and long wavelength with a central region, situated west of Zurich through Aargau which display the most gains, and which is surrounded by broad areas of lesser and lesser accessibility gains (*Map 8-26*). This is concordant with the extension of commuting range, which would benefit above all the denser regions of the country. Superimposed on this pattern were smaller regions concerned with highway openings, for the period under review this concerned mainly the Zurich Unterland, the Biel-Solothurn axis and the southern Bernese Jura, and at a lesser level the Neuchâtel lakeside and the Rapperswil region. For their part, differences in relative accessibility remained very small as compared as what they had been in previous decades, even if in terms of ranking, those small differences had an impact. Seen through this prism, a ring of progressing communes situated about 50 km of Zurich was conspicuous, which expressed the impact of extending commuting times on communities rather far removed from the urban centers: as already said, this extension of commuting ranges allowed more and more communes, further and further away, to integrate regions that in the inside looked less and less differentiated: the typical concentration-dispersion double move of metropolitan space.



Map 8-26: Accessibility evolution, 1998-2008

8.5.4.9. Long-term trends: from a network of cities to a metropolitan net

The evolution of accessibility through time from a geographical point of view showed different but concomitant tendencies. The first is that as a whole, accessibility grew all along during the period under review, at first explosively with it doubling or more with each decade passing, in a more leisurely manner afterwards. The growth of accessibility was provoked in large part by the progressive extension of the commuting range, at first mostly by technological and progresses and better access to cars for all people, then by the extension by commuters of the time they were ready to pass commuting. As this commuting range extended geographically, it also leveled to a very large extent the stark differences in accessibility they had initially displayed. As time went by, accessibility became more regionally-based: differences in regions which were growing larger with time tended to grow smaller. At the same time, differences between regions tended to grow bigger, and in a sense a mesh of high accessibility points – cities – separated by a substrate of low-accessibility rural regions was progressively replaced by a system of high versus low-accessibility regions. This explains, for instance, the progressive down ranking of the other major centers of Switzerland, which regions were systematically taken over by the ever enlarging Zurich area. In the same vein, while high-accessibility regions grew larger and concerned more and more communes, they were letting down entire regions of the country, especially in peripheries. Geneva and Basle, to a point, suffered from this effect - albeit, in latter times, an artificial one as we can't take into account the cross-border workforce for lack of data. True peripheral regions suffered even more, the mountains in particular. Growing accessibility seemed to concern only the lower lying areas of the country, and progressively most of those areas were engulfed in higher accessibility zones. Inside those accessibility zones geography tended to disappear – accessibility-wise, they were growing more and more similar, but differences between high and low accessibility regions grew, at least in absolute terms. The fact is that this evolution allowed most rural communities in low-lying areas of the country to be included in metropolitan or metropolizing space, while most mountain communities remained outside such processes. The period under review marked, from this point of view, a period of stark differentiation between the Mittelland areas and the mountains. Superimposed on this regionalizing pattern which ran throughout the period under review was the emergence of a web of highway corridors which were especially apparent between 1965 and 1985, at a time when spatial differentiation in accessibility were still important at the local level. As time went, those corridors generalized across the whole country, while starting to blend again in their surroundings, as the extension of the commuting range made those especially accessible places less relevant.

8.5.5. Conclusive remarks: the anecdotal evidence of a link between job localization and accessibility

Many of the facts we just described correlate seemingly well with the development of job places. In 1939, the only places displaying some accessibility, and thus some diversity and numbers in their reachable workforce, were the cities. At a time when transportation was slow and difficult, and where, as a rule, most people worked where they lived or nearby, hierarchical relationships between places were very high, as the scores in cities demonstrate. However, the rapid extension of commuting range after 1939 provoked a gradual softening of those major differences, as well as the promotion to high accessibility of many suburban communes and their emergence as job centers was clearly noticed by 1965.

From 1965 to 1985, the regional accessibility pattern which was taking over the old urban-rural dichotomy was strongly perturbed by the advent of the highways and the accessibility corridors they created out of nowhere – coincidentally, this period was showing an explosive job growth in many places which were ideally located on the new highway network. Indeed, the suburban job center structure which is in place today originated during this time.

The third period, that of true metropolization, took place after 1985 in terms of accessibility, and after 1991 in terms of job places development, which was marked by regional accessibility taking more and more importance against local and corridor-like versions of it, at a time also when it grew rather linearly with less and less hierarchical changes between places, which is to be linked to the fact that likewise, the urban network after 1991 did not see major changes or major suburban and exurban emergences the way it had in the 1965-1991 period, but instead gradual, progressive changes in the way places grew or shrank as job places.

All this strongly suggests that there is a link between accessibility and its variation, and job place location and their evolution. Coupled with the fact that highways seem to be the most influential factor on accessibility evolution, this seems to reinforce the link we establish between the advent of highways and the spatial redistribution of jobs through the effects of highway development on accessibility. However, the evidence we point out is purely coincidental – at this point we still haven't demonstrated a statistical link between the two, even if there are many similarities in the way accessibility on one hand, job growth on the other hand, were evolving.

8.6. Management summary

In this chapter, we studied accessibility for its own sake and also because we intend to compare it, as a statistical measure, to other measures we deemed of interest, most notably job density. Here is a summary of the work we covered in this chapter:

A review of the computing of accessibility as a measure of potential population has been conducted, and such an indicator has been built for using in this research. The accessibility measure which was built draws on a corpus of literature which is well established.

According to the definition used in this work, the accessibility of a place is the number of actives which are liable to commute to this location to work. Accessibility is then linked to a place, in this work to a commune. As such, it depends on four distinct factors: the active population distribution, the layout and state of the road network, the commercial speeds available on the road network, and finally the behavior of the active population towards commuting time – that is, the mean maximum time the active population is prepared to spend to commute to work. All four parameters vary independently in the statistical sense from one another through time.

Accessibility is most sensible to developments of the road network, in the sense that small modifications made to the road network have large effects on accessibility. The variation of the three other accessibility components are less pronounced. Of those, variations of commuter times have the most effect, as its linear growth translates to area changes which are squared in comparison – a doubling of commuting time translating to a quadrupling of the area it covers. Variations in speeds should theoretically have the same magnitude but as their evolution through time has been contrasted, variations of commercial speeds have the least effect on accessibility. Lastly, active population variation has a larger effect but its inertia plays down its relative importance in the changes which have been recorded.

The spatial behavior of the four parameters differs. Active population variation through time result in very long wavelength accessibility variations: differences are seen but only at a relatively broader scale, typically at the metropolitan region scale, and thus differentiating between regions rather than inside them. Commuting time changes also have a rather large wavelength, although it tends to discriminate within regions – a longer commuting time favoring outlying areas of a region against its more integrated centers, inner and mid-distance belts. Commercial speeds have the same kind of effects but differentiate above all centers from their surrounding belts and in that their effect on accessibility is predominantly felt on shorter distances than commuting times or active population distribution changes. Lastly, road network modifications display a very strong local component, promoting small regions over the rest, drawing very steep boundaries – its often massive effects are predominantly local.

Accessibility has grown nearly without interruption throughout the period under review, albeit for differing reasons as time went by. At first, population growth, technological advances, road development and the generalization of the automobile all concurred to make accessibility grow explosively until 1975. From 1975 on, the advent of urban congestion, the end of technological progresses in terms of commercial speeds, the slowing of highway development and active population growth meant that accessibility stopped to grow. Growth resumed from 1985 on, but only due to the changing behavior of the active population towards commuting time.

In spatial terms, accessibility evolved from a strong center-periphery pattern in 1939 where accessibility in centers were closer to one another than to their hinterland to a strongly regional pattern where interregional differences were far stronger than intraregional ones. Thus, accessibility evolved from benefiting above all urban centers to benefit urban metropolitan regions and in Switzerland one region above all others, the Zurich greater area. In transiting from one state to the other, Switzerland was marked very profoundly during about a generation by the development of accessibility corridors along its main highways. Although somewhat engulfed by subsequent metropolitan processes at play, these corridors are still in place today.

As such, there are strong anecdotal links between the way accessibility developed and the way job distribution evolved. The three phases seen in job center development were found again, in a slightly different time frame, in accessibility. The emergence of accessibility corridors, and then their relative taming correspond quite well to the massive emergence of edge cities as well as their subsequent calmer development.

The study of accessibility suggests that it may have strong links with job distribution. In the next chapter we will statistically test for the existence of such a link.

9. Showing the link: comparing accessibility and employment

9.1. Introduction and goals

In this chapter we aim to demonstrating or disproving the existence of a statistically measurable link between accessibility as it was defined in the preceding chapter, and a measure of job concentration linked to the job center structures which have been studying thoroughly through five different chapters of this work, and whether there is still more to study than just to establish a significant link. In particular, we will explore how regional and local variations in the interplay between accessibility and job presence could affect the global link and what there is to learn from such studies.

To this end, we will in the second part of this chapter briefly review the discipline field of quantitative geography and then move on towards the specific techniques we will use in this work to assess the links we just mentioned. In the third section we will describe several measures of job quality we could base our comparison on, and assess their intrinsic value, leading to the choice of one measure to test. Then, the core of this chapter is devoted to the actual results of the hypothesis testing and their interpretation for data pertaining for each of the epochs under review, and will try to go deeper into understanding by introducing temporal lags between accessibility and job quality to see if causality relationships can be inferred. A fifth part of the chapter will then be devoted to local and regional aspects of the relationship between accessibility and job quality as a possible explanation for variance unaccounted for by the primary model, while the sixth part of the chapter will attempt to capture the spatial component of the relationship between accessibility and job quality by the means of geographically weighted regression. A last part will conclude the chapter.

9.2. Statistically comparing spatial data: a literature review

9.2.1. The advent of quantitative geography

Our scientific approach is firmly rooted in the paradigms of quantitative geography, defined as "the analysis of numerical spatial data, the development of spatial theory, and the construction and testing of mathematical models of spatial processes" (Fotheringham et al 2000, p. 6). In our study, we are especially concerned with the first of these three assumptions, the analysis of numerical data.

Historically, geography has been for a large part a descriptive discipline which aimed at representing the earth and the populations which inhabited it. It was thus firmly attached to history, which had about the same paradigmatic treats, the description of events in their chronologic dimension. During these times, however, many quantitative methods were already in use. The most ancient method of quantitative geography is probably thematic mapping, which has been in use since the middle of the 19th century and the famous maps of Minard (Robinson 1967) and Snow (Mosenthal & Kirch 1990). Thematic mapping is the method of representing numerical information on a map. As such it lets appear spatial processes very clearly, even if no explicit assessment is made that there is a spatial link underlying the mapped phenomenon. In thematic mapping, the spatial association is suggested by the view, but it is not shown in a statistical way. Nevertheless it remains one of the major tools of the quantitative geographer, if not the tool of the geographer, and we have made abundant use of it throughout this work.

The advent of regional geography as a dominant paradigm around the middle of the 20th century helped to put forward the works of Von Thünen 1842, Weber 1909 and Christaller 1933, as well as of contemporary or later developments, such as the gravitational model of Reilly and Converse (Reilly 1929, 1931, Converse 1949), the exegesis made by Lösch and Isard on Christaller's work (Lösch 1940, Isard 1956, 1960), and works like Huff 1963 or Haggett 1966. Those works were clearly quantitative in Fotheringham's sense as they were strongly in the modeling paradigm and derived their strength from mathematical formalism. In that way, they somehow paved the way for the quantitative revolution, which occurred in human geography when computers started to be available to geographers, in the 1960s and 1970s. The quantitative revolution stemmed directly from regional science and its first major proponent, Brian J. L. Berry, started to investigate multivariate statistical methods in his work about regional systems and the way to correctly devise them - see for instance Berry 1961.

Quantitative geography has been, and to a large extent still is, assimilated to the use of the methods in use at the height of the quantitative revolution, namely correlation and regression analysis and their derived multivariate methods such as factor and principal component analysis, discriminant analyses, and clustering, along with lesser used associated methods, even if the domain has enormously evolved since (Fotheringham et al 2000, p. 3) – for this reason, we feel useful to remind of some problems with what we could call "classical" quantitative geography. Certainly, the "new" methods of factor & principal components analysis, hierarchical clustering and discriminant analysis had been thoroughly used during the 1960s and 1970s and diffused as computers started to become available to geographers – the combination of these methods and of computing power indeed allowed data treatment at a scale which was unmanageable before. For a good review of those first works, see Clark et al 1974.

Factor analysis, which is still widely in use today, is ultimately an extension of bivariate correlation analysis. Factorial designs are based on the correlation or the covariance matrices of all the variables entered in the analysis, which are used to resume information contained in the original data matrix into several relevant dimensions – factors, for each of which new synthetic variables are created. Then, hierarchical cluster or discriminant analysis can be used to create groups of cases based on the new variables (z-scores) created by the factor analysis. Ultimately, everything is based on the correlation or the covariance matrix. Such analysis postulate that variables are normally distributed and that they are independent from one another. However, as Cliff & Ord 1970 demonstrated, the second assumption is almost never true with spatial data, which normally exhibits at least some amount of spatial autocorrelation. Thus, the extensive use of aspatial statistical methods on spatial data elicited very early critical assessments.

Nevertheless, especially in human geography, its use remained dominant in the quantitative field up to this day. This unawareness of quantitative human geographers towards this methodological flaw probably played a role in the critical assessment which was then made by the rest of the discipline – the fact is that a sizeable part of the critics heaped at quantitative geography relates to the use of aspatial techniques on spatial variables (Fotheringham et al 2000, p. 3). At the same time, techniques and theory advanced to tackle this problem. However, this happened at a time of a double divorce: between human geography and quantitative research on one hand, between methodologists and practitioners on the other hand. In that respect, quantitative researchers in human geography became doubly excluded: first from human geography as critics of the methodology took over the field, and secondly from methodologists which were more and more inclined to methodological developments, mathematical formalism and computer programming.

This precluded most researchers with less formal education, in which we can count many first-generation quantitative researchers in human geography, to keep up with the advances made in spatial statistics. As a result, quantitative human geography dropped both from the geographical mainstream and from the theoretical advances.

Meanwhile, in other domains the explicit spatial methodologies which we will describe now took hold, most notably in geology, biology, ecology and genetics. Geology and to a lesser extent geomorphology have made wide use of geostatistics, which is based on explicitly spatial data analysis – in these domains spatial autocorrelation is a given. Studies linked to ecology and genetics dominate clearly the literature about the effects of spatial autocorrelation (Rangel et al 2006), which illustrates that explicit spatial analysis has become a major field of concern there, and shows that explicit spatial analysis had been incorporated in the mainstream of their domains: in biology and ecology, the link between methodologists and field researchers has been maintained. Not coincidentally, the two main statistical packages geared towards explicit spatial statistics have been developed and proposed to the researchers by laboratories active in these domains. The PASSaGE software has been developed by Michael S. Rosenberg, from the Center for Evolutionary Functional Genomics / Biodesign Institute of the School of Life Sciences at Arizona State University (Rosenberg 2010, Rosenberg & Anderson 2011), and the SAM software by a team of researchers active in macroecology in the Department of Biology of the Federal University of Goias, in Brazil (Rangel et al 2010). Thus, this very economical, human and urban geographical study lies in great part unto foundations laid by biologists and ecologists.

9.2.2. The problem of spatial autocorrelation

As we already said, the subject of spatial autocorrelation first arose with Cliff & Ord 1970, in which the authors pointed out the fact that one of the fundamental assumptions of the statistical models in use in geography was violated, that of independence between cases, because cases are spatially autocorrelated. Spatial autocorrelation is the tendency of close units to be more similar than far-away ones. Spatial autocorrelation is a problem with regard to significance levels when comparing two or more spatial datasets using classical, aspatial statistical techniques. Verbally, the idea behind this is that we correlate two spatially autocorrelated variables, most cases will tend to take values that are not too far from those taken by their neighbors, this being true for both variables under investigation. For this reason, a part of the correlation measured between the two variables will only express the fact that the variations across space are gradual.

In order to evaluate and study spatial autocorrelation, specific statistical measures were needed. Those most used today are Moran's I and Geary's c, both of which were developed first in Moran 1948, 1950 and Geary 1954. In both cases, the original authors were dealing with the interpretation of statistical maps. Both works were rediscovered by Cliff & Ord 1970 in a more systematic review of spatial autocorrelation and its measure, in which several other measures were proposed to tackle the autocorrelation problem. Very briefly, both measures compare the variance around a given point to the global variance of the population under review, repeat the comparison locally for each point and integrate the results globally. If the mean local variance is significantly smaller than the global variance the population under review is said to be spatially positively autocorrelated: local values tend to take values more similar than farther ones, which is the most frequent case. If the local variances take larger values than the general variance then the spatial distribution is said to be negatively autocorrelated: locations tend to take values dissimilar from those of their neighbors, like different cultures in adjacent fields.

While existing, negative spatial autocorrelation is far less encountered than positive spatial autocorrelation in the field. Ultimately, the science of geography is based on the fact that space has a role to play, and that locations are not equal. One of the ways space differentiates in cities, centers, hinterlands, central and peripheral regions is the fact that moving about space has a cost, and that this cost is somewhat proportional to the distance to be covered. Thus, it is easier to communicate and exchange with close locations than with far-away ones. Consequently, there is a natural, innate tendency to be closer with close neighbors than with distant communities. In other words, spatial autocorrelation is consubstantial of geography. This very fact has been widely used in the sub domain of spatial analysis called geostatistics, with such techniques as spatial interpolation and kriging – for a summary of techniques, see for instance and besides many others Cressie 1993, Haining 2003, Kanevsky & Maignan 2004 and Lloyd 2010. Spatial interpolation is essentially a way to infer the value of a parameter in a place for which no data is available by studying the known values this parameter takes at neighboring places. Thus, for all domains where data varies continuously through space, such as climatology, most of geology, biology, ecology, spatial autocorrelation is, in the words of Legendre 1993, more a paradigm than a problem.

Moran's I and Geary's c are available in different software packages, such as PASSaGE and SAM. Those software packages have been used to assess whether out data exhibit spatial autocorrelation.

9.2.3. Comparing distance matrices: the Mantel tests

For applications where spatial autocorrelation is not a given – i.e. where the goal isn't to interpolate, spatial autocorrelation is a problem. That, as we already said, was pointed out in Cliff & Ord 1970. A way to counter spatial autocorrelation when comparing spatial datasets is to compare not the data directly, but to compare the differences between data points for each variable with the distances between the points – in essence it means comparing distance matrices, one of which contains geographical distances and the other ones containing the differences between values for a give variable in the dataset. This is the idea behind the Mantel test, which was proposed by Mantel 1967, and developed in Smouse et al 1986, which expanded the initial method to allow multiple and partial Mantel testing. In principle, the Mantel test is a regression analysis of distance datasets; as such it compares exclusively different distance data. The chief interest of such a method is that it allows explicitly taking into account the geographical distances into the modeling. The partial Mantel test procedure developed by Smouse et al 1986 allows for the explicit determination of the spatial effect, which is one of several possible variables entered by analogy with a multiple regression procedure, which yields partial correlation measures. Thus, space is then entered as one of several independent variables and its effects can then be extracted by the procedure, which then can be used to assess the relationship between other variables with the spatial component removed. In principle, this is a very interesting method.

However, the Mantel tests family suffers from several drawbacks. The first is that there is no definite theoretical test of significance which could be used in analogy with the Student t. The classical t-test can't be used as we work on distance matrices, thus artificially inflating the case numbers to the square of the actual sample size. Thus, significance can only be assessed by permutation techniques, which are very computer-intensive. This is to be seen in context with the fact that the datasets themselves are massive as they are composed not by the data matrix but by the distances between each case of the data matrix, for each variable. Thus, the data requirements are stringent and the permutation techniques very heavy to put into practice – in fact only recently have the partial mantel tests been integrated in software for desktop computers, in this case in the beta version of PASSaGE 2 (Rosenberg 2010; the full version was released in early 2011: Rosenberg & Anderson 2011). The second difficulty is that the method relies on distance matrices only, and not on the fundamental data which those distances are based on. Thus, the results are somewhat more difficult to interpret; ultimately, it was found to be powerful only when distances were to be compared as such and less than as a proxy for original data (Legendre 2010). Lastly, there have been doubts as to the reliability of the results given by the mantel procedure, which can be seen in particular conditions as wrongly concluding to significant relations where there are none, and to be less effective at finding true relationships. Critics have been notably made in Legendre & Legendre 1998, Legendre 2000, Dutilleul et al 2000 and were confirmed in Manly 2007 and 2009. For all these reasons, the Mantel tests will not be used in our analysis beyond the exploratory processes.

9.2.4. The comparison of spatial datasets: the CRH modified t-test for correlation significance

Another way to counter the autocorrelation problem has been offered by Clifford et al 1989. In that seminal publication, the authors established notably that spatial autocorrelation problem degraded the significance of any aspatial correlation test if both datasets were spatially autocorrelated. However, for this to be true both spatial datasets need to be autocorrelated – if one of the datasets exhibit no spatial autocorrelation, then the aspatial association measures holds their significance. In the same article, the authors propose a way to statistically assess the significance of a classical statistical association measure when taking into account the presence of spatial autocorrelation in both datasets. This method, often dubbed "CRH method" for the initials of the article's authors (Clifford, Richardson and Hémon), is a modification of the classical Student t-test which seeks to evaluate the effective size of the sample, that is an estimation of the number of remaining data locations once autocorrelation taken into account. This, of course, put a more stringent criterion on classical correlation analysis as the effective sample size is far smaller than the actual sample size if the sample is affected by spatial autocorrelation. In practice, the methodology only affects the sample size, but not the correlation coefficient. Its interpretation is then straightforward and only the t-test is modified, but in a very intuitive manner. Dutilleul et al 1993 propose a more precise way to determinate the effective sample size, although this refined method is largely more computer-intensive. Dutilleul et al 2000 pointed out that the CRH method was far more stable in its assessment and that it looked more reliable than the Mantel test to assess the significance of a relationship between two processes which are spatially autocorrelated, and the method has been proved to be very reliable by Legendre et al 2002. The CRH modified t-test method has been integrated in the PASSaGE software and the SAM Package, and has been thoroughly used in this study.

9.2.5. Beyond the CRH method: geographically weighted regression (GWR)

Up to this point, we were only concerned with the eventual statistical significance of the relationships we want to test. However, at this stage, the results of the Mantel test are truly global and offer no hint as to how the relationship affects space, while the CRH method doesn't modify the results of the ordinary least-square (OLS) regression on which it is based, only their significance. Of course, those results can be spatially mapped, especially the predicted value and its residues, and those have much to offer in terms of detection of regional or local trends in their distribution. However, those possibilities remain largely empirical and qualitative. There is the need for a more systematical approach of the part of the variance which could be explained by local and regional variations.

Geographically Weighted Regression (GWR) is a methodology which accounts for spatial non-stationarity. It has been mostly developed by A. Stewart Fotheringham and his team, and its principles and uses have been published in Brunsdon et al 1998, Fotheringham et al 1998, 2000 and 2002. In essence the ides between GWR is to make the parameters of an ordinary OLS regression vary according to location and taking predominantly into account the cases around this location. The general idea behind is that the any relation between two spatial variables is likely to vary, a bit or a lot, across the territory. Thus, GWR, by allowing the parameters to vary according to local circumstances, is likely to enhance the quality of representation given by the model over a global OLS one, as well as allow explicit regional variations in parameters. It is, of course, computationally very heavy, as parameters are estimated for each data point, and it has specific data needs such as a distance matrix to be able to take into account proximities. Nevertheless, the procedure is now gaining hold and used in more and more studies, even though many of those are still in the form of white papers or unpublished articles - see, for instance and in peer-reviewed papers, Fotheringham et al 2001, Huang & Leung 2002, Yu 2006, Lloyd 2007. The GWR procedure is available in an ad-hoc application proposed by Fotheringham and its team (Fotheringham et al 2002), and in the SAM package already noted, besides many others – GWR is also available as part of an R package, and as an add-on in ESRI ArcGIS software. GWR has been put into practice in this study.

9.3. Towards an operative measure of job quality

9.3.1. Four possible measures of job quality

9.3.1.1. Selection of measures and reasons for choice

Before being able to compare between accessibility and job quality we need a measure of job quality. While we have abundantly invested into the study of job centers as distinct geographical units in the chapters 3 to 5 of this work, and then to their group characteristics, actually those results aren't directly usable to test for an association with accessibility as defined in chapter 8. Therefore, a catalogue of possible measures has been tested in order to be used with accessibility. The goal of those tests is to select the measure which yields the strongest correlation with accessibility.

In order to be submitted to the test the indicators must be numeric and continuous, as to conform to correlation analysis. Thus, categorical segmentations, as used in chapters 3 to 7, can't be retained in the analysis and the job place quality proxy variable must come from other sources. Four such variables have been tested. Those are: absolute job numbers, job density, job intensity (both as used in chapters 3 to 7) and finally general job density. Here is the rationale behind the testing of these four variables.

The idea between comparing accessibility and absolute job numbers would be to test if accessibility is strongly linked to a mass effect. Of course, the measure is fraught with problems, the most notable of which is that it depends on the communal mesh and the relative size of different communes. Nevertheless, the Swiss communal mesh is very fine and relatively equilibrated, which means that genuine size effects do actually occur – we hypothesize that a genuine relationship could be shown by using this measure. If it shows to be the most relevant measure of job quality against accessibility, then it would mean that sheer job center size would trump other measures as a relevant proxy for job quality, meaning that this very simple factor, mass, is still very much relevant.

The second measure we will test is the job density parameter that we largely used in preceding chapters. Job density is measured by the numbers of jobs per built hectare. The rationale behind its use is to hypothesize that the more accessible a job place is, the more jobs would be concentrated on its built environment, and that this stronger density means higher diversity, productivity and desirability of those jobs to make up for higher rents to be paid. This measure also postulates that land planning restrictions hold well: if this measure qualify, then jobs tend to concentrate on available space more than to occupy new land. A strong correlation between accessibility and job density as measured would lead us to conclude in two forms, first that accessibility would lead to job density, and presumably quality and diversity, in a relatively strongly regulated environment where places would go higher up as job places more by making their existing built environment denser than by opening new land to office and industrial development, and that this form of territorial organization would dominate other possible effects like mass or specialization.

The third measure we will test is the job intensity measure we also used in the preceding chapters. Job intensity is the ratio between jobs and active residents. The rationale behind its use is to postulate that higher accessibility would provoke job specialization of places, which is a different but probably associated effect to the preceding measure. A strong link between accessibility and intensity would lead us to conclude that in very accessible places, jobs tend to replace residents and that this specialization issue would dominate the territorial organization, with centers devolved to jobs and less accessible places to residential functions.

The last measure under review is the general job density, which differs from job density as defined in the preceding paragraphs as it would be computed not only on built areas, but on the whole area of the concerned spatial unit. This measure is strongly linked to job density with respect to built-up areas, except for the regulatory environment. If this measure comes to dominate the other ones, then the conclusions would be rather analogous than with built-up job density, that is that accessibility would be linked strongly to job density, quality and diversity, but in a weak regulatory environment. If this measure dominates, it would mean that central places would tend to get new jobs more by opening up new land to urban development than by concentrating new jobs on existing built-up areas.

As we can see, the way those four indicators will link with accessibility have rather profound consequences on our view of the evolution of the urban system. This small study will in effect tell which of the four associated ways of measuring job quality comes to dominate the other, whether job centrality occur predominantly as a sheer mass effect, as place specialization, as job densification on existing built-up areas or as job densification by land development. Of course, those four possibilities have distinct consequences in terms of urban and land planning and policy.

9.3.1.2. Four measures compared to accessibility: results

Preliminary results

All four indicators have been tested directly as well as in logarithmic form, which was also the case for accessibility. Before testing the measures with accessibility, we have sought to evaluate if they are independent or linked to one another. The measures were compared year for year as to identify some possible trends.

The first result is that in all, logarithmic transformations of the variables correlated better than variables taken directly, which suggests that they are somewhat exponentially distributed, which is expected with a few locations taking very high values and most locations taking low values, this being valid for all four indicators under review.

In 1939 there was a strong link between job center size, built-in job density and overall job density, a link which steadily reinforced up to 1975 and then held. The strongest link appears to be between job center size and built-in density, a result already found in preceding chapters. The bigger a communal job market is, the stronger its built-in job density: big centers are denser than small ones. Both measures of density are also very strongly related, which means that both internal and spillover job center growths are linked: locations where jobs are concentrating in built areas are also seeing land development for economic use. As the link between overall job density and job market size demonstrates, those places tend to be the bigger ones. And as the strength of the mutual correlation tend to show, there isn’t much space for special cases.

Job intensity behaves somewhat differently during the whole period under review. At the start of it correlations are quite weak, indicating that the economic/residential segregation process was largely independent of size and job density. However, as time went by, correlations between intensity, densities and size climbed markedly, although never attaining the levels seen between the three other variables, although the rise in correlations has been gradually making them ever closer to the trio mentioned. As spatial segregation between jobs and residences progressed, job specialization tended to be more and more associated with size and densities. However, there are more exceptions to this link that there are between jobs and both densities.

Analysis shows that all four variables exhibit some degree of spatial autocorrelation, as demonstrated by correlogram studies reporting both Moran’s I and Geary’s c for all four variables, and for all years under review. The way the variables are autocorrelated is rather robust throughout the years, with total numbers of jobs and general job density showing the most spatial autocorrelation, with Moran’s I of about 0.3 for both and Geary’s c at around 0.7 for job numbers and even lower, at about 0.5, for general job density. Special job density and job intensity also display some spatial autocorrelation, but at clearly lower levels throughout, with Moran’s I’s between 0.10 and 0.15 and Geary’s c close to unity, all for a bandwidth of 10 minutes of commuting time.

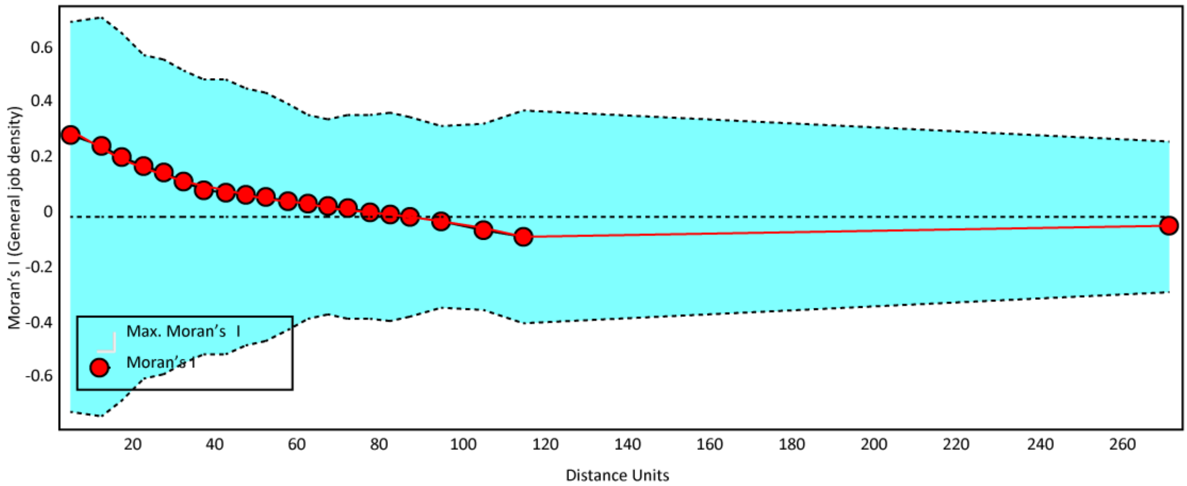


Chart 9-1: Moran correlogram for total job density in 2008; distance units in minutes of travel time

A preliminary modified t-test (CRH) evaluation of the correlations between the four variables under consideration confirms that the effective sample sizes for all couples are very much higher than needed to conclude to the reality of their association after taking into account spatial auto-correlation. Thus, the variables are statistically linked together in the way described above.

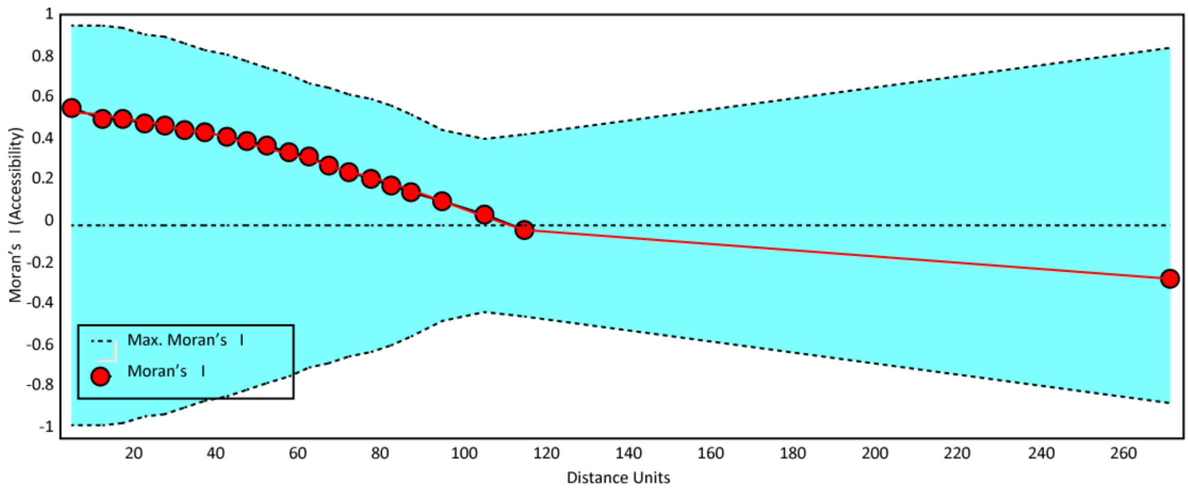


Chart 9-2: Moran correlogram for accessibility in 2008; distance units in minutes of travel time

Finally, accessibility, by construction, displays far higher spatial autocorrelation, with Moran's I climbing, for the first bandwidth of 10 minutes, from 0.46 in 1939 to 0.57 in 2008, and remaining significantly over zero for all time bands under 60 minutes. Geary's c is even more spectacular, very close to zero for the first time bands, indicative of a very strong spatial association between cases.

Core results

A rapid correlation study between the logarithms of our four indicators of job place quality and those of accessibility give the following results.

Accessibility ->	1939	1955	1965	1975	1985	1991	1995	1998	2001	2005	2008
Job Size	0.367	0.265	0.214	0.226	0.258	0.272	0.278	0.284	0.284	0.287	0.289
Sp. Density	0.217	0.159	0.154	0.190	0.229	0.253	0.269	0.286	0.285	0.293	0.297
Gen. Density	0.657	0.551	0.475	0.456	0.473	0.487	0.489	0.492	0.485	0.480	0.476
Intensity	-0.121	-0.139	-0.105	-0.108	-0.082	-0.099	-0.077	-0.044	-0.031	0.002	0.014

Table 9-1: Correlation coefficients between accessibility by year (columns) and four measures of job quality (lines)

By a surprisingly clear margin given the strong interrelation displayed by the four variables under consideration, the strongest correlations are found between accessibility and general job density, with figures between 0.45 and 0.65 according to the years. Job size comes behind (correlations between 0.25 and 0.35), with special job density (correlations between 0.15 and 0.30). Last, there is no relation between accessibility and job intensity.

A second battery of correlations were run using accessibilities considered differently, with mean times corresponding to actual mean times found in censuses, and not maximal commuting time as estimated in chapter 8. However, the correlations results found by using those alternate accessibilities are very similar to those we just exposed, which tend to show that accessibility is a relatively robust measure.

The conclusions we can reach are then twofold. In terms of interpretation first, it shows that accessibility is most strongly correlated with general density, over built-in density and job size. This tends to show that accessibility is linked with land development more than with densification and sheer size effects, while job intensity show distinct spatial patterns which are not linked to accessibility. While densification under its two forms and job size are strongly linked, it can be said that as a first approximation, accessibility seems linked to quality as job centers, as three out of four variables under review show. But it also show that this quality is obtained primarily by developing land and opening up space for economic development, although there is a weaker but existing link with built-in job density, which indicates that densification was also happening as a concurring effect. Size mattered also, meaning that bigger centers tended to be denser on both counts and that greater accessibility was linked with larger, denser centers.

The second conclusion to be reached is that for the remainder of this work general job density is chosen as proxy variable to infer job quality.

9.4. Demonstration: modified t-test results

9.4.1. The statistical link between accessibility and job density

In this part we return to the results we found of a strong association between accessibility and general job density and assess its validity through use of the modified t-test as described in Clifford et al 1989 and Dutilleul et al 1993.

The results are as follows:

	1939	1955	1965	1975	1985	1991	1995	1998	2001	2005	2008
Correlation	0.657	0.551	0.475	0.456	0.473	0.487	0.489	0.492	0.485	0.480	0.476
ESS, CRH	55.31	59.78	59.67	48.1	50.56	51.26	48.39	46.24	46.48	46.7	46.69
Prob. of null H	0.0000	0.0000	0.0001	0.0011	0.0005	0.0003	0.0004	0.0005	0.0004	0.0007	0.0008
ESS, Dutilleul	58.57	63.19	62.47	50.01	52.37	53.06	50.08	47.79	47.98	48.14	48.12
Prob. of null H	0.0000	0.0000	0.0001	0.0009	0.0004	0.0002	0.0003	0.0004	0.0006	0.0006	0.0006

Table 9-2: Association statistics for various years between accessibility and general job density

As we can see, the CRH and Dutilleul estimations of the effective sample size are very close to one another. The second conclusion is that both estimations give unambiguous results as the highest probability of the null hypothesis being correct is 0.0009, or about 1 chance in 1100, for the more tested Dutilleul method, which is very much lower than the usual significance thresholds used in statistics. We can then safely conclude that there is a statistical link between accessibility and general job density in Switzerland for the entire period under review, even after having taken into account spatial autocorrelation which was present in all the datasets tested.

9.4.2. The evolution of the statistical link through time

The strength of the statistical association between accessibility and general job density decreases from 1939 to 1965, and then remains largely stable. This seems to indicate that dependency between accessibility and job density, or more generally job quality was actually stronger in the beginning of the period than afterwards. In that sense, the generalization of individual motorized transportation in the 1950s and the 1960s really was liberating and giving access to new territory for all. It is also likely that the decrease in the correlation coefficients is due to the changing nature of accessibility, due to the generalization of the automobile and the possibility given to workers to commute on longer distances, which made proximity relationships somewhat less relevant than before. In effect, the broadening of the reachable commuting area around each worker between 1939 and 1975 somewhat blurred the very strong dependencies people had with their immediate environment before. In a way, the loss of strength experienced between accessibility and general job density could very well reflect this loosening of local ties more than anything else.

9.4.3. Time-lag effects and possible causality relations

Up to now the only comparisons made have been between accessibilities and job densities at a given time, as if the link was direct. However, we could hypothesize that there are time lag effects between accessibility and general job density. In particular, we could hypothesize that accessibility causes job density so that a change in accessibility would cause a change in general job density, only with a response time. Conversely, it could be that the inverse phenomenon is at play. Admittedly, our chief hypothesis is that accessibility drives job quality and localization – thus we expect a time lag to be present between accessibility and general job density. This would manifest itself by the fact that general job densities for a given time would be responding to accessibilities a few years past, thus, correlations between a given general job density would be higher with past accessibilities than with current ones, and lower with future accessibilities.

In order to assess the time lag effects, we correlated all accessibilities with all general job densities. Thus, we obtained a matrix of correlation coefficients which allows us to see how time lags affect the relationships between accessibility and general job density.

	Accessibility											
General Job Density		**1939**	**1955**	**1965**	**1975**	**1985**	**1991**	**1995**	**1998**	**2001**	**2005**	**2008**
	1939	0.657	0.603	0.548	0.534	0.538	0.533	0.529	0.525	0.516	0.511	0.507
	1955	0.622	0.551	0.487	0.471	0.479	0.475	0.470	0.463	0.454	0.448	0.444
	1965	0.621	0.545	0.475	0.460	0.469	0.464	0.456	0.448	0.438	0.431	0.426
	1975	0.617	0.540	0.470	0.456	0.467	0.462	0.453	0.446	0.437	0.430	0.425
	1985	0.625	0.548	0.478	0.461	0.473	0.469	0.459	0.451	0.441	0.433	0.428
	1991	0.645	0.567	0.497	0.479	0.492	0.487	0.477	0.469	0.459	0.450	0.445
	1995	0.655	0.577	0.508	0.490	0.504	0.498	0.489	0.481	0.472	0.463	0.457
	1998	0.663	0.586	0.518	0.500	0.514	0.509	0.500	0.492	0.482	0.473	0.468
	2001	0.668	0.590	0.522	0.504	0.518	0.513	0.503	0.495	0.485	0.476	0.471
	2005	0.671	0.594	0.526	0.508	0.523	0.518	0.508	0.499	0.489	0.480	0.474
	2008	0.674	0.597	0.530	0.511	0.525	0.520	0.510	0.501	0.491	0.482	0.476

Table 9-3: Correlation coefficients between accessibility and general density, with time lags introduced

The first remark to be put forward is that all accessibilities correlate pretty well with all general job densities, regardless of the respective years under study. The lowest correlation coefficient found, at 0.425, is between accessibility in 2008 and general job density in 1975; however even for this case, the effective sample size is estimated by the CRH method to be around 73, which gives a probability of the null hypothesis of about 0.0002, or 1 in 5000. Thus, even though we have not checked for effective sample size for all the correlations, we can be pretty confident that all of the correlations we found here are highly significant in statistical terms, even after taking spatial autocorrelation into account.

The way the table can be read is as follows. Lines show the correlations obtained by general job density for a given year as compared to accessibilities for all years under review. Columns show the inverse, that is the way general job densities for various years correlate with a given accessibility.

The study by lines show that in very general terms correlations decrease from left to right, and that this is valid for all sets under review. The only exception relates to the 1975 to 1985 period where correlations went up. This seems to indicate that on the whole, for each general job density, correlations are always higher with older accessibilities than with newer ones, and that "future" accessibilities correlate still lower. In all, this is indicative of a general temporal lag where general job density responds to accessibility conditions with a delay. The fact is equally that there is no anticipation effect where job density responds well to future accessibilities, except for the 1975-1985 case. Thus, we can't exclude, on the basis of those correlation coefficients, that there is a link between accessibility as a cause and general job density as a consequence. However, this affirmation needs to be qualified.

The only exception to the previous rule concerns the 1975-1985 period, with job densities of all ages responding more strongly to 1985 accessibility than to 1975 accessibility. Admittedly, the difference is small but consistent and growing with more recent job densities. It is difficult to explain this effect, but one possible cause for the bump is that in 1975 accessibility was strongly marked by the partial state of the highway network, whereas the main structure of the network was in effect complete in 1985, at least where it counted. The fact is that the highest response for each general job densities since 1975 is with 1985 accessibility, as if job distribution was as a whole still adapting on accessibility defined by the state of the highway network at this time. The fact is that this proves valid also for 1975 general job densities could indicate an anticipation effect from the actors, an effect which is not found for any other period.

For its part, the study by columns shows a very clear dichotomy: from 1939 to 1975 there is first a decline of the link between a given accessibility and successive general job densities, tending to show that dependency on accessibility go down with the generalization of the motor car, and then it starts to climb back, from 1975 to 2008. This means that for all accessibilities, general job density in 1975 was the least responsive, while from then on general job densities responded better and better to accessibilities – this would corroborate the idea that from 1975 on at least, job densities do actually respond well to varying accessibility.

The period before 1975 is harder to encompass. The trend was that general job densities were less and less linked to accessibility, as if there was a general relaxing of geographical rules concerning job localization. The effect isn't linked to specific accessibility changes, as it is measured for accessibilities up to the 2008 version. The most probable cause is that in 1939 accessibility and job density were very strongly correlated in a world where travel was costly and difficult, and that the advent of the motor car for all relaxed the grip both components had on each other, letting both workers and jobs to locate more freely on the territory. The fact that the lowest association between the two occurred in 1975 is more easily explained by the fact that at this time accessibility was changing very fast and massively with the inception of the highway network, which may have provoked an imbalance in the way general job density redeployed on the territory. In a way, 1975 was a transition period with rapid changes, to which general job density failed to adapt immediately. Once the major infrastructural changes implemented, around 1985, general job density could adapt to the new situation, hence the better correlations measured afterwards.

Thus, both when looking at line trends and at column trends, there is a strong case to be made for causal relationships between accessibility and general job density, which seems to be confirmed for most of the periods under review. A weakness in the relationship in the 1970s and

1980s could be attributed to the massive changes happening at the time in the transport infrastructure.

9.4.4. The big picture: long-term stability and the geographical imprint

The conclusions we reached in the preceding section are interesting, but they do not represent all that it to say about the results we just found. Behind the variations we mentioned and which seem to confirm the existence of a causal relationship, it is remarkable that the 121 variable pairs show all approximately the same relation, with correlations ranging from 0.425 to 0.674. Accessibility for every year is correlated to general job density for every year in a similar way. The second great stability found is that the decrease in correlations for the general job density of a given year goes back all the way to 1939. Granted, we think that the 1939 accessibility was far more constrained than subsequent versions and that the relaxing of the tight grip between accessibility and density would explain a general decrease in correlation indices between 1939 and 1965, but it is still remarkable that the highest correlation obtained for the 2008 general job density is with the 1939 accessibility, and that with the lone exception of the 1975-1985 hiccup, the older an accessibility, the better the correlation with general job density for any given year. It is as if trends seen long ago in accessibility were still translating into changes in general job density, on top of other accessibility moves before and after it. The fact that since 1975 successive general job densities correlate better and better with accessibilities seems to show that a incremental adaptation to multi-layered accessibilities is happening, but at a very slow rate.

That being said, everything we just mentioned indicates a very strong territorial stability of the system. Despite massive societal changes in the way people move about, the geography of job places in 2008 is still broadly similar to the 1939 one. Things evolve: general job density does evolve, and we believe we showed that it does so to adapt to changing accessibility conditions. But it does so in a context of massive inertia, in a minute and incremental way. In a way, general job density is probably still adapting to accessibility conditions which changed in the 1960s, along with changes having occurred at other periods, and the territorial response time to those is extremely long. And it is a fact that by taking a 69 year period under review we could not find the time after which correlations between current general job density and past accessibilities start to decrease. Maybe the Swiss territorial organization is still adapting to the advent of the railways 150 years ago – for what it's worth, we can't exclude such a hypothesis on the basis of our work.

In all, this is strongly indicative of the permanence, the persistence of a given spatial organization confronted to condition changes. There seems to be a geographical imprint which imparts a great dose of territorial inertia, meaning that once a territorial structure is in place all subsequent evolution can be only incremental as the territory will resist change and only allow for it to happen slowly and gradually, while keeping the mark of past evolutions: in that sense, space is a palimpsest. Conversely, the spatial structure can never be in equilibrium as it always lags behind the determinants of its change, which vary at a far greater rate than space itself, never letting it catch up. In retrospect, massive territorial structural changes can only happen on a virgin territory, whether it is more or less open to colonization, like Australia or the American west in the 19th century, or because there has been a civilization change, like in Europe after the fall of the roman empire. Intuitively, we would expect "young" territories to be subject more easily to climactic changes in their territorial organization, as the American experience seems to hint at, while in "old" countries the mark of the past, its geographical imprint, are so well rooted in space that changes are difficult to perceive, and the advent of alternative spatial organization near impossible. Switzerland certainly belongs to the second category. Its territorial organization bears the weight of multiple centuries which territorial imprint is deep, and it does not evolve easily. Barring the collapse of western society, changes in the territorial structure of the country are set to remain gradual.

9.5. Linear regression results and residuals: the search for a regional effect

9.5.1. Aspatial results: a varying and intensifying relationship

Up to this point we have only commented upon the generality and the validity of the link between accessibility and general job density, and not so much to the actual levels of the correlation coefficients. We now return to this subject, and try to extract more information from the relationship found between accessibility and general job density. Here are the global results for three parameters: the intensity of the relationship, as given by the correlation coefficient, and then the two parameters which characterize the models estimated by the method: the intercept, i.e. the value at which the regression line crosses the y-axis at x-value zero, and its slope.

Year	1939	1955	1965	1975	1985	1991	1995	1998	2001	2005	2008
Corr. Coeff.	0.657	0.551	0.475	0.456	0.473	0.487	0.489	0.492	0.485	0.480	0.476
Intercept	-2.194	-2.004	-1.984	-2.355	-2.603	-2.710	-2.856	-3.368	-3.250	-3.411	-3.553
Slope	0.865	0.740	0.682	0.718	0.778	0.805	0.823	0.910	0.882	0.903	0.930

Table 9-4: Linear regression parameters between accessibility and general job density, for various years

The allure of the eleven models shows the following picture. First of all, it is to be noted that those parameters apply to a double logarithmic relationship: both accessibility and general job density were put in logarithmic form before being studied. As it is, the slope is always positive – the stronger the accessibility, the larger the general job density. This is the expected, trivial result. The intercept is always widely negative, which expresses the fact that a nil accessibility would result in about zero density, also an expected result.

More interesting are the moves the regression line shows with the years. At first, until 1965, the intercept remains approximately stable, while the slope is significantly reduced, from 0.865 in 1939 to 0.682 in 1965: it is as if during these times rules about the accessibility of job places relaxed somewhat, probably in line with the general accessibility increases seen at the time. In 1939 there was an almost one-to-one relationship between accessibility and general job density – a doubling of the former was expected to be matched by a doubling of the latter; by 1965 this relationship had evolved with accessibility needing to treble to provoke a doubling of job density.

From 1965 on, a double move was seen, of intercept sinking and of concomitant slope rise. By 2008 the relationship between accessibility and general job density was back to par, with slopes getting from 0.682 in 1965 to 0.930 in 2008, while the intercept lost about 1.5 points from -2 in 1965 to -3.5 in 2008. This all suggests that the regression line slope was being more and more pronounced as time went by, while the pivot around which it swung wasn't situated on the y-axis but at an x-axis value of about 6, which is the base 10 logarithm of a million. That is to say, from 1965 to 2008 the relationship between accessibility and general job density remained stable for an accessibility situated at about one million. Such accessibility is never reached by any location at any point of time during our study.

In all, the regression line went down, first by pivoting down around a point situated approximately at an x=1 value, then from 1965 on in a reverse direction, pivoting around from a point situated at approximately x=6 (*Chart 9-1*). In the bracket of values actually taken by both accessibility, which logarithm rank from 2 to about 5.5, and general job density, which logarithm ranks from about 0 to about 5, this means that for a given accessibility general job density went down with the years. At first this decrease was above all felt in higher accessibility places – mirroring the strong loss of relative accessibility those places experienced up to 1965. Then, the effect was stronger in lower accessibility places, expressing the job desertification those places experienced from 1965 with their specialization towards residential places.

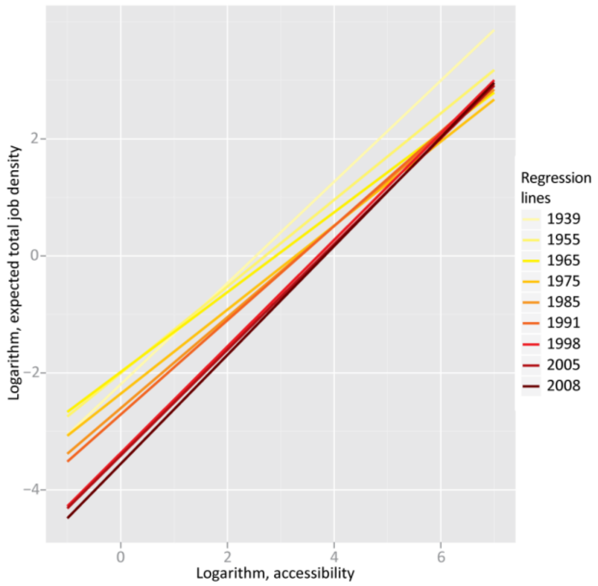


Chart 9-3: Regression lines between accessibility and job density, for various years

More accurately, as accessibility climbed everywhere, any particular value taken by it was inflated down as the years passed. In such a context, for a place to remain accessible was signifying that it had to see its accessibility climb, lest being degraded in the long run. More importantly is the rise of the regression line slopes since 1965. This can be interpreted as follows: up to 1965 massive rises in accessibility resulted in smoother accessibility gradients – in effect easing the effect it has on job density through the country, and expressing the unraveling of the Christallerian order on a territory where movement was becoming easier and easier. From 1965 on though, accessibility rise went with a more and more discriminating effect on general job density, expressing the rising dichotomy between accessible regions and remote ones and the importance this particular parameter took with time. By 2008, the gradients in job density according to accessibility were back to where they were during Christallerian times, only this time the regression line was about 1.2 units lower, which means that as a general rule by 2008 the same accessibility than in 1939 would command a job density 10 to 20 times lower. There has definitely been such a thing as accessibility inflation from 1939 to 2008.

9.5.2. Spatial results: non-stationary residuals

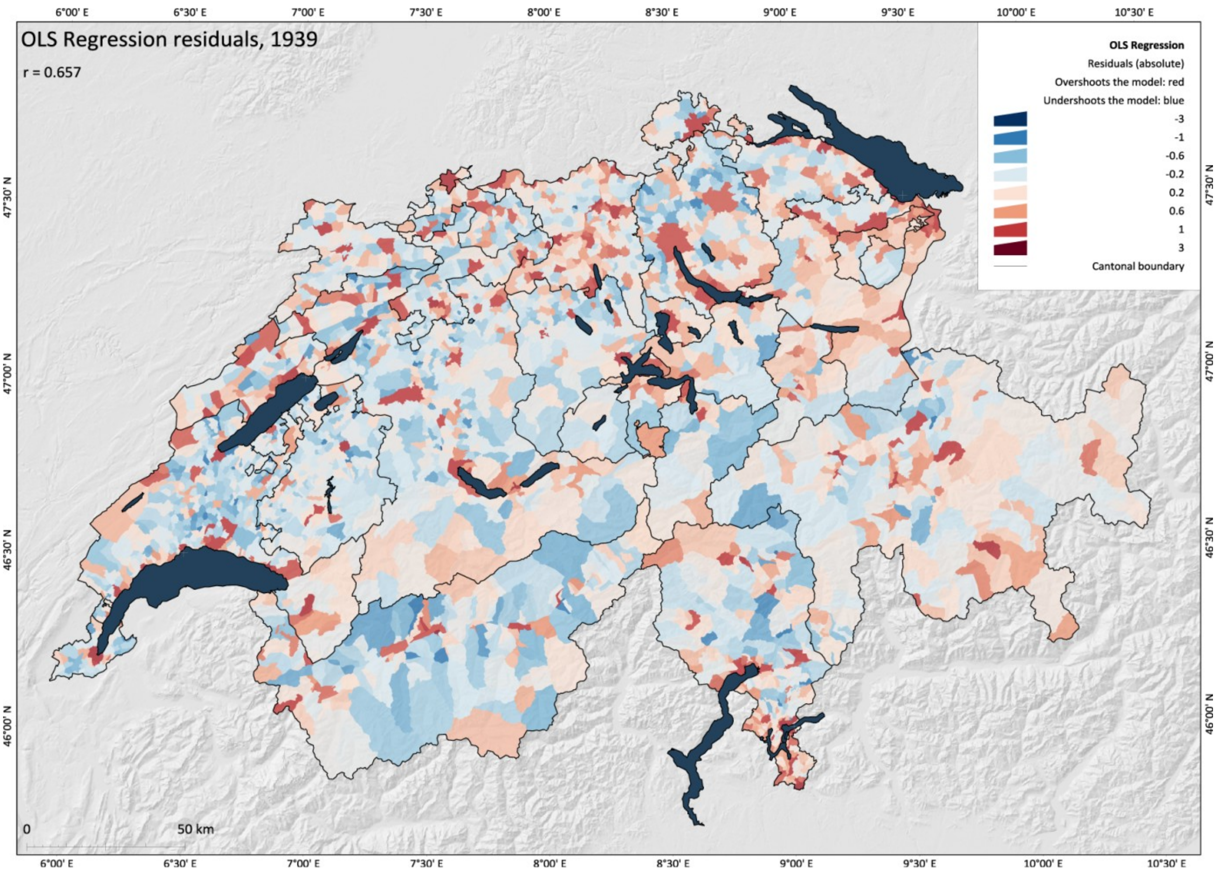
The actual correlation coefficients for the accessibility-general job density couples for each of the eleven years under review are situated between 0.45 and 0.65, which means that the variance share explained by the relationship is situated between 20% and 40% of the total variance of the population, once spatial autocorrelation has been taken into account. This means that other factors account for between 60% and 80% of the total variance. Part of the remaining variance to be explained could be of spatial origin. In particular, regional and boundary effects are likely to play a role in the disturbance of the relationship under investigation. A common way to investigate possible spatial effects not covered by the model at hand is to investigate residues left by the model. In this part, we map the residues of each linear regression made between accessibility and general job density to see if regional or boundary effects are present in the misspecification of the model.

The study of the geographical distribution of residuals following the OLS regressions made for eleven periods gives the following results.

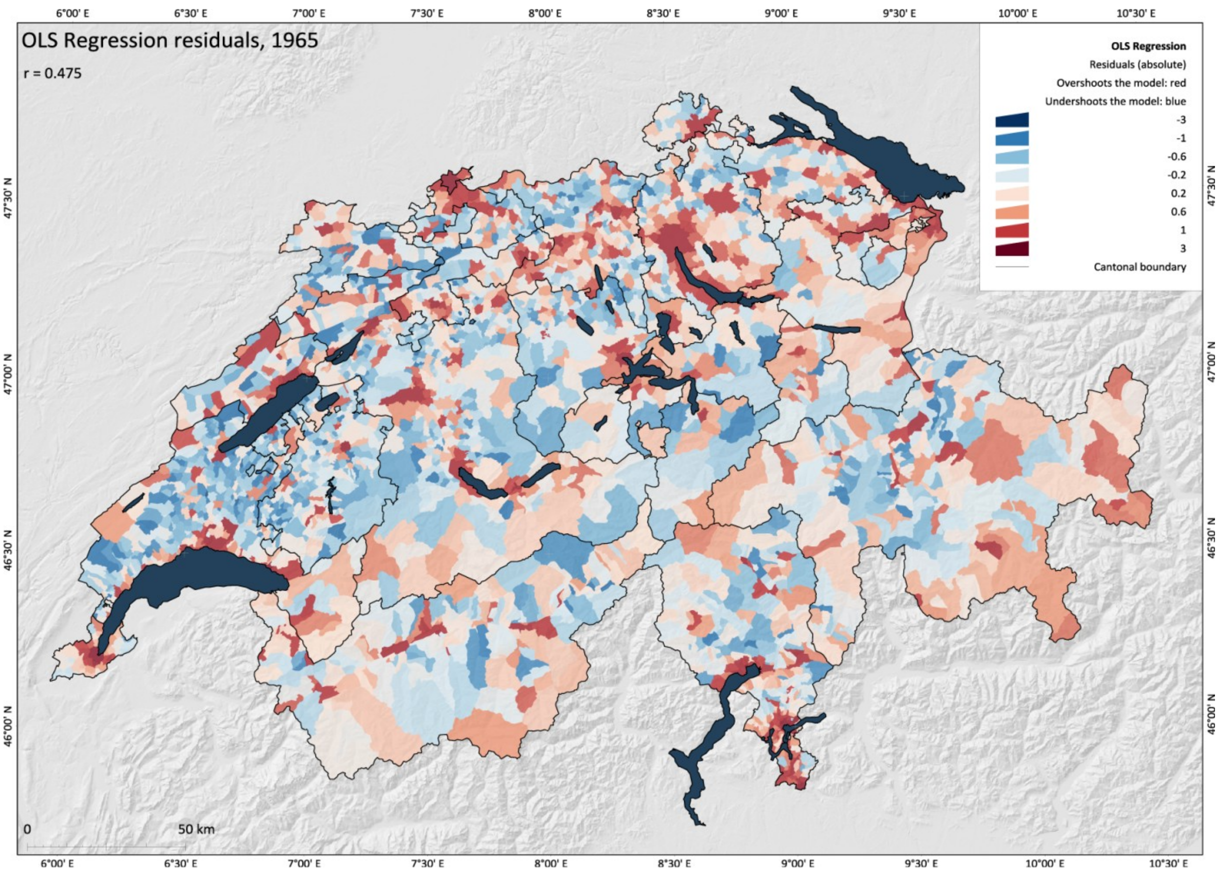
First of all, residuals for all epochs show distinctly the same pattern – for whom can read the map, besides obvious stochastic distributions in some regions, it very much appears that urban regions have strong positive residues, whereas strong negative residues are to be found primarily in rural and peripheral areas. Residuals are not located in a geographically stochastic way.

As those results are seen throughout the period under study, we will limit here our study of their geography to four epochs, namely 1939, 1965, 1991 and 2008, which we have often used before as turning points in the way the urban network evolved (*Maps 9-1 to 9-4, overleaf*). By looking at this short series of maps which model absolute residuals, the first remark is that residuals reinforced between 1939 and 1965, a normal result given that the correlation coefficient went from 0.657 in 1939 to 0.475 in 1965. More importantly, the deepening of residuals affected above all the rural regions. Whereas in 1939 in all rural regions were only slightly overestimated by the model, by 2008 those periurban belts were very strongly overestimated by it. In a way space structured differently in 1939 than in other epochs; in 1939, the global model was doing a good job at modeling job quality throughout the territory, save for truly urban areas which were clearly underestimated by it. By 1965, and this would be furthered ever since, the growing urban regions were still being underestimated by the model, but now the periurban regions, the rural ones and the peripheries were starting to be overestimated by it. A point worthy of note is that by 2008 most touristic resorts are assimilated to cities: their job quality is systematically underestimated by the model.

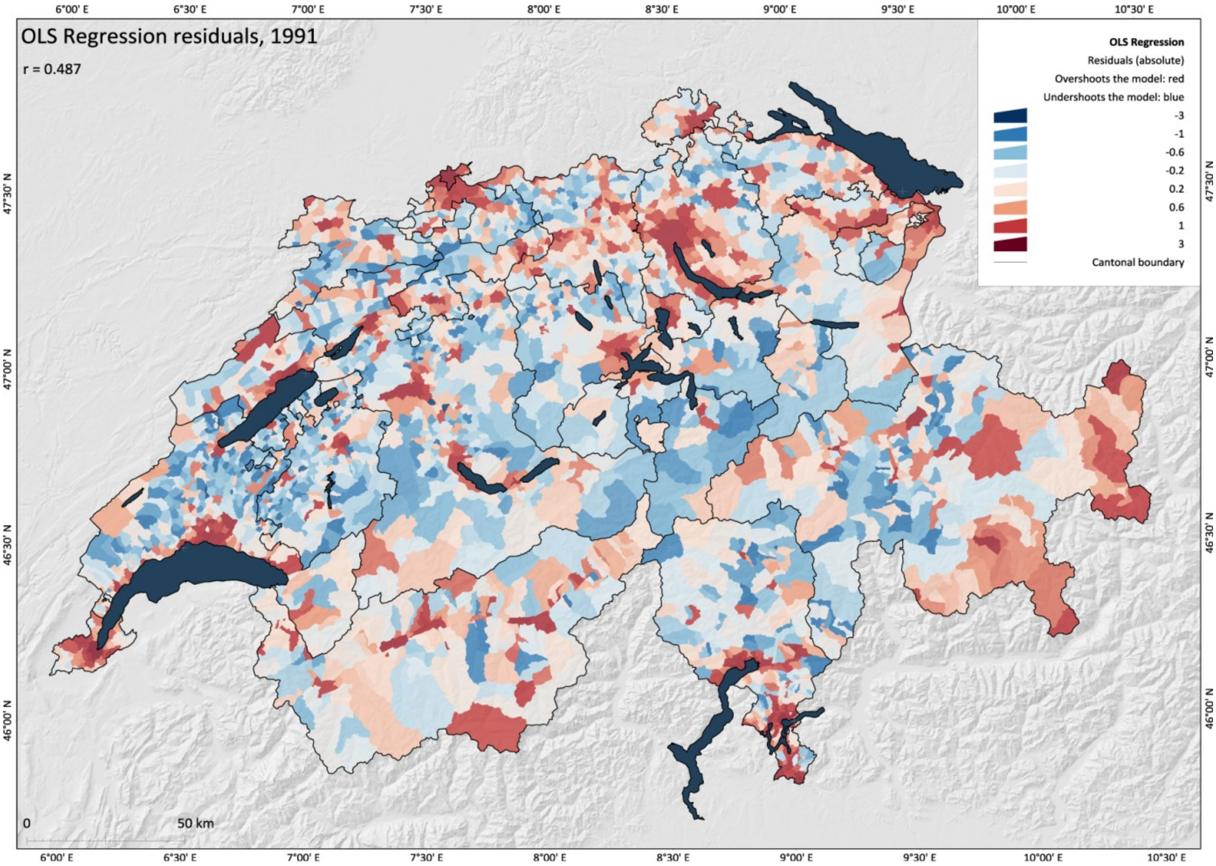
Several conclusions can be reached at this point. First of all, the general model functioned quite well in the 1939, Christallerian Switzerland, being overshot only in urban areas. This seems to further the idea that, by and large then, the territory was relatively undifferentiated, especially in rural areas, which could be modeled globally. However, by 1965 and above all afterwards, a new geography was put into place which made a global model less successful, first because urban areas, which were still underestimated by the mode, grew in size, numbers and number of communities affected, and second because the growingly residential oriented periurban belts started to show strong negative residuals. In short, the global model in 1965 and beyond systematically underestimated the job quality of urban and then suburban areas, while systematically overestimating the job quality of the rest of the country.



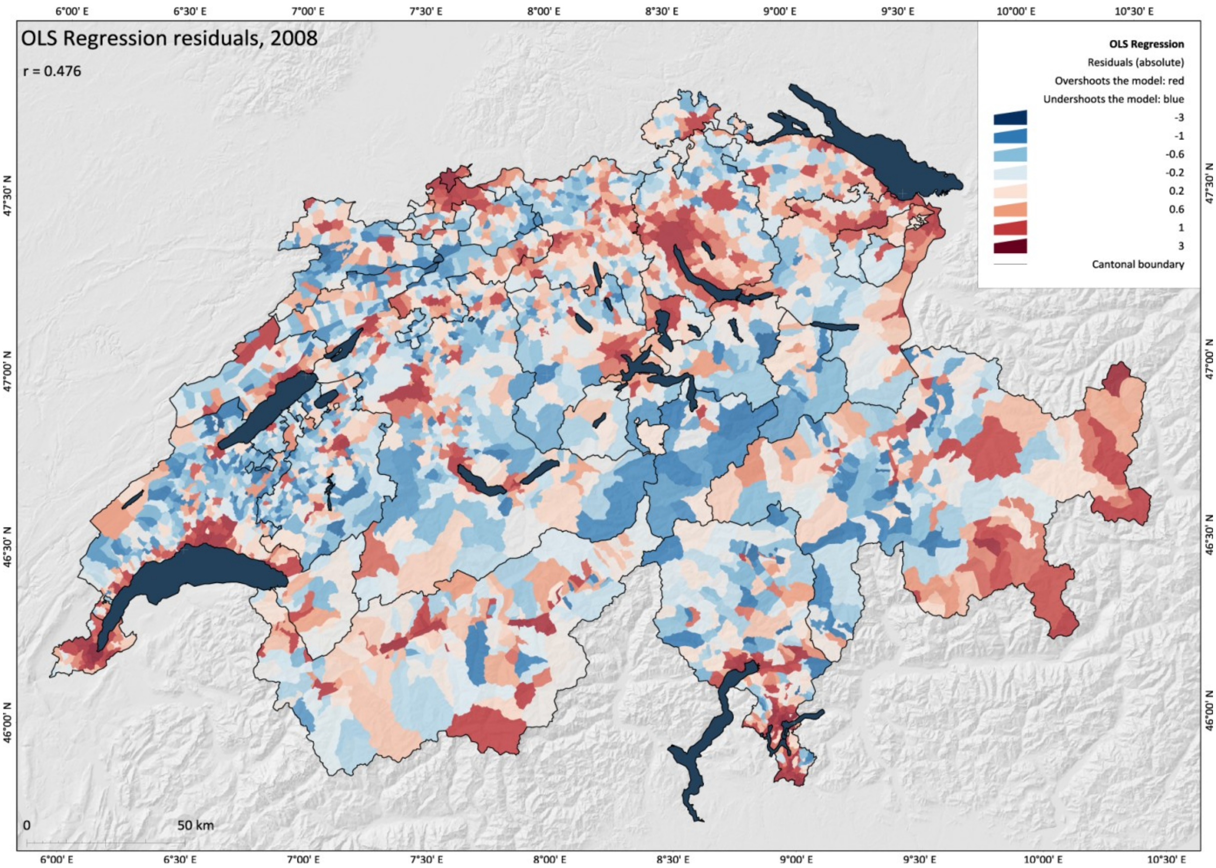
Map 9-1: Ordinary least squares regression residuals between accessibility and general job density logarithms, 1939



Map 9-2: Ordinary least squares regression residuals between accessibility and general job density logarithms, 1965



Map 9-3: Ordinary least squares regression residuals between accessibility and general job density logarithms, 1991



Map 9-4: Ordinary least squares regression residuals between accessibility and general job density logarithms, 2008

Apart from this general center-periphery effect, true regional effects were also seen; those are the most marked for the 2008 situation. In one word, boundary effects, absent in 1939, started to creep in the model. By 2008, all of the boundary regions which actually have dealings with the other side of the border showed strong underestimates of their job quality, be it in urban regions – Geneva and Basle regions above all, but also in the Rheintal and Mendrisiotto areas, or rural ones, notably in the Jura arc and most spectacularly in Graubunden. Those effects were expected, as the way we built accessibility did not take into account populations across the boundary, for data access reasons. Essentially, accessibility as we built it considered Switzerland as an island, whereas the 2008 economy takes full advantage of the proximity of cross-border workers – since 2004 Switzerland has an open border policy with the EU. Thus, island accessibility does not represent true accessibility in those regions, but only a part of it – admittedly the largest one, except in Rheintal and Mendrisiotto. By consequence, the model would be expected to give those areas a lower job quality than if true accessibility would be considered.

Contrary to the overriding center-periphery effect, this regional effect was expected. That is concerns only border regions is a surprise to us – we expected strong regional effects to be present. Instead, we obtained a picture of strong center-periphery dichotomies which are indeed rather constant across Switzerland as long as we do not approach active borders of the country. Regional effects are limited to the boundary regions but apart from that do not seem to show strong interregional variations. This last point seem to show that the massive rise in accessibility that the greater Zurich area experienced to the detriment of all other urban regions of the country was somewhat mirrored by the job qualities measured here and there. Zurich did indeed take a strong precedence as compared to the other metro areas of the country. Size matters: in regional terms, job qualities do respond to accessibility; the global model defaults materialize at a smaller scale, inside each of the metropolitan areas, as a center-periphery component. In any case, the residuals do not take a spatially stochastic distribution. There is additional information to be gained from their spatial arrangement.

9.6. Beyond residuals: the GWR approach

9.6.1. Introduction: where to from residuals?

As we've just seen there is much to be learned by looking at residuals and their territorial distribution – here we learned that to our surprise there weren't strong regional effects in the distribution of residuals; such effects were seen only in border areas, which was expected for data limitation reasons. We also learned that most of the remaining variance wasn't spatially indifferent, with positive residuals clustered in large urban areas – indeed, in job center areas, while negative residuals were above all spread in periurban, rural and peripheral regions.

Recently, however, new techniques have been offered to geographical research to go beyond such a global analysis. For instance, Luc Anselin (Anselin 1995 besides many others) has developed a whole array of local indicators of spatial analyses, the idea beyond which is that those indicators should be left free top vary across space. In Anselin's research, in particular spatial autocorrelation measures already encountered, Moran's I and Geary's c are allowed to vary across space, allowing for the systematic and easy detection of coherent core regions and boundaries around them. The same idea, applied to OLS regression, has been championed by A. Stewart Fotheringham and his team (Fotheringham & Charlton 1998, Brunsdon et al 1998, Fotheringham et al 2002), who developed a form of ordinary least squares regression where regression parameters were allowed to vary across space: the geographically weighted regression, GWR.

Once it became evident that our regression results and residuals still had a definite geographical component we choose to submit our data to spatially explicit methods to extract this information. At this stage our main interest was to see if a spatially explicit regression model could beat the results we had already obtained using OLS regression; this was the reason for which GWR was chosen as method to further our research. Additionally, it provides with an array of localized statistics which can be mapped to help understanding of the underlying phenomena.

9.6.2. Methodology

9.6.2.1. Data considerations

In this part we describe shortly which data were used in our GWR study. For each epoch, we will try to model general job density, which is our job quality proxy variable of choice, with only one independent variable, which is accessibility. The distances we will use will be the same used throughout our work, which are the estimated travel times.

9.6.2.2. Distance decay functions and bandwidth choice

The idea behind GWR is to give at each point a distance-decaying weight to all other points, two other parameters were to be chosen before running the analyses. First, the distance decay function, which will model how weights will decrease according to distance, and then the bandwidth, that is the distance at which we will work. The GWR procedure we used, implemented in SAM Software (Rangel et al 2006, 2010) allowed several possibilities.

The study will consider two possibilities. The first is to hypothesize that the same rules that pertained to accessibility should pertain to the distance-decay function. That is, the choice of function and of bandwidth should closely match those used, for each period, to calibrate accessibility. The second approach is to optimize the bandwidth as to obtain the best results possible without hypothesizing anything about what the bandwidth should be.

Two distance-decay functions more or less match the general allure of the Gumbel curve. The first is a Gaussian function, given by:

$$w_{ij} = \exp[-1/2\,(d_{ij}/b)^2]$$

Where w_{ij} is the weight attributed to location j from location i, d_{ij} the distance between both locations, and b the bandwidth.

The second distance-decay function under consideration is the bi-square function:

$$w_{ij} = \begin{cases} [1-(d_{ij}/b)^2]^2 & \text{if } d_{ij} < b \\ 0 & \text{if } d_{ij} \geq b \end{cases}$$

Where all symbols have the same meaning.

In the first case, the bandwidth is located about at the middle of the distribution, with a weight of 0.61; for comparison, the Gumbel bandwidth point corresponded to a weight of about 0.43. In the bi-squared function case, however, the bandwidth equals the distance at which the weight turns to zero; it is the limiting distance.

Both functions have roughly the same allure as the Gumbel function. However, the Gumbel function is more flexible as it authorize the use of two parameters - a bandwidth-like one, and its standard deviation, where both the Gaussian and the bi-squared functions take only one parameter, the bandwidth. A preliminary study in curve fitting shows that compared to the Gumbel function put at the parameters we used to build accessibility, both functions show a stronger decay at about half the bandwidth specification, even when fitted to the best of our knowledge, that if with the same weight at the Gumbel bandwidth. Furthermore, the bi-squared function also shows a tendency to attain zero weight more rapidly than the Gaussian function. For this reason, for the first of the two studies, a Gaussian function was used as proxy for the Gumbel function. The bandwidth value was set as to best mimic the allure of the Gumbel curve, which meant a division of the Gumbel bandwidth by about 1.3 to obtain the Gaussian bandwidth. Thus, we obtained a GWR which parameters closely approximated those used for the building. The effective bandwidths used are given in the table further down, along with the correlations obtained.

For the second analysis, the bandwidth selection was left free for the software to elicit following the minimization of the Akaike Information Criterion (AIC) procedure described in Fotheringham et al 2002, pp. 95-7. The general logic behind this is as follows. The smaller the chosen bandwidth, the freer the parameters can be set in various places, which is good in terms of model exactitude and relevance. However, the smaller the bandwidth, the smaller the number of data points to be considered in each of the local analyses, which is bad in terms of statistical significance and stability. Thus, the bandwidth should be chosen as small as possible to let the parameters vary as much as possible, while being still large enough that it encompasses enough data points for the statistics to remain robust. The procedure chosen does that by minimizing a global entropy measure, the AIC we mentioned. Thus, the bandwidth will be selected by this procedure, and vary from one case to another. For practical reasons in the settings of the boundaries between which the software was to optimize the bandwidth, we used the bi-squared function.

9.6.3. Results

9.6.3.1. General results

The general results are as follows:

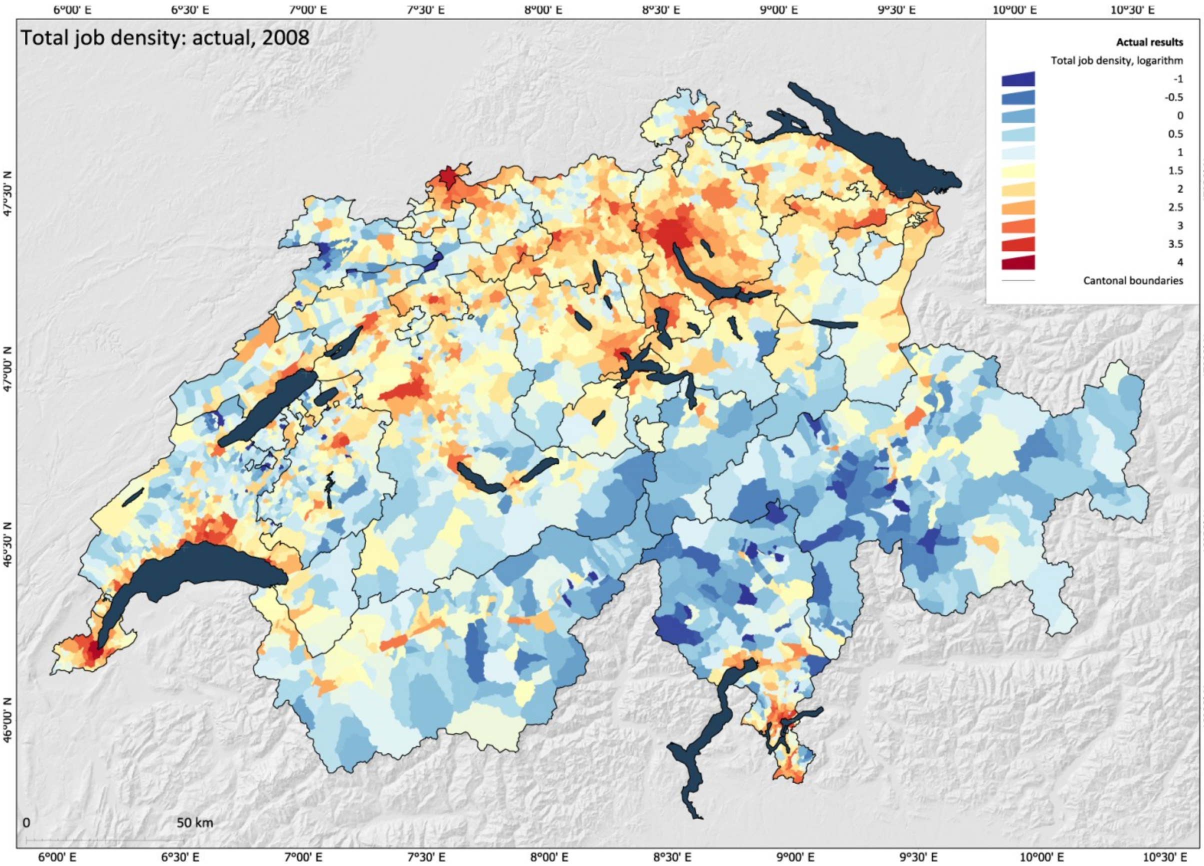
Year	OLS Reg Corr	OLS Reg AIC	Fixed GWR Corr	Fixed GWR Bandwidth (Gaussian function)	Fixed GWR AIC	Free GWR Corr	Free GWR Bandwidth (bi-squared function)	Free GWR AIC
1939	0.657	4046.444	0.756	22.00	3691.865	0.759	52.319	3701.712
1955	0.551	5070.515	0.695	22.00	4542.313	0.767	28.013	4442.826
1965	0.475	5915.592	0.653	22.00	5307.738	0.755	24.049	5098.262
1975	0.456	6267.904	0.634	22.00	5651.088	0.761	21.784	5360.522
1985	0.473	6336.384	0.657	22.00	5641.865	0.770	23.082	5398.866
1991	0.487	6190.646	0.658	23.25	5516.048	0.797	21.059	5151.944
1995	0.489	6166.128	0.658	24.00	5487.704	0.788	23.057	5120.345
1998	0.492	6236.190	0.659	24.75	5550.846	0.798	22.160	5146.712
2001	0.485	6330.224	0.655	25.50	5639.911	0.807	20.990	5187.580
2005	0.480	6466.199	0.657	26.25	5738.842	0.789	24.285	5276.298
2008	0.476	6581.173	0.651	27.00	5869.219	0.791	24.292	5361.881

Table 9-5: Correlation coefficients, Akaike Information Criteria, bandwidth in minutes of travel time, for three distinct regression procedures for various years

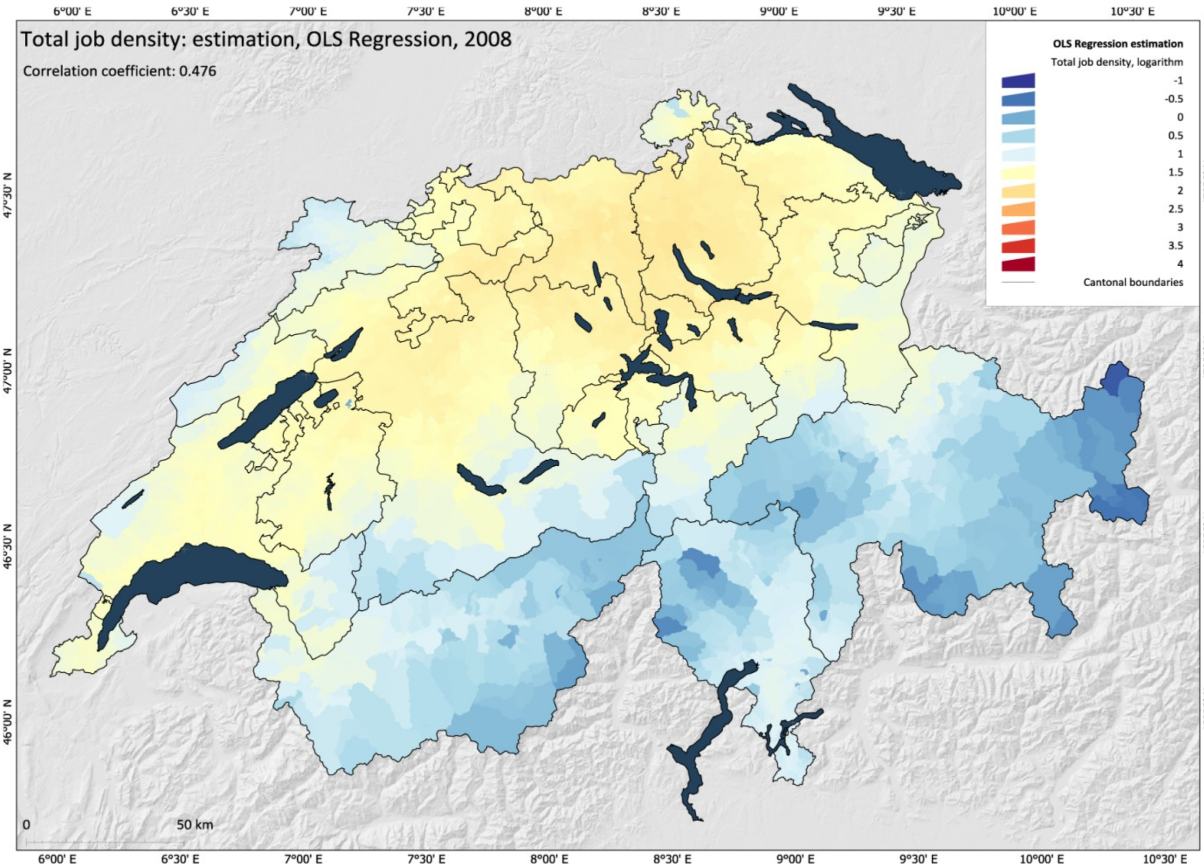
As we can see, in terms of correlation coefficients, both GWR models gave better results than the OLS regression. It can be seen, both in terms of correlation coefficients than in terms of AIC differences, that broadly, the constrained bandwidth GWR bring about an enhancement of the model which is about half the one that the AIC optimized GWR. On the face of it we would be tempted to take the AIC optimized results as the ones which give the best agreement with the reality.

This can be seen when looking at the four maps (*Maps 9-5 to 9-8, overleaf*) which describe for 2008 the actual values to be modeled, and the three models according to the classical OLS regression, the constrained bandwidth GWR and the AIC optimized bandwidth GWR.

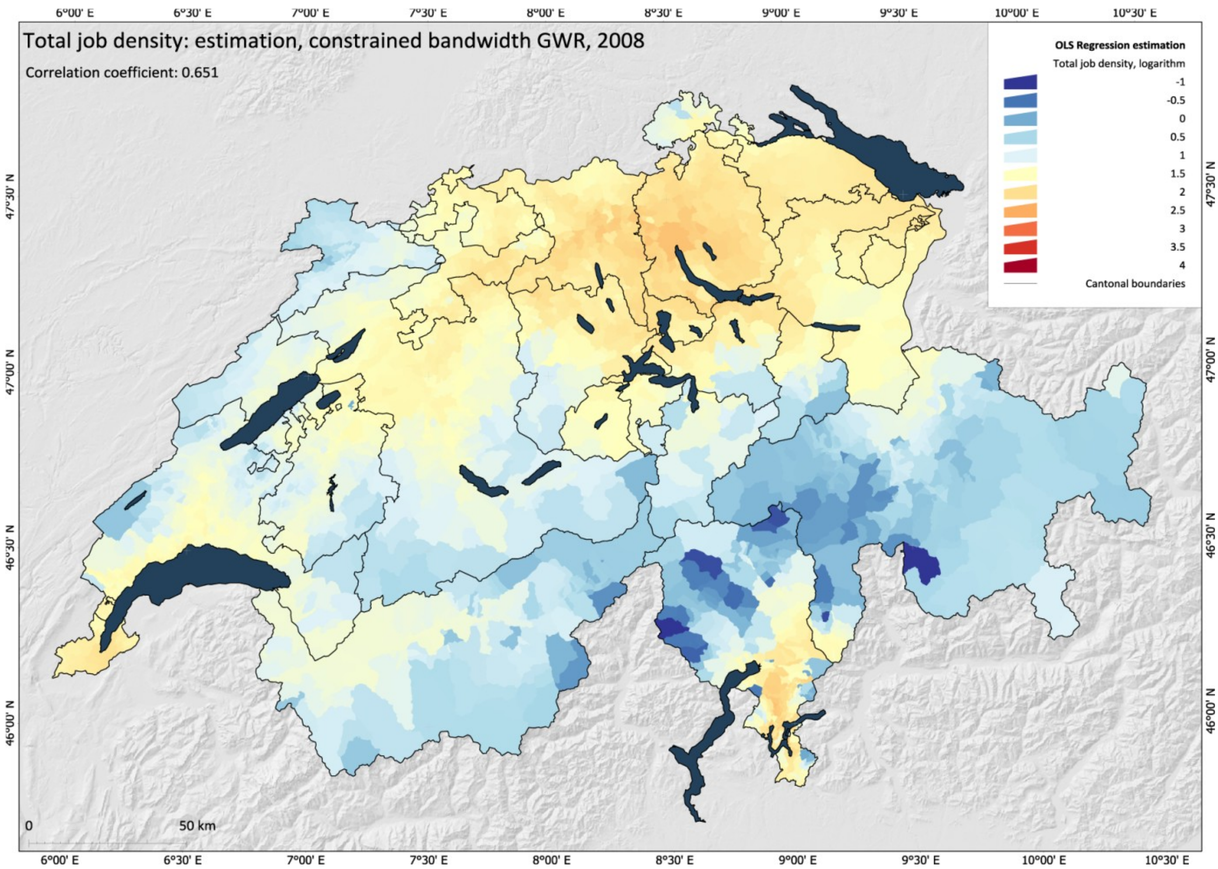
A second feature of the AIC optimized bandwidth is that it gives startlingly similar results through the years, at least in terms of correlation coefficients, which are all constrained between 0.76 and 0.80. Another interesting feature is the optimal bandwidth that this series gives, with a strong decrease from 1939 to 1965 and then a very stable bandwidth (about 21 to 24 minutes). As this bandwidth is computed with the bi-squared distance decay function, the bandwidth is actually the limiting distance; it would correspond to about 8 to 9 minutes bandwidth in Gaussian terms, i.e. about a third of the constrained bandwidths used in the constrained bandwidth GWR.



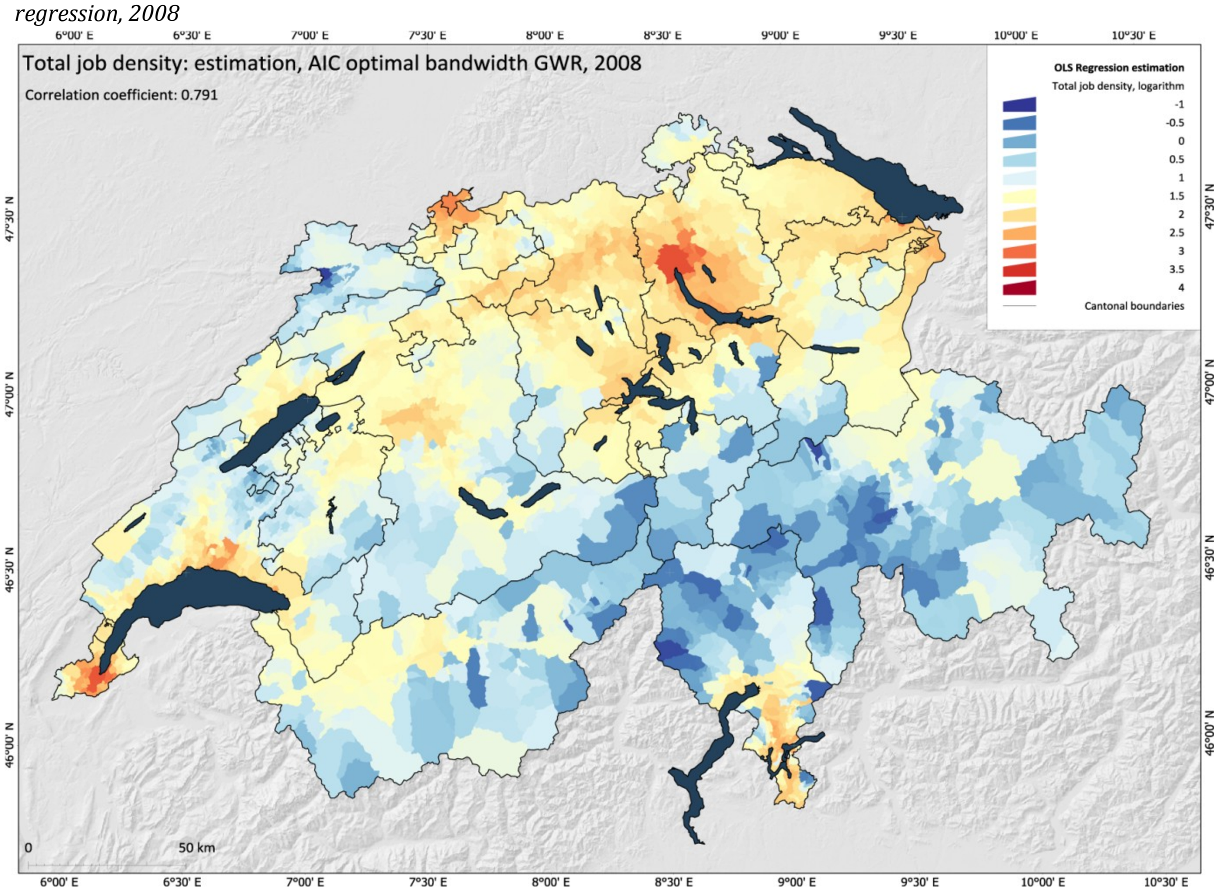
Map 9-5: Logarithm of the actual total job density by commune, 2008



Map 9-6: Logarithm of the total job density estimation through the ordinary least square regression, 2008



Map 9-7: Logarithm of the total job density estimation through the constrained bandwidth, geographically weighted regression, 2008



Map 9-8: Logarithm of the total job density estimation through the AkaikeInformation Criterion optimized bandwidth, geographically weighted regression, 2008

It is interesting to look at the coefficient of determination for each of the results, which are given in the following table. It shows that by and large the general relationship, as approximated by the standard OLS regression, account for about a quarter of the total variance shown by the data. A further fifth seems to be covered by regional variations when using the same bandwidth that the ones used to model accessibility surfaces across the country. Thus, the constrained bandwidth GWR results, which model a general relationship and its regional variation across the country, account for a bit less than half the variance of the population under review. Last, the optimal bandwidth GWR would seem to account for as much as three fifths of all the variance shown in the population – an extreme result which would suggest that once regional and local variation of the relationship is taken into account, the response to accessibility completely dominates all other explanations for the territorial distribution of general job density.

Year	1939	1955	1965	1975	1985	1991	1995	1998	2001	2005	2008
OLS regression Coefficient of determination	0.431	0.304	0.226	0.208	0.224	0.237	0.239	0.242	0.235	0.230	0.227
Fixed Bandwidth GWR Coefficient of determination	0.571	0.483	0.426	0.402	0.432	0.433	0.433	0.434	0.429	0.432	0.424
Optimized Bandwidth GWR Coefficient of determination	0.576	0.588	0.570	0.579	0.593	0.635	0.621	0.636	0.651	0.623	0.626

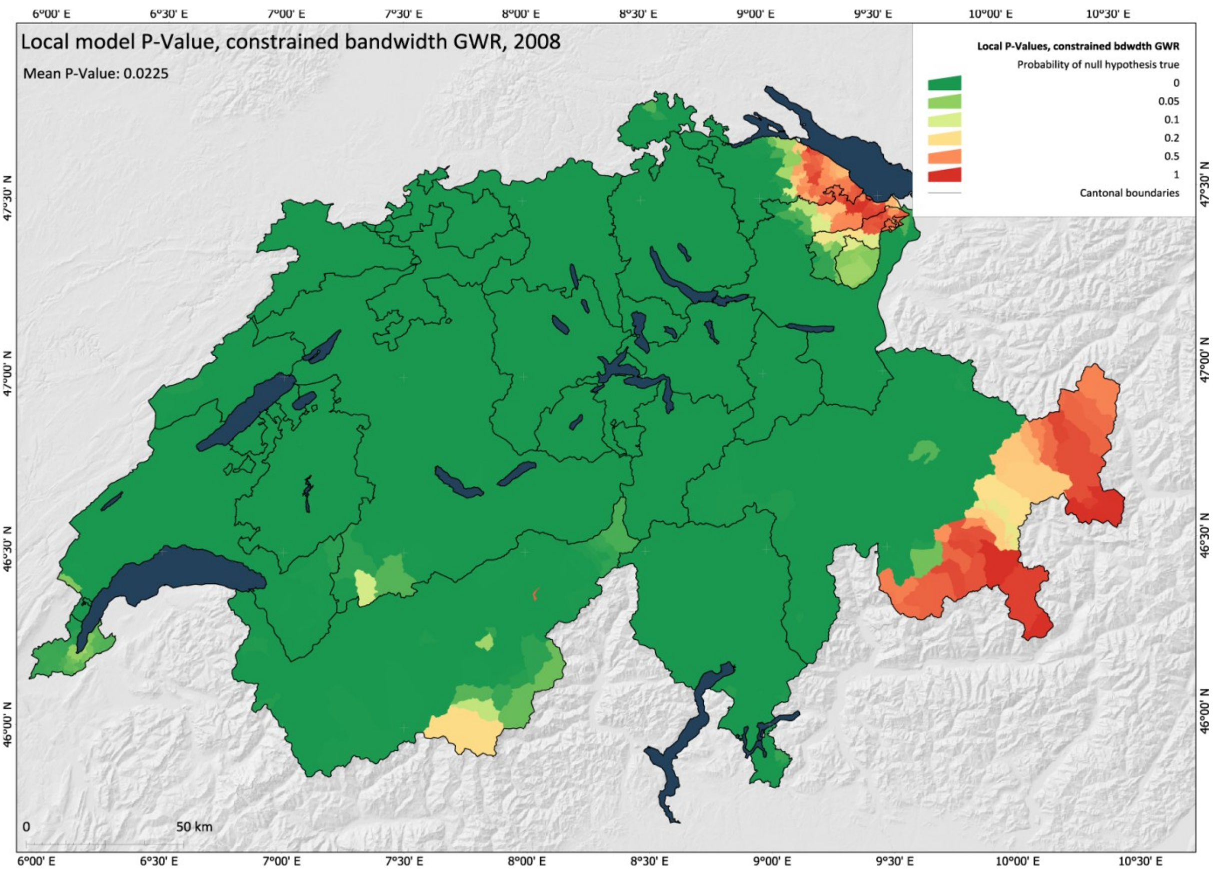
Table 9-6: Coefficients of determination for three distinct regression procedures, for various years

However, when going into the entrails of the AIC optimized bandwidth GWR results, there seems to be a problem. The GWR technique allows for setting the parameters at each data point taking into account only data points nearby. Then, parameter values can be inferred, along with their standard errors, and various other statistics such as the local r square and r, the t-statistics, and the P-value. We are here particularly interested in the P-values at each of the data points. While the constrained bandwidth GWR gave local P-values which were well within critical values, with national means situated between 2.1% and 3.3% chance of the null hypothesis being true at any data point, the AIC optimized bandwidth GWR is marked by very high P-values national means, at between 22% and 37% for all years, except 1939.

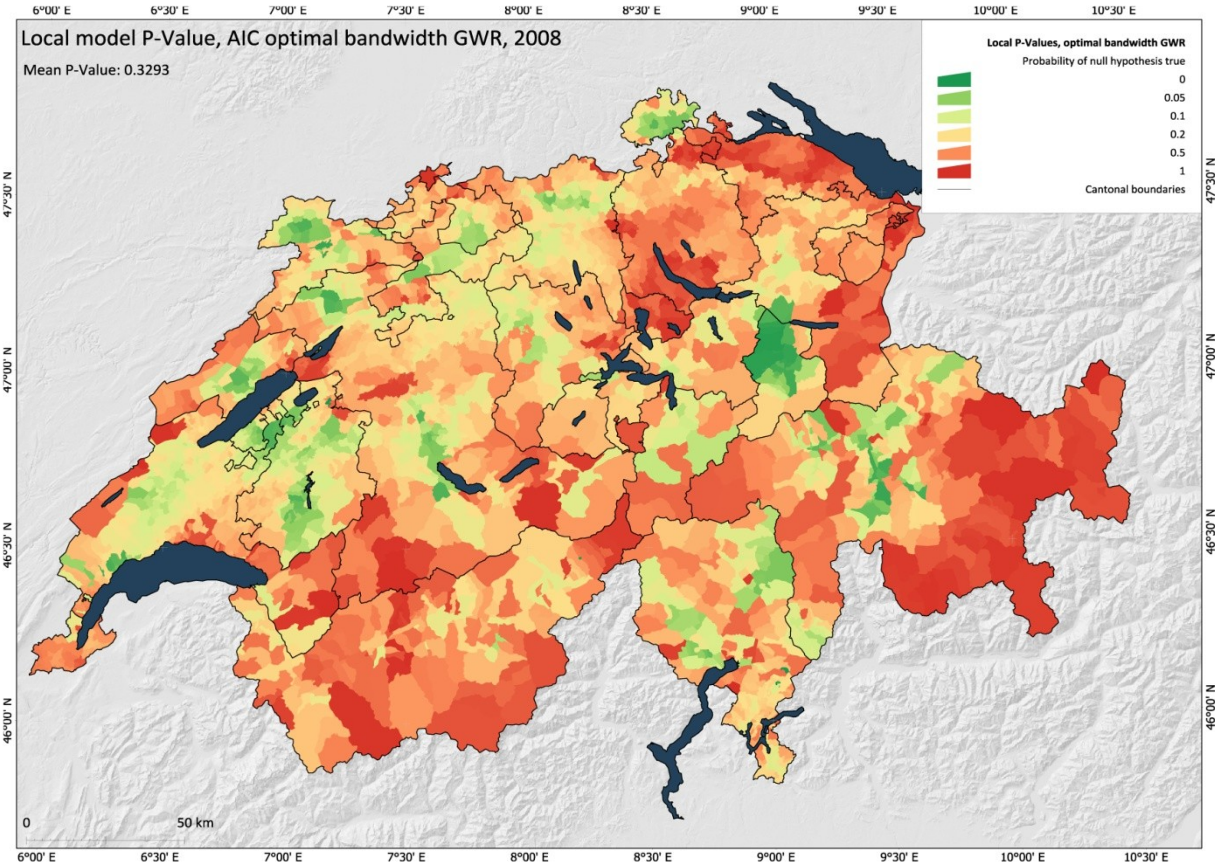
Year		1939	1955	1965	1975	1985	1991	1998	2005	2008
Mean local P-Value	**Constrained Bandwidth GWR**	0.0207	0.0243	0.0330	0.0248	0.0224	0.0218	0.0215	0.0224	0.0225
	AIC Optimized Bandwidth GWR	0.0356	0.2215	0.3671	0.3555	0.2984	0.3686	0.3567	0.3144	0.3293

Table 9-7: Mean P-values for two distinct geographically weighted regression procedures for selected years

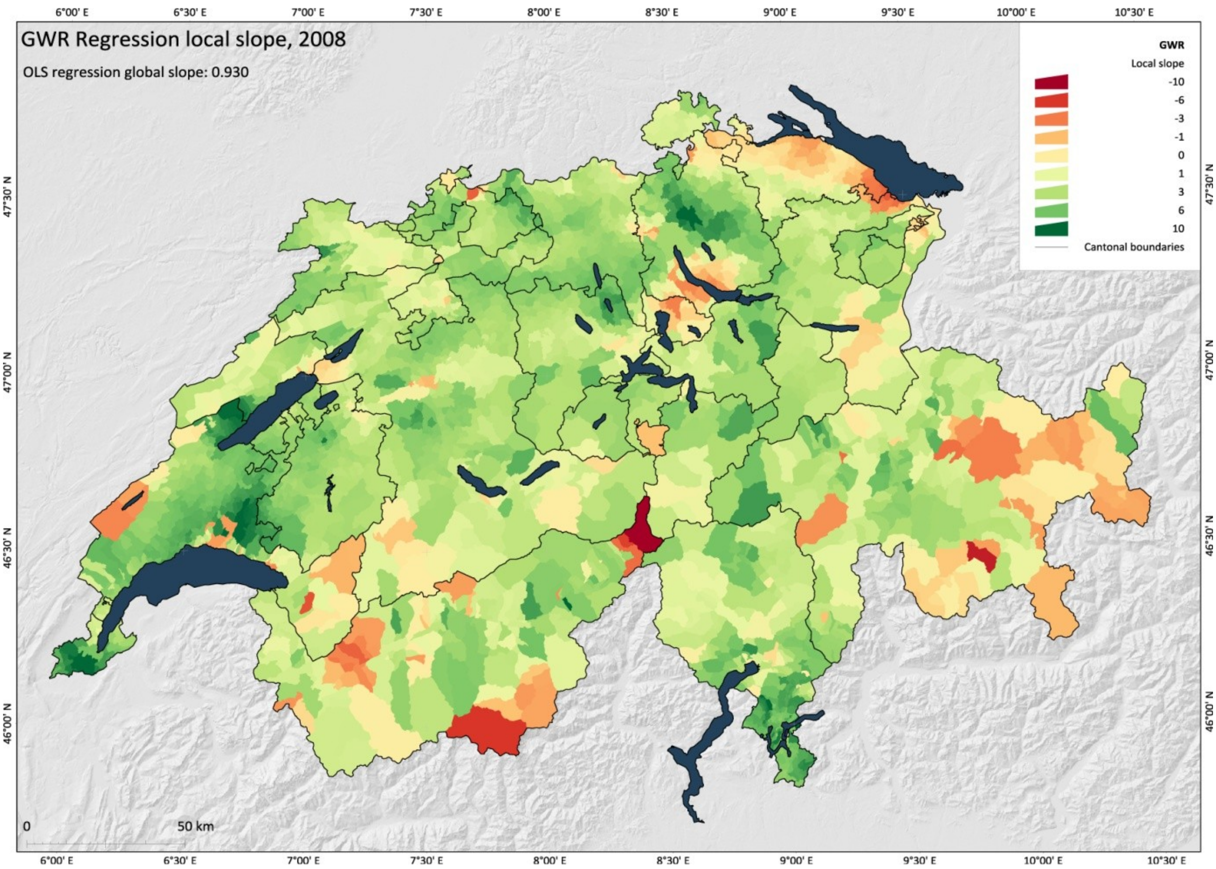
The mapping of those results for 2008 expresses the big difference between both GWR results (*Maps 9-9 & 9-10 overleaf*): while P-Values are close to 0 for most communes in the constrained bandwidth GWR, in the AIC optimized bandwidth GWR, only a small minority of the communes shows P-Values amounting to less than 10%. Those results seem to indicate that there is over specification with the AIC optimized bandwidth GWR, which manifest first by an impossibly high amount of agreement with the phenomenon to be modeled, and secondly by the low statistical quality of the relationships found at the local level. This puts into question the use of the AIC as an optimization technique for bandwidth selection – in effect, it seems that in our specific case, this technique destroys the quality of the local relationships by setting the bandwidth too low and allowing for modeling to be locally made with not enough data points to be reliable.



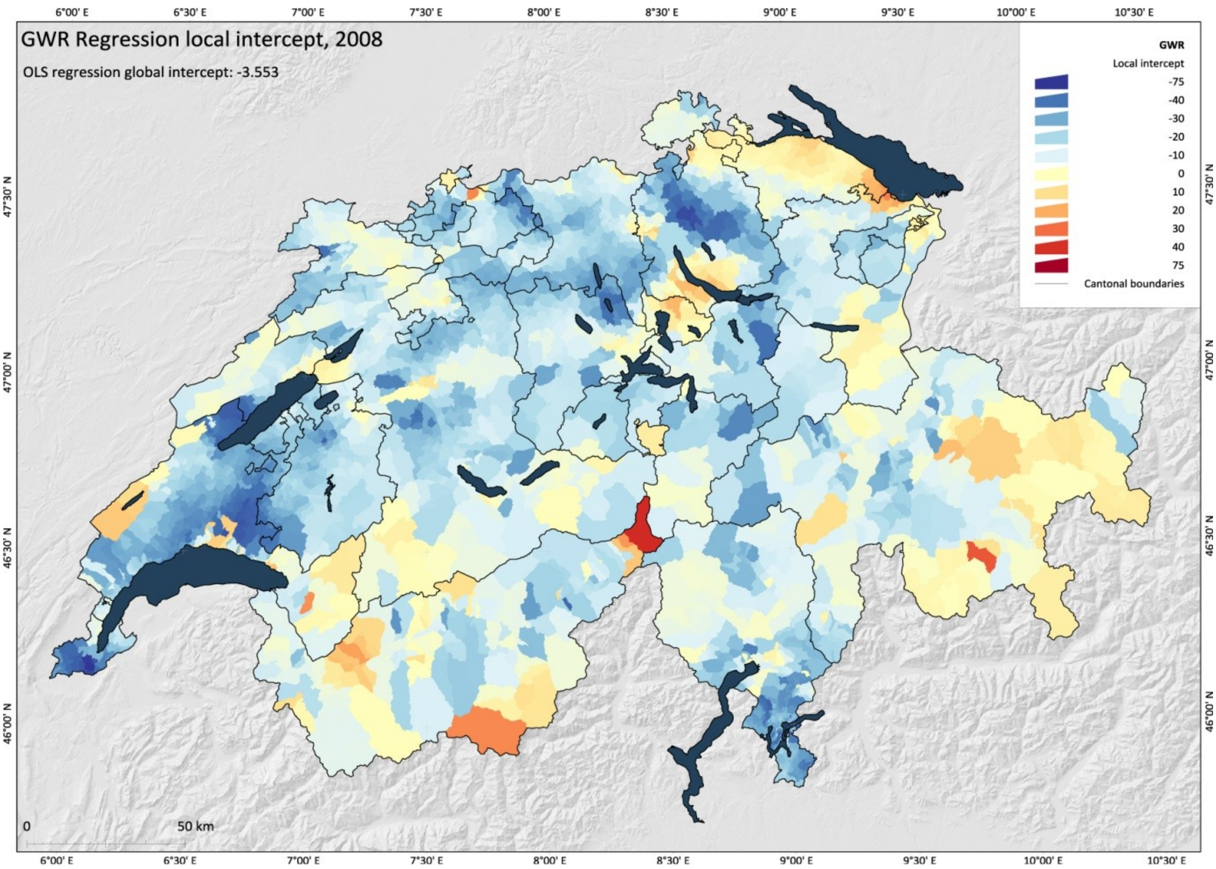
Map 9-9: Local P-Values for the constrained bandwidth geographically weighted regression, 2008



Map 9-10: Local P-Values for the AIC optimized bandwidth geographically weighted regression, 2008



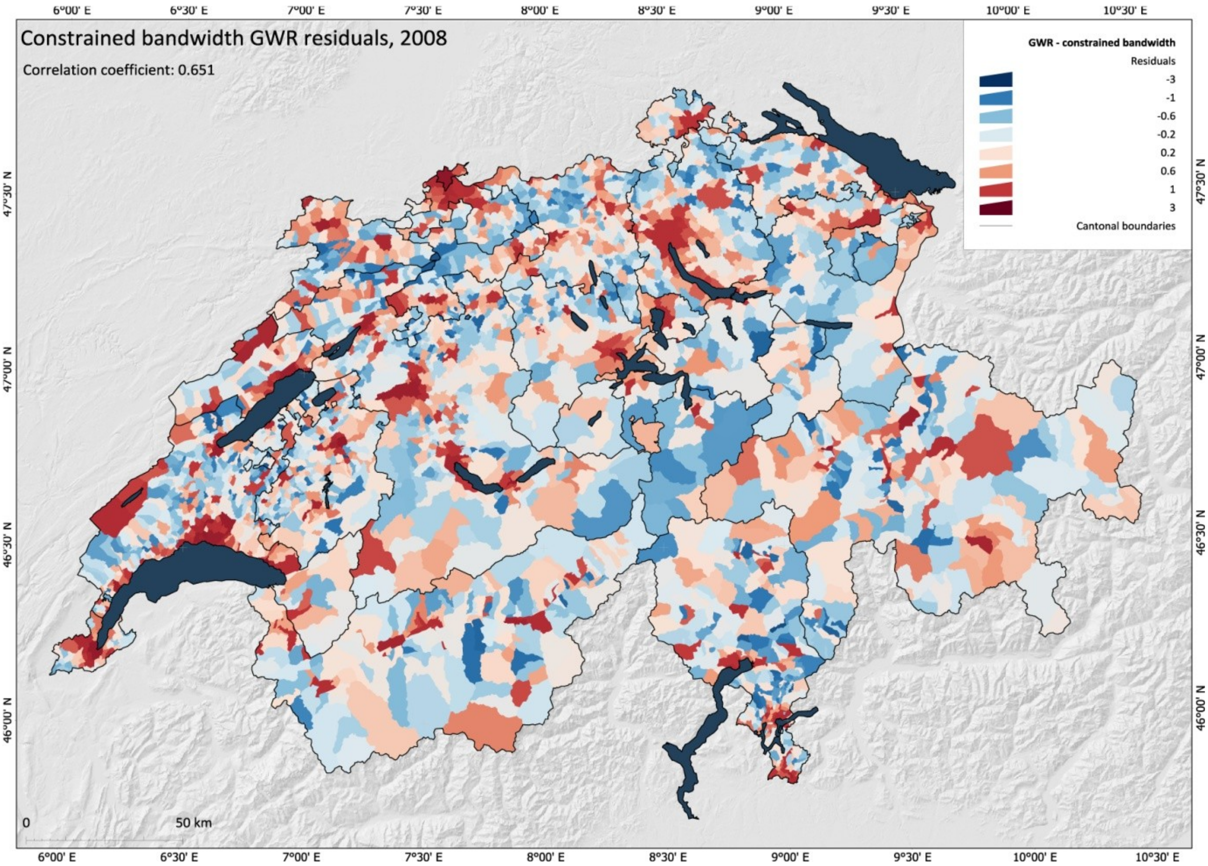
Map 9-11: Local slope value for the AIC optimized bandwidth geographically weighted regression, 2008



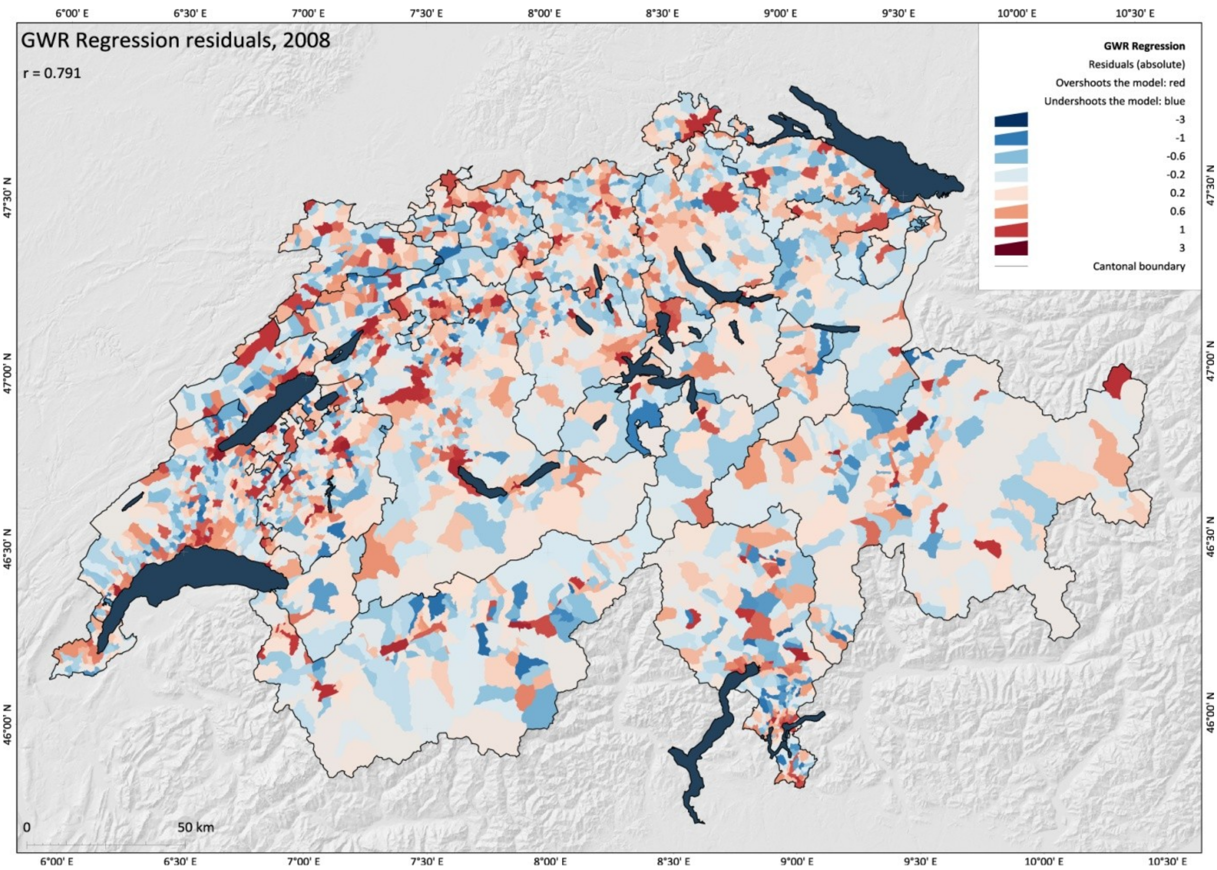
Map 9-12: Local intercept value for the AIC optimized bandwidth geographically weighted regression, 2008

That there may be some amount of over specification in the AIC optimized bandwidth GWR is also apparent when looking at the local intercept and slope values returned by the procedure (*Map 9-11 and 9-12*). As can be seen, the range is much extended both for intercepts and for slopes, which suggest that values can vary wildly from one point to another, to aberrant values: for instance, a slope value of 6 would indicate that the local job density would vary in step with the sixth power of accessibility. The mean local slope value is 3.5, which would suggest that in general the relationship would show a tremendous response situated between the third and the fourth power, a doubling of accessibility provoking a tenfold increase of general job density, all this with local values varying between less than zero to close to ten. Local results do not seem to be very robust, neither are they very believable.

While local relationships seem to be too good to be true when looking at specific points, the look at the spatial distribution of residuals for all three models under investigation (*Maps 9-4, 9-13 and 9-14 overleaf*): OLS regression, constrained-bandwidth and optimized-bandwidth GWR, tend to show that only the optimal bandwidth GWR does get rid of spatial non-stationarity, while the pattern we found by studying the OLS residuals is still somewhat present when looking at the constrained bandwidth GWR. Thus, the latter did not completely get rid of spatial non-stationarity. In that sense, the AIC optimal bandwidth GWR results are valid as it does effectively dispose of spatial non-stationarity.



Map 9-13: Constrained bandwidth geographically weighted regression residuals, 2008



Map 9-14: AIC optimized bandwidth geographically weighted regression residuals, 2008

In conclusion, we're left with a mixed picture. The AIC optimized bandwidth GWR allows us to effectively suppress all spatial non-stationarity in the residuals of a collection of models which display striking results with correlation coefficients situated close to or at 0.8, which means a variance explanation of about 60%, a tremendous result if there was one. However, those impressive results seem to be a little over the edge, obtained at the expense of stability and reliability of local parameter estimations. The model seems to be over specified. And over specification would manifest itself in precisely the way seen here, with unstable and statistically unreliable local parameter sets. The constrained bandwidth GWR, taking into account the bandwidth used to define accessibilities, displays far more reliable and stable local parameters, but at the expense of its quality of representation and the spatial stationarity of its residuals. The literature seems to indicate that we shouldn't discard the optimized GWR results altogether – however, we feel much more confident in exploring local circumstances which seem reliable and stable to a point.

In all, it seems that the relationship we tried to establish between accessibility and general job density is well established, even more so by the use of the GWR technique. The optimized bandwidth GWR gives us hints at a very high correlation between accessibility and general job density, once spatial non-stationarity is taken into account, that is, once regional and local effects are taken out of the picture. However, for local circumstances, parameters estimated by the constrained bandwidth GWR seem more reliable. Those, then, will be used exclusively when looking at the spatial patterns given by locally varying parameters, slope and intercept.

9.6.3.2. Local results

Aspatial results

Before delving into spatial patterns, first we take a look at some general remarks about the data encountered. First, it is to note that for each epoch, local slope and local intercept values are very strongly anti-correlated, at absolute values situated between 0.98 and 0.99. That is to say that, as for the OLS regressions, a steeper slope goes with a lower intercept and that their spatial variation is practically identical. This means that the pivot around which all local regression lines pivot is situated well away from the y-axis at x = 0. In fact, the pivotal points are situated around the actual values taken by accessibility's logarithm, which for the most part lie between 3 and 5.5, expressing accessibilities ranging from 1000 to 300'000 accessible active residents.

That is to say also that in effect only one of the parameters is free to vary, as the second one is basically determined by the value that the first will take. Here, as intercept values concern whatever value will be taken by density when accessibility is nil, we will be more interested by the values taken by the local slopes, which will be studied hereafter.

The second important point is to note that for each epoch under review, local slopes are significantly steeper than the global slope provided by the OLS regression. That is to say, the global relationship was being blurred by the differing values slopes and intercepts were taking locally, to the effect of lowering the slope of the general relationship. When considered locally, the slopes are way steeper than reported by the OLS regression model, the ratio varying from 1.5 in 1939, to 2.2 in 1985. This means that the actual relation between accessibility and general job density, as felt locally in all points of the territory, is much stronger than emphasized by global methods.

Year	1939	1955	1965	1975	1985	1991	1998	2005	2008
OLS Regression slope	0.865	0.740	0.682	0.718	0.778	0.805	0.910	0.903	0.930
GWR mean local slope	1.224	1.436	1.446	1.566	1.711	1.710	1.838	1.959	1.993

Table 9-8: Regression slopes for OLS and GW regressions for selected years

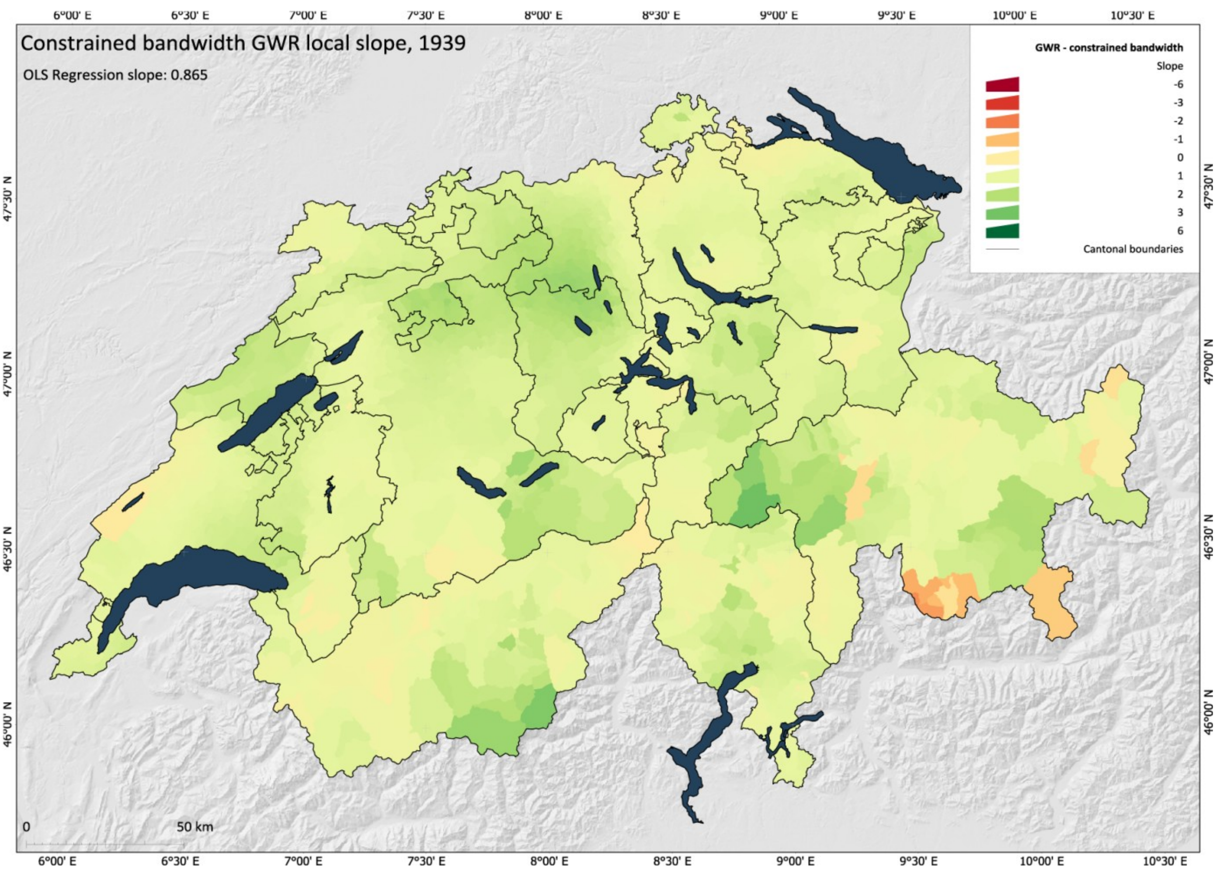
Moreover, the mean local slope has become steeper with time, going from 1.224 in 1939 to almost 2 in 2008, meaning that the link between the two has become more intense with time. Locally, in 1939 a doubling of accessibility would be expected to result in a multiplication by 2.3 of the general job density, but by 2008 the same accessibility doubling would be resulting to a quadrupling of the general job density.

Two facts must be retained from this small study; first, that considered locally the relationship between accessibility and general job density is steeper than the OLS regression would model, by a important factor considering we work in logarithmic scales. Secondly, this relation has been exacerbating with time, with the response in general job density growing stronger with time to changes in accessibility. Both these general conclusions comfort us in our idea that a strong link exists between accessibility and general job density, our proxy variable for the quality of a location as a job place.

Spatial results: Changes, 1939-1975

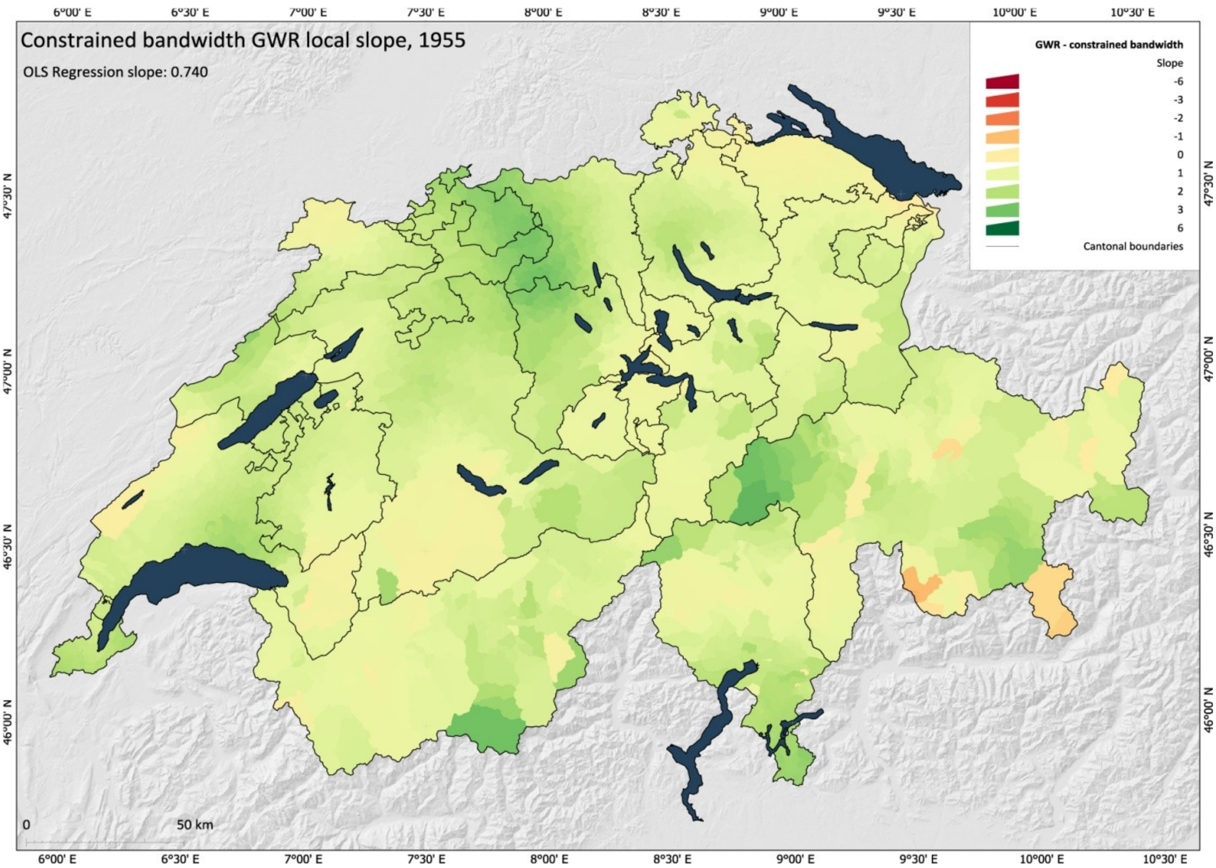
The slopes are not only varying with time, they are varying with space. GWR allows us to explore slope variations through space and time. This part explores these variations.

In 1939 (*Map 9-15*), the local slope mean was relatively low, at 1.224, and we can see that its

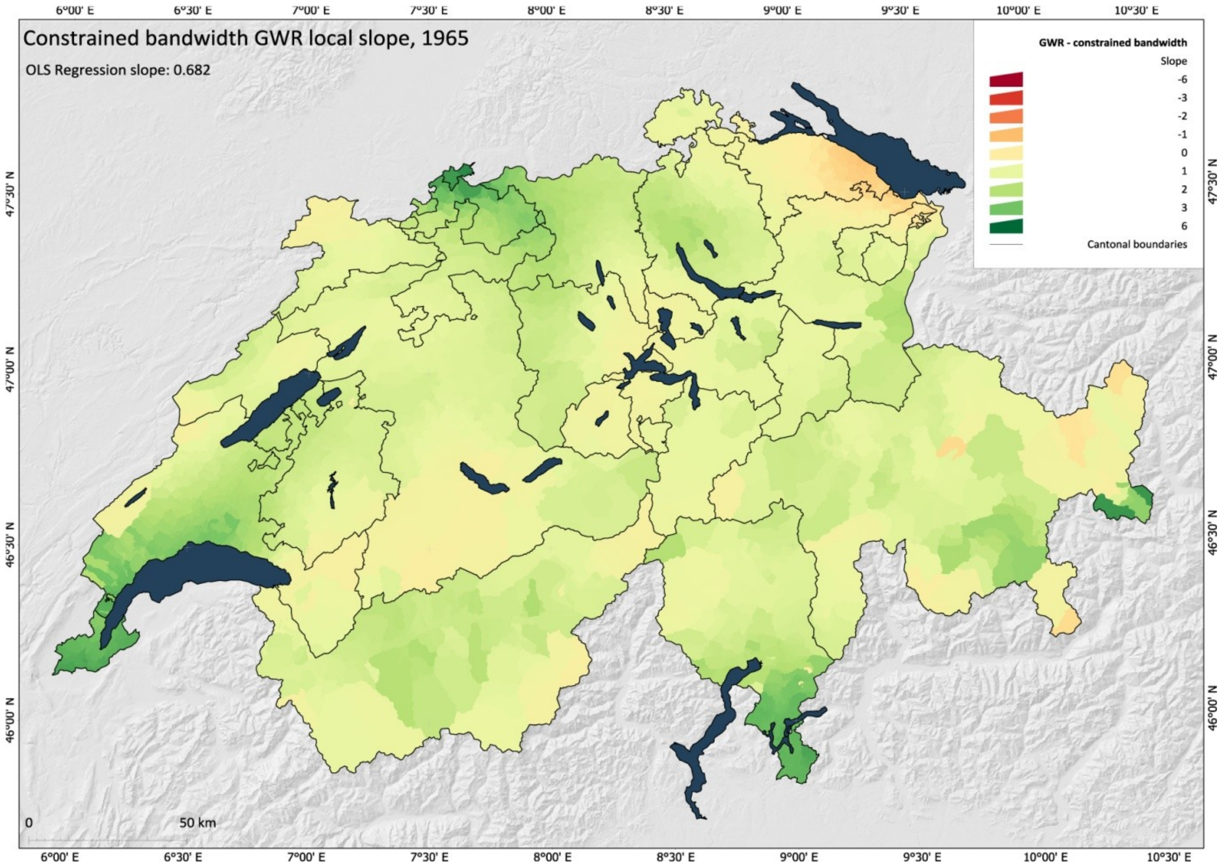


Map 9-15 : Local slope value, constrained bandwidth geographically weighted regression, 1939 variation wasn't very impressive, at least in low-lying areas. This would confirm that at this epoch territorial differentiation was above all local, between urban centers and their rural countryside, far more than between regional ensembles. Notable are two Graubunden high valleys where the relationship is being inverted, lower accessibility going hand in hand with higher job densities. This can be explained by local circumstances, where lowest lying areas, where the valley is the widest, is also situated right on the border and the least accessible from the rest of the country. This effect will be encountered in various states and regions of the country – it generally affects such special geopolitical anomalies, which are quite numerous in Switzerland.

By 1955, the local slope had grown to 1.436, and genuine variations started to appear throughout the territory and in particular in areas where it counted much (*Map 9-16*). For instance, slopes were being clearly steeper than the mean value between Basle and Olten, and they were also rising in the Lake Geneva region, the Zurich agglomeration and the Sottoceneri region of Ticino. In the Basle-Olten axis, values were typically found around 2.5, meaning that a doubling of accessibility translated to more than a quintupling of general job density. In this area, by 1955, job places were strongly being structured by accessibility. To lesser degrees that was also the case in the other regions mentioned, although the slope values there were being more modest, with 2.2 in Lausanne, 1.9 in Zurich and 2.1 in Lugano. Meanwhile, in some other areas values remained low, like in St-Gallen, with 0.9.



Map 9-16: Local slope value, constrained bandwidth geographically weighted regression, 1955

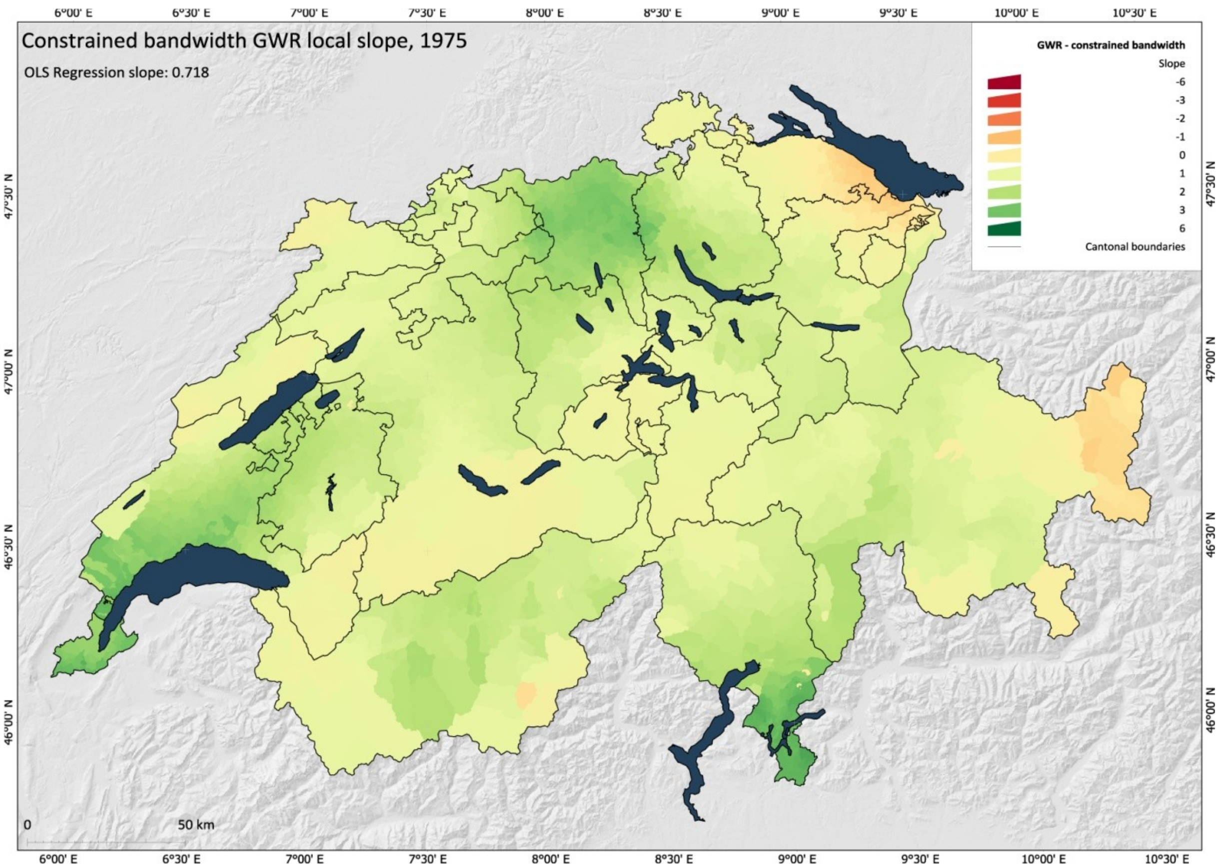


Map 9-17: Local slope value, constrained bandwidth geographically weighted regression, 1965

The interesting point in 1965 is that the patterns found in 1955 had greatly evolved to make place to newer patterns, which were exacerbating the trends seen in 1955 (*Map 9-17*). The mean slope had remained stable at 1.446, but in some regions the relation had clearly exacerbated. This was particularly the case in several well defined regions: the Basle region at first, with gradients around 4 (!), then the Lugano greater region and the Lake Geneva area, the only one at the time to benefit of a highway, where gradients commonly amounted to 3 (3.3 in Lugano and Geneva, 2.9 in Lausanne). In Zurich a modest steepening of the slope was also noted. In areas like Basle and Geneva and Lugano, general job density responded very strongly to accessibility. In Basle and Geneva it could be surmised that all locations had approximately the same accessibilities: there was basically a factor of 2 between lowest and highest accessibilities in the agglomerations of the time, then the very steep gradients were "needed" in order to account for what could amount to normal differences in job densities. Such an argument is more difficult to hold in the Lugano region, where the topography ensures very wide variations in accessibility from one place to another – the fact that even in such settings the slope of the relationship remains very high is a testimony of the strong phenomena at hand. In any case, even if accessibility was getting smoother across the territory, which it definitely was, the steep slopes, combined with the very small local P-values and the high local r-values meant that only minute changes in accessibility were sufficient to create wide gaps in general job density. In that case, only minute advantages for one location against others could translate in big differences in quality as a job place.

Another very important point to be made by 1965 is the peculiar behavior noted in Eastern Switzerland, with the apparition of a wide region where the relationship was inverted (Arbon TG: -0.55). This warrants further research, but a first explanation can be held there. To the contrary of Lake Geneva, in the southern shores of Lake Constance, the main axes of communication with the rest of Switzerland do not run parallel to the shore, but perpendicular to it. Seen that way, the region looks a bit like a hanging valley, with paths ending at the lakeshore at established cities: Romanshorn, Arbon, Rorschach, which looks a lot like cul-de-sac places – there, the same explanation than the one we gave about Graubunden upper valleys would seem plausible. It is to note that a highway was initially planned along the shores of Lake Constance in the 1950s but did not make the final selection. It would be interesting to test for the impact such a highway could have had on the accessibility-general job density relationship on this region. In mitigation of this explanation it is to note however than in the Jura mountains slopes were getting flatter than before, as in the relationship between accessibility and general job density was less important in industry dominated regions, as the Jura mountains and the cities along Lake Constance shores, as in other, more tertiary ones, like Zurich, the Lake Geneva area and Ticino.

Again, there were many changes between 1965 and 1975 in terms of spatial variation of local slopes (*Map 9-18*). In general, slopes went a bit steeper, to 1.566. More importantly, the spatial variations patterns for 1975 showed both similarities and differences with the 1965 situation. The most notable difference concerned the Basle-Aargau region, with a strong slope flattening for the Basle region and a strong steepening in Aargau. By 1975, the gradient slope in Basle was back to 1, down from 4 in 1965. Conversely, Baden AG went from 1.5 in 1965 to 2.8 in 1975. At the same time, all other focal points remained rather untouched, with the Lake Geneva, and the Sottoceneri regions still exhibiting slopes way above the national mean, while the Jura arc and especially Eastern Switzerland still showing their strong difference.

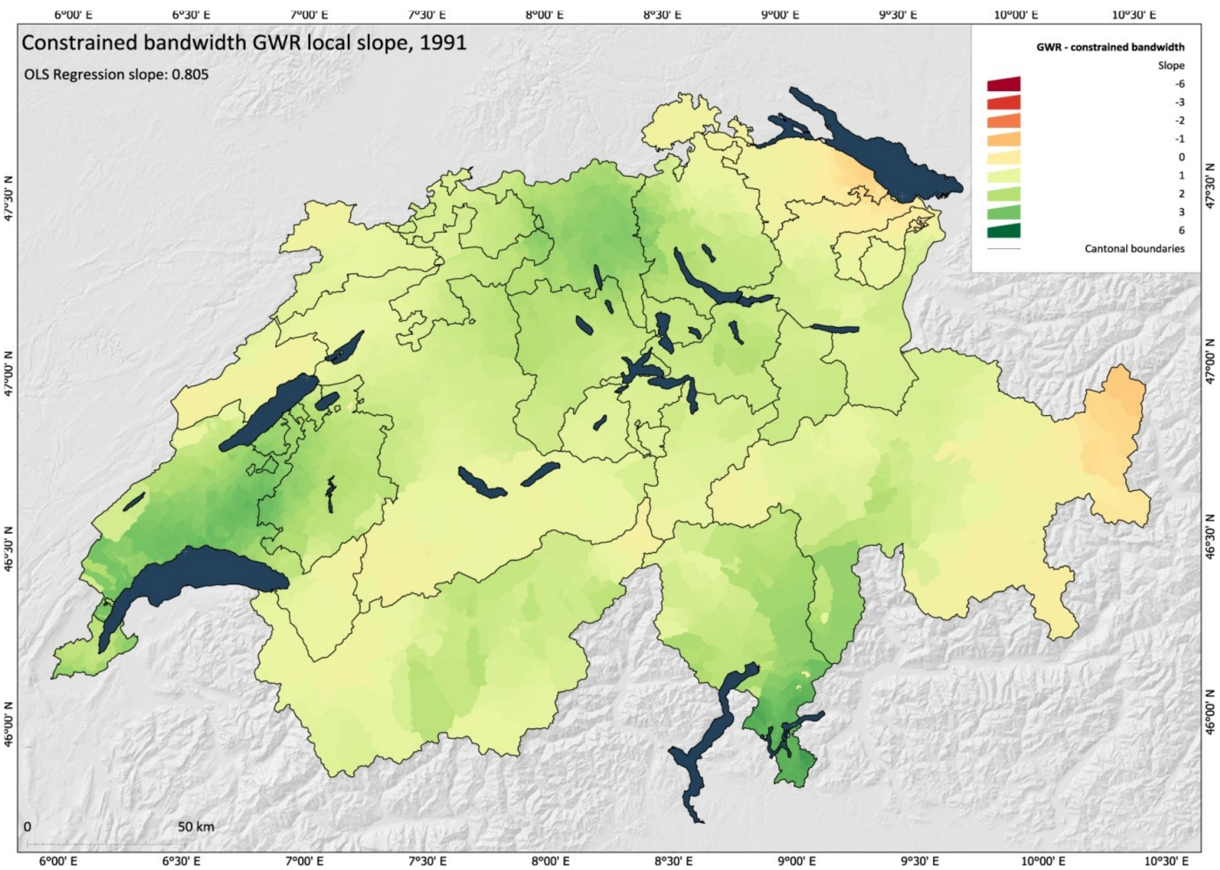


Map 9-18: Local slope value, constrained bandwidth geographically weighted regression, 1975

Spatial results: Stability, 1975-2008

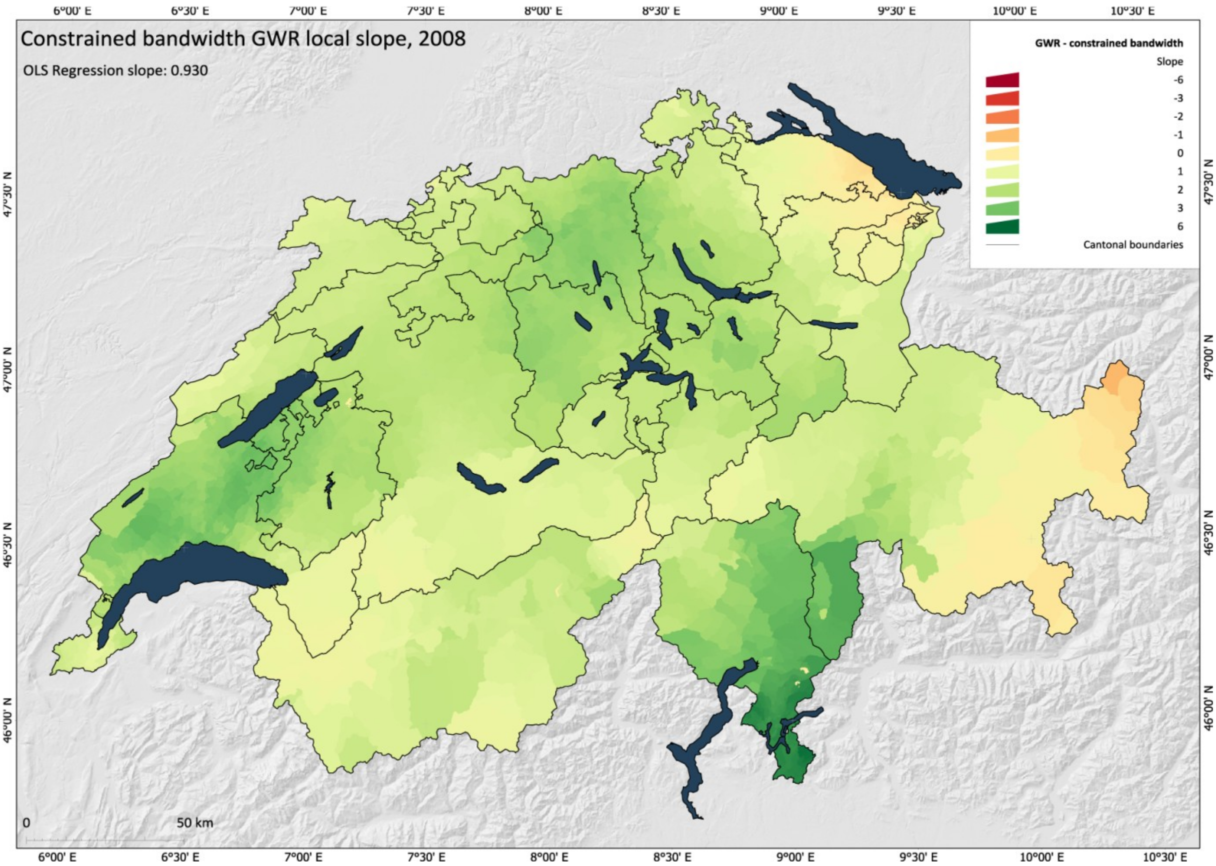
The most interesting feature of the 1975 distribution is that it has remained broadly stable ever since. While from 1939 to 1975 massive changes were seen in terms of local circumstances, suggesting massive changes happening in territorial hierarchies across the country, from 1975 on the "new spatial order" seems to be in place, at least in terms of local variation of slope parameters. We show here maps for 1991 and 2008 (*Maps 9-19 & 9-20*) which confirm the global impression of stability. Of course, some changes were noted: in the Lake Geneva region, the progressive spillover of steeper slopes from the shores towards the countryside around and beyond Lausanne, towards the Broye valley and Fribourg and the relaxing of conditions in the Geneva area; in Ticino, the progressive colonization of the Sopraceneri and Moësa by steeper slopes, and a strong reinforcement of slopes towards 2008, the gradual enlargement of the Aargau region of steep slopes to adjoining regions, most notably towards central Switzerland and the greater Zurich area, the reinstatement of steeper slopes in the Jura arc during the last period under review, and the progressive but slow obliteration of the negative slopes seen along the Lake Constance shores along a broadening of such tendencies in the whole Engadine valley and its three ultramontane annexes over the Maloja, the Bernina and the Fuorn passes – in Engadine, remoteness seems to be an asset, which is probably correct given the touristic orientation of the valley's economy.

More generally, what is the geography revealed by varying local slopes since 1975? Essentially, metropolitan regions appear to sport steeper slopes than non-metropolitan ones. At the same time, as metropolization advances in Switzerland, the mean local slope tends to reinforce across



Map 9-19: Local slope value, constrained bandwidth geographically weighted regression, 1991

the board, while differences are smoothed out. In 1975 important differences between the steep slope regions and flat slope ones remain, and in some areas transitions can be abrupt, like in northern Zurich, or between Aargau and Lucerne. By 2008, such gradients weren't seen anymore, and it is as if, at least in low lying areas, metropolitan processes had smoothed out major regional differences while raising gradients everywhere. Here is a list of cities with their gradients for 1975, 1991 and 2008, across the Swiss Mittelland along the east-west and the north-south axes, along with the economic center of Ticino (*Table 9-9*).



Map 9-20: Local slope value, constrained bandwidth geographically weighted regression, 2008

City	Local slope, 1975	Local slope, 1991	Local slope, 2008
Geneva	2.493	1.688	0.948
Lausanne	2.840	3.127	2.865
Fribourg	1.698	1.925	2.189
Berne	1.338	1.426	1.837
Olten	2.019	2.010	2.199
Baden	2.781	2.643	2.560
Zurich	2.041	1.885	2.119
Winterthur	1.186	1.180	1.577
Wil	0.617	0.530	0.794
St-Gallen	-0.126	0.128	0.168
Basel	1.006	1.246	1.266
Schaffhausen	0.771	0.680	1.414
Zug	1.118	1.698	2.112
Lucerne	0.778	1.452	1.880
Lugano	3.260	3.429	4.644

Table 9-9: Local slope values for selected cities and selected years

What can be seen is that for 12 of those 15 cities, gradients have climbed since 1975. The three exceptions are Geneva, Lausanne and Baden, areas where in 1975 gradients were very high; the most pronounced climbs were recorded in Lugano, Lucerne, Zug, Schaffhausen and Bern, all areas outside metropolitan areas in 1975, but included in them by 2008. True metropolitan cores: Geneva, Lausanne, Basle and Zurich, remained stable or in the case of Geneva, saw its gradient decline. This confirms the idea that metropolitan areas expanded and brought with them their enhanced dependence on accessibility.

The main find here remains that by 1975, metropolitan areas seem to depend more on accessibility to locate their job centers than the rest of the country, and that the core territorial patterns were in place by 1975. As metropolitan space expanded into neighboring territories it brought them this added dependency to accessibility, while in outlying regions, obviously in the touristic areas but also, to a point, in industrial ones, this dependency was less evident. This is also true of metropolitan cores: in the major urban centers, by 2008 the gradients are clearly less than they are in most of their suburban belts. Thus, the geography revealed by the varying values local slope take by 2008 is one of two worlds, a metropolitan one, largely suburban, where accessibility is a very important component of the spatial competition and where any accessibility gains may translate handsomely in terms of job centrality: a landscape of highway exits development zones and of edge cities, juxtaposed to areas where accessibility, while still important, plays less of a structuring role, areas which seem to include major urban centers, some industrial regions, what's left of rural areas and most of the mountainous regions.

9.7. Management summary

In this chapter, we made the following conclusions:

The measure of job quality which correlated the best with accessibility is the general job density, by a wide and undisputable margin. This means that as far as our core hypothesis is concerned, there is a link between accessibility and at least a measure of job quality. This measure, general job density, indicates that in a given community, the more accessible it is, the more jobs it will hold per sq km, regardless of the affectation of its land. This, in turn, indicates that the regulatory environment is weak: an accessible commune will get an important number of jobs, but those will tend to be located in newly opened real estate as well, and probably more so, than in existing, dense developed land.

The statistical relationship between accessibility and general job density holds after taking spatial autocorrelation, which is present to a varying degree in both accessibility and general job density. Spatial autocorrelation doesn't destroy the significance of the statistical link between the two, as tested by the modified t-test by Clifford et al 1988, Dutilleul et al 1993.

The study about possible time-lags between accessibility and general job density seems indicative of two different conclusions. The first seems to show that there is a causal dependency between accessibility and general job density, as the latter responds better to the former when time lags are entered. We have not found an optimal time lag at which the relationship would peak. This seems to indicate that this time lag could possibly be very big, exceeding several decades. The data at hand seems to sustain such a conclusion, which brings us to our second point, which is that there is a very strong territorial imprint of past processes, and that current spatial distribution is the sum of all moves made in preceding decades and very possibly centuries, and to a large part space is still trying to adjust to those past changes as well as to current ones. The inertia space demonstrates seems to preclude it from ever reaching an equilibrium state with current conditions, as those conditions seem to evolve far more rapidly than space itself.

The residuals of the classical OLS regressions on which the preceding results are based show definite spatial non-stationarity. Urban areas general job density is systematically underestimated, while rural areas general job density is systematically overestimated by the model. This indicates that the relationships under review display a significant amount of spatial variation which doesn't seem to be random.

The residuals study does not show any overriding regional effects in the way accessibility plays against general job density. This is a surprise as we were certainly expecting such regional effects to be present, which would show over-modeling of central regions against peripheral ones, for model specification reasons – namely the fact that Switzerland was taken as an island. This seems to confirm that the most prominent metro area of the country, the Zurich-Aargau complex, is decidedly stronger than all other metro areas of the country Basle, Lake Geneva, Berne and Ticino.

The introduction into the model of the hypothesis of a spatially varying relationship between accessibility and general job density through the use of the geographically weighed regression allows for a clear amelioration of the quality of representation of the model, to about the same variance share than the non-spatial version of the model, or about a quarter each. The models used which integrate spatial variation as a component do show that a very important share of the variance of general job density can be explained by variations in accessibility. Thus, our core hypothesis seems vindicated.

The intensity of the relationship between accessibility and general job density seems to grow with time. This could be due to a general smoothing of accessibilities throughout the territory as its bandwidth grows, but even so, the implication is there that smaller and smaller advantages in accessibility do translate in the same gains in general job density. As such, spatial competition seems to be sharpening across the board.

The spatial variation of the relationship between accessibility and general job density shows that by and large, since 1975 at least, metropolitan areas seem to experience a sharper link between accessibility and general job density than older urban cores, and above all from industrial and peripheral regions in general. Thus metro areas, particularly its suburban and periurban components, are experiencing stronger competition for better accessibility than peripheral regions, and to a point than urban centers which seem to be somewhat shielded from those effects, having benefited from them earlier.

10. Conclusion: what was achieved, what remains to be done, and does it matter?

10.1. What we have found

The core hypothesis of this research was the belief that above all things accessibility by car was the main reason behind the modifications in territorial distribution of jobs and of the economy since 1939, and in particular behind the rise of the suburban job centers. The whole work was like a long march towards this main goal: first it defined and researched job centers so as to have a complete database, and a complete understanding on the inner dynamics of the spatial evolution of job centers through the bigger part of the last century; then it defined, studied and got a feel of what was accessibility, how it evolved with time, why it evolved that way, what were the determinants of its evolution; and finally it grouped those two questions into one by comparing job distributions with accessibilities to search for a statistical association which would be indisputable.

In the end, we pretend we succeeded at demonstrating our core hypothesis in chapter 9: our work statistically shows that there is a causal link between accessibility by car as we defined it, and job distribution. Changes in car accessibility cause changes in job distribution. Jobs are attracted to points which are more accessible by car than their neighbors. If the accessibility of a point is getting better, especially in relative terms, it will attract more jobs that it did before. All those propositions were confirmed when studying Switzerland between 1939 and 2008, and we think Switzerland is a pretty exemplary country to that respect.

We have also seen in chapter 9 that while entirely true, the link between accessibility and job distribution was playing in the very long term. Spatial inertia is very strong and it takes decades, or more, for a territorial distribution to adjust to new accessibility conditions and to new accessibilities, to the point that it is probably illusory to think that there is such a thing as a territory in equilibrium – clearly, conditions which cause spatial variation change at least as rapidly as space can adjust, and for this reason space is always in a state of evolution. There is ample evidence in this work of an ever moving, ever evolving spatial distribution of jobs.

In those evolving conditions, in the last quarter of a century at least, places are not equal in the competition they face for job locations. While there is a general link between accessibility and job locations, this link has become sharper with time, meaning that gains or losses in accessibility are likely to have more impact now than they had before. Studies on the spatial variation of those links also show that some areas now respond better to spatially and temporally changing accessibilities – currently, metropolitan areas outside traditional centers are more sensible to accessibility changes than peripheries and to a lesser extent classical urban centers. In those metro areas, accessibility plays a huge role in shaping what goes where.

Those fundamental finds merit some more attention in what they indicate on the current and possibly future state of the spatial economy in Switzerland – the implications of those finds are far-reaching and we will come later on about what they really signify. In the meantime, we have made many side finds in the course of the long walk we were talking about, which answer to the many hypotheses we formulated in chapter 1. Here is a summary of those finds, which answer those hypotheses.

We amply showed that major changes have affected the way jobs are spatially spread since 1939, which manifest themselves as a general, long term evolution from an urban-dominated hierarchical network towards a metropolitan mesh of accessible places where hierarchical links are more subtle and less territorially evident than before. This evolution saw, or more correctly was epitomized by the massive rise of suburban centers, which have taken a major place in the urban network with close to a quarter of all non-agricultural jobs in 2008. As metropolization is the major functional change the territory has experienced since 1939, the suburban centers emergence is the major morphological change we have witnessed over the years; other urban forms: urban, exurban and touristic centers were already present in 1939, while mixed centers still represent but a small part of the total job numbers. Suburban centers are even more significant in that they absorbed the major part of urban growth since 1939, and practically exclusively so since 1965. While we hypothesized that they would demonstrate frailty, at least when emerging, the fact is that they have proven far more resilient than most other urban locations we have encountered during the better part of the century under review. Urban, touristic and above all exurban centers showed way more frailty, tendency to disappear or to flicker in and out of view than suburban centers. We could almost say that once a suburban center has emerged it is very likely there for the long term, and that the size threshold above which they surely persist is decidedly lower than for any other urban location.

In the same vein we hypothesized that with time, important suburban centers would see their economy diversify and their functions evolve towards greater commanding responsibilities – this was indeed shown beyond any doubt in chapters 6 and 7, which showed that this was precisely the case: from humble beginnings when suburban centers were above all industrial and then superstores and warehouses, in the course of the latter decades of our period of study they have seen their economy diversify by gaining higher end activities, most notably in the high tech sector – software and telecoms come to mind, and in the professional services. This confirms another of our hypotheses, which was that non-central job centers were hotbeds of innovative enterprises and activities: as we've seen, while this wasn't always the case, as for a long time those centers remained relatively unqualified places, but recently they have indeed gained major high tech functions. Furthermore, while for most of their history suburban centers were clearly subservient locations, in recent times they have come to host a number of headquarters, which now control almost as many jobs in urban centers than cities are controlling suburban jobs: while not yet of the same size, in terms of controlling power cities and suburban centers are now on equal footing.

That being said, another of our hypotheses has been soundly disproved: we expected to find that non-central centers would show a more integrated economical structure than urban centers; we expected cities to display more of a mix of independent and dependent establishments, and we expected to find more of the latter, and especially more subsidiaries, in non-urban centers than in urban ones. Actually, we found the reverse: the urban economy is way more integrated than the non-central ones. In particular, suburban centers, since 1985 at least, have been less integrated than urban centers, with a higher job share in independent companies than urban centers. This pretty much kills the argument that suburban centers are inert entities created from the cities to receive whatever the center does not want to accommodate anymore. By 1985 already, suburban centers were hosting a healthy mix of independent companies which had independently decided to locate there.

We also surmised that suburban centers would be metropolis markers. This is in fact a truism – as we saw in chapter 1, the forces which lead to metropolization are the same than those which lead to suburbanization: spatial and functional disintegration of business, advent of the knowledge, IT-based economy, post-fordist, just-in-time production techniques all help to develop suburban job centers by mitigating the built-in advantages of the urban centers in terms of interaction qualities and scale economies. What remains is that almost by obligation, suburban centers develop best in metropolises and that metropolises can't but develop meaningful suburban centers. In fact, we could say that suburbanization and metropolization are two faces of a same phenomenon, and as the economy moved from an agglomerative state to an agglomeration-free state, accessibility replaced proximity as the measure of potential relationships. What proximity signified for the rise of the urban centers and networks, accessibility signify for metropolises and suburban belts alike. This fits nicely with larger scope studies on globalization and metropolization along the lines of Sassen 1991, Castells 1996.

Let's come back now to the larger picture of Christallerian networks and metropolises. In chapters 4 and 5, we showed that we were in presence of a classical Christallerian situation in 1939, with a Swiss urban network dominating rural landscapes, and very few things in-between. Throughout this work though, this view has come under attack. In chapter 4 and 5, we saw that as time went by, the rank-size relationships diverged more and more from a distribution which would be commensurate with a Christallerian network. In essence, small centers tended to disappear while larger centers grew out of proportion in a Christallerian framework. Maps, in the same chapters, illustrated the transition from a rather regular spatial layout of urban centers to the disappearance of many centers in lower levels and the advent of seemingly anarchic, aspatial agglomerations in upper levels of the urban hierarchy. In chapter 6, we showed that while in earlier times the economic structure of the urban centers was complete – a requirement under the Christallerian framework, in latter times urban centers have become to specialize in well determined domains, namely financial activities, personal services, both high-end and low-end, and public services. Other economic branches were more represented outside cities, like industry, trade and warehousing, business support services, but also some higher end functions like the high tech sector. In those domains cities have now lost their edge. In particular, the demise of urban retail is in complete contradiction of the role urban centers should play in Christallerian theory. By that fact alone, urban centers aren't Christallerian anymore – in fact we're back into a neo-Weberian paradigm with, inside metropolitan areas, specialized, very much un-Christallerian sub-regions. Then, there's chapter 7 and the illustration of the relationship upheavals from dominant vertical relationships, urban centers commanding the territory and large urban centers commanding smaller ones, to horizontal relations between metropolises, between urban centers of the same size, and between urban and non-urban centers in a more equal footing than before. Horizontal relations seem to have replaced vertical ones. In terms of territorial organization, this again translates as a transition from Christallerian hierarchical urban networks to metropolitan networks, or patchworks, of interconnected and interdependent cities, suburbs, exurbs and edgeless areas.

By the way, the fact that accessibility played a major role in the reorganization of the economical spatial distribution is further confirmed by its spatial evolution, which closely mirrored that of the urban network: it started from a strong emphasis on urban centers, with greater urban centers having better accessibilities than smaller ones and with urban centers dominating their suburban, exurban and edgeless surroundings, and evolved towards a structure where accessibility displays a primarily regional and metropolitan scale, very much in step with the transition from a Christallerian to a metropolitan urban structure.

Accessibility as we defined it – the capacity of a place to be attained in a reasonable amount of time by a certain number of people plays a vital part in this spatial reorganization of the economy – as we said before it plays the role proximity has played through most of history. In turn, accessibility varies according to several parameters, but its sensibility to those parameters varies greatly. We have demonstrated in this work that changes applied in the geographical structure of the transportation network had the most far-reaching consequences of all possible changes on accessibility, first because even minute modifications applied to the network could have major effects on accessibility of a place, and secondly because those effects were deploying at short scales: changes in the transportation network have the capacity to completely redraw the accessibility map at relatively short ranges, typically within a section of a metro area – in areas where we have seen that the connection between accessibility and economical success is strongest. Another strong contender for accessibility changes is commuter behavior towards what they consider as acceptable commuting times, although those effects are more regional in their scale; however those regional effects can be far reaching as they strongly favor the urban fringe against the urban core. A change in the road network can promote a specific region to economical success, but a change in commuting behavior will allow peripheral regions to become better competitors against central ones. Both changes are likely to apply favorably to suburban and outlying spaces against core and central ones, and their recent evolution clearly favors further urban deconcentration of both residential and economic functions. And there's no negative feedback effect from those, as the principal possible negative feedback factor we can think of: urban congestion, is still affecting central spaces way more than outlying ones, even if it is indeed progressing in suburban belts. Everything in what we found favor deconcentration and sprawl.

Before we delve on the alternate hypotheses which have been floated to explain the spatial distribution of centers, we'll finish this section by a regret. Should we be starting it all over, we think our results do not warrant the consideration of job concentrations under 1'000 jobs as urban centers. In many ways those have been found as being quite different from the other centers and often close to edgeless cities. We realized this quite late in the process of this work which made then impractical to remove them from the center list, but we think that if we undergo a revision of this work, we will certainly try to redo some of the calculations, and some of the maps, considering them as edgeless space.

10.2. The larger picture: accessibility besides other localization determinants

When it came to understand the underlying reasons for which job olocalization behaved like it did during the period under study, we choose to concentrate solely on car accessibility as we felt that the spatial effects of shifting accessibilities had been somewhat understudied as a job localization determinant against others. At the end of this work we feel vindicated as we have ample, overwhelming indications that our core hypothesis is broadly correct, and that it makes sense in the larger scheme of globalization, metropolization and suburbanization of the current economic structure. As we have seen throughout this work, accessibility plays a major role on job location – we feel it is one of the main determinants of job localization at play. However, accessibility is by no means the sole determinant of job and company localization. It is but one in many factors which together help form the spatial fabric of interspersing central and peripheral places, residential and economic-oriented ones, besides for instance and in no particular order land policies and politics in general, land rent pressures, organizational shifts in companies, technological progress. All those factors have definite territorial implications which could play a major role in the way companies, units and jobs are located in space.

Land policy, for instance, is tipped to play a major role in the way the economy is located. This, of course, has been shown true in dirigist countries and the way most socialist countries spatially developed their economy during the 20th century was essentially through land planning. While more liberty is given to actors in capitalist economies, it remains that public policies play an important role in the way jobs are eventually located, and Switzerland isn't an exception to this rule. Since about the late 1960s, all cantons have progressively enacted land planning ordinances, which are for instance visible in the suburban belts of most cities under the guise of "industrial zones". At the neighborhood scale, as well as when it comes to the conservancy of natural space, forests and to a point agricultural lands, land policy seems to be the main force behind actual localizations. At this scale, zoning seems to work. Economic actors do locate where the authorities would have them located: according to plan. At the communal scale, which is the one relevant to this study, things become more blurred. Switzerland is a federal republic and land planning is enacted in cantons, which can and do adopt very different land policies.

Examples of strong land planning authorities include the City of Zurich, the Canton of Geneva and the City-Canton of Basle-City. In all three places, regulations have been put into place to direct where the economy should develop. In Geneva, for instance, all major development has to be located either in the city or in one of three designated areas (ZIMEYSA, ZIPLO and Praille-Acacias). This has led to the rise of the only major industrially-dominated edge city of the country, in Plan-les-Ouates. In Zurich land planning was used to protect inhabitants who risked eviction to make way for more lucrative office parks and buildings, and also to protect inner industrial zone from anarchic conversion towards service activities. In Basle, strong public policy is thought to have retained the core of the chemical industry in the city. That is certainly true of its directing and R&D functions.

However, we feel that the abovementioned examples do not give a full picture, in the sense that even if they registered successes, they weren't able to completely stop, let alone reverse, the trends against which they were trying to alleviate. Zurich, for instance, lost its industry, regardless of public policy – and if it can claim success in relaunching its population growth, that happened only after massive population losses it had experienced in the height of its population protection policy. And population has grown above all by occupying space left by the departing or dying industry, not by replacing lucrative offices. The canton of Geneva succeeded at framing this growth in designated areas, and in part at orienting its economic structure, but it could not impeach the development of massive suburban centers, or the economic orientation of two of them. Likewise, Basle could not avoid losing large parts of the chemical industry to suburban and exurban centers. Massive suburban centers have emerged around all three cities mentioned – indeed, the most massive ones of the country.

And those are the cases where land planning can claim some successes. As a whole Switzerland is a pretty liberal country, keen on the economy, and its authorities see themselves more as facilitators of the economy than as protectors of the land. In most cantons then, land planning is subservient to economic policy – in many places companies are given facilities to locate or expand, including land planning facilities. Thus, in large parts of the country politics trump land policy and land planning, unable to fully apply its principles. Thus, in many places, the position of the land planning authorities is indeed difficult, in a country in which the economy had traditionnally the upper hand over public policies. In most places planning autjhorities haven't the clout to impose their views on the land, at least in terms of territorial development. One of the possible effects of their helplessness can be to radicalize them and open a gap between their discourse and their ability to influence territorial processes – in a sense, some land planning authorities can become radical because it doesn't matter that much. In many places, land planning hasn't been allowed to have a real influence on things – it seems weak because it wasn't allowed to be strong. The current state of Swiss territorial development is also a consequence of this intended weakness and more generally of the liberalism of the country. On most of the territory under review, at the scale at which we study things, economic actors had and still have near full liberty to do as they see sound, at least with regard to weak and inefficient land planning authorities. The latter's success at harnessing economical forces is exceptional.

A very capitalist way of spatially ordering things is through land prices and rents, and accordingly land pressures as monetarized in the Swiss economy is expected to play a major role in the way activities are located in space. The literature strongly advocates land pressures as the major determinant of urban structure and more generally land organization. This explanation seems to match the anecdotal reality well. It is a fact that manufacturing, transportation and warehousing needed space to develop and that as the cities explosively grew and engulfed their production sites, those land-hungry activities had no other options but to get out of the city to find the space they needed. The land rent hypothesis generalized this phenomenon to all activities and is based on the bid-rent theory: the ones who occupy the most desirable economic space are the ones who can pay for it. The land rent hypothesis offers direct ways to testing. It provides for predictions, which are as follows: urban centers, as most desirable places, should concentrate the activities most able to pay for rent there. Activities unable to compete for space in the urban centers should locate as close as possible from it, along communication axes linking it directly to the urban center in which they would be located if they could, regardless of the actual position of its suburban or exurban centers in the broader context. The land rent hypothesis thus postulates a very strong gradient of added value by area, of qualification and of interaction quality from the center to the periphery.

In a way that's what was found in earlier times – the inception of the suburban centers was indeed strongly related to the rents economic branches could pay and how much space they needed. Land-hungry activities have generally low added value per square meter and this affects their ability to pay top rents. However, in recent times two concomitant developments can be construed to partially challenge the land rent hypothesis. The first is that suburban centers do not develop only with respect to their parent center: they seem to develop exclusively on high accessibility points. The lesser accessible suburbs of the greater centers do not develop suburban job centers, at least not the way the more accessible parts of those same suburbs do. Strictly speaking, the land rent hypothesis would surmise that the lesser accessible suburbs would receive about as much development as the more accessible ones. But they don't, although there restrictive land planning probably plays an important role as it is allowed to deploy in full to protzect the tranquility and the real estate prices of those least accessible suburbs, which often happen to be the wealthy ones.

The second and more damning fact is that lately, suburban centers have gained functions which are more productive and add more value, in one word which can pay more rent, than some activities which have remained or developed at the city center. In recent years, suburban centers have gained a very strong position in the high tech sector and are catching up on cities in terms of professional services and commanding functions. Conversely, cities have seen some of their most productive functions leave, while retaining others which, according to a strict land rent theory, should not be able to pay for such desirable space, most notably in the personal services. Ominously, many of those functions are shielded from competition by their public status – in the cultural domain for instance. But this find isn't limited to public services; it extends to some private activities, most notably in the larger recreational sector: bars, restaurants, clubs, spas, gym studios, and their sheer presence in very desirable settings seem to contradict the land rent hypothesis. More subtly, it may be that urban centers aren't that desirable anymore for a range of activities. This would then reinforce the validity of one of our postulates, which is that desirability is shifting from proximity to accessibility. The most desirable places aren't necessarily the most central, but the most accessible, where land tends to be more available, and land rent plays a smaller role. Either way, the land rent hypothesis seems partially challenged, unless we are prepared to admit that centers aren't that desirable anymore, and that some personal services can now concentrate in cities because a range of more valuable activities do not compete with them there. This has far reaching consequences as we'll see further down.

A third, even more subtle hypothesis was that the economical transition to post-fordism, just-in-time horizontal relations between disintegrated enterprises and entities are at the roots of the spatial deconcentration of the economy. As we have surmised before in this conclusion, we think that actually job suburbanization, metropolization, globalization, and the changes made to the economic branches and structures are all closely related, as has been shown for the three latter phenomena by Sassen 1991 or Castells 1996. Within metro areas, job suburbanization is strongly linked to those phenomena, so that the post-fordist hypothesis isn't contrary to the car accessibility one. In a way, it just looks from a different standpoint at the same situation and put the emphasis elsewhere: both processes as linked. But with this caveat in mind, we can still raise some interrogations. We see both processes to be concomitant, but our hypothesis insists on the causality of changing accessibilities, while the post-fordist hypothesis implies that spatial disintegration came above all because of functional disintegration.

If the post-fordist hypothesis was strictly true, accessibility changes aren't as important in the onset of spatial deconcentration as functional disintegration. Functional disintegration would lead to spatial deconcentration regardless of accessibility conditions. But in the proximity-based relations of the fordist integrated economy, functional disintegration doesn't automatically lead to spatial deconcentration, as there is no advantage to be gained by locating different activities in vastly different places, especially if just-in-time economic flows are becoming the norm: in a proximity-based economy, just-in-time flows would benefit from proximal relations, and be hindered by transportation over longer distances than absolutely necessary. There is no advantage to be gained from deconcentration in a functionally disintegrating economy if the latter is proximity-based. On the contrary, the accessibility framework makes more sense and it is not difficult to see how, once we enter an accessibility-based economy instead of a proximity-based one, different functions can be spatially disintegrated to be located where each of them benefits from the best externalities. It is true that several concomitant technological advances have made the post-fordist economy possible, most notably the development of telecommunications, the advent of IT technologies which came on telecoms back. It is also true that those developments were territorial and favored metropolitan areas over peripheral ones, because new technologies find more customers in dense areas than in sparse ones and because the investment per customer is lower there – a classic positive feedback effect.

In that sense, the development of fast and reliable individual transportation is only one of the reasons for functional disintegration of the company. As we said, we think post-fordist organizations are the result of all those changes more than their cause. The fact we worked on one of those causes instead of all should not lead us to underestimate the other causes of those changes, but nor should reversing the argument: there is scant evidence that post-fordism initially created those developments and in particular spatial deconcentration.

While we haven't really formalized the following, an evident criticism of this work is the focus we chose to apply on car accessibility, against either more general accessibility measures, or in particular public transportation based accessibility. As we said before, we think Switzerland as a pretty exemplary country in the western world. If there is one domain in which Switzerland is exceptional, though, it is certainly in the quality and density of its public transportation network. In particular, the public transportation of the Zurich metropolitan area has been recently deemed the best of the world (Mees 2010), one of the very few instances where somebody can go from any point in the metropolitan area to any other and be there without hassles, especially in terms of tariffs, and in an amount of time which is competitive with that of the private car. Thus, it has been suggested to us, time and again, that we complete our study with data pertaining to public transportation, with the evident hope that it would prove essential to our explanation. This has not been done, for several reasons. The first is that it is more difficult to build a public transportation travel time matrix as the information is more difficult to obtain – several institutions do benefit from such a database but we didn't succeed to secure access to them. However, we didn't try seriously to have access to those data, because we didn't think that they would alter in a significant way our findings. Here's why.

In the current commuting patterns, the 2000 population census results, as cited in Schuler et al 2006, show that in the last decade of our work commuter patterns were that more than half of all movements were made by individual motorized transportation, against a quarter in public transportation and another quarter in slow transportation, walk or bike. Moroever, public transportation is very uneven in spatial terms, peaking in large cities but declining very steeply as soon as the city limits are reached. In places where it is indeed dominant its commercial speed is slightly better than that of a car – meaning that the accessibility pattern it would show would approximately be that of a car. It is also better, and clearly so, for center-to-center relationships, and recently in some relations between nodal points in selected agglomerations, so that it can compete there with the car. However, we strongly feel that those relations are exceptional, in the same way land planning successful restrictions are exceptional. Since about 1965 and the generalization of the individual car use, the majority of commuters have been engaged in commutes where public transportation was in no way competitive with the car. Indeed, the generalization of car use is at the root of the problem as it allowed the transition from proximity-based centralities to accessibility-based ones, as surely as the advent of information technologies allowed for functional and spatial disintegration of companies. Residential and job suburbanization has been made possible by the generalization of car use and at the same time has destroyed the competitive advantage public transportation, which needs density, had. Public transportation is trying to stage a comeback and has the broad support of the land planning community to do so, but even in public transportation paradise which Switzerland is, it does so only in and between select locations – in the dense urban centers, and between the metropolitan cores. In other words, public transportation in Switzerland pursues niche strategies, in which it correctly feels it can beat the car. But even public transportation enthusiasts admit that they will need very strong measures against the car to be able to allow for public transportation to take over in other, broader contexts. We think such restrictions will be politically impossible to apply, except maybe in select cases we will describe later on. In the meantime, and even if it goes against the political mood of the times, the individual car rules. We do not feel we would have meaningfully different results if we had combined public transportation and private transportation in our study.

10.3. Where we should go further

As extensive as we feel this work is, there are an infinity of domains where we haven't exploited the full richness of the different databases we have mined, and here's a catalog of what we could explore further. We start here where we just finished: is it possible to better define accessibility?

Obviously, the addition of a way to take into account recent developments in public transportation, much along the way we just described, would be very important to strengthen the results found here, as in some very important places: major urban centers, public transportation trumps car transportation. While we may hypothesize that the inclusion of public transportation accessibility wouldn't change much to the finds we have made, clearly we have no proof of that and the only way to see if this affirmation is true or not would be to integrate such a matrix in our model and to see what happens when accessibilities are computed in a mixed way instead of based on automobile only. This isn't technically or theoretically difficult – the only problem is the construction of the travel time matrix for public transportation. The information is currently held by the federal railway company, and several university and polytechnic institutes have some degree of access to them.

As we have worked it out here, some of the accessibility parameters have been considered territorially invariant, in particular the mean and maximal acceptable travel times. However, those times do vary spatially, and we know by experience (Schuler et al 2006) that given the residential area the average and maximal travel times aren't the same – likewise, private transportation commuters have different travel times than public transportation ones. A refinement of our computing would be to take those spatial variations into account, based on census results which would give us an idea about how the travel times of different populations situated in diverse areas would vary. At this point we have no definite hypothesis about what we would find if we were using such refined travel times, not more in fact than for the inclusion of public transportation travel times in the model. At this stage, this would be purely exploratory moves, aimed at bettering our understanding of the mechanisms which are spatially at play in the mutual relationships of centers, suburbs, exurbs. We do not feel that our general conclusions would be changed much by such refinements, but their spatial impact would likely be meaningful.

One of the major finds we have made is that space takes a very long time to adapt fully to new accessibility conditions. This wasn't foreseen and when we explicated our hypotheses, we explained that we expected a time lag in the order of one or two decades between a change in conditions, and the adaptation space would then provide. However, we have found that this time lag seems to be far larger, to our surprise. This means that the time span we elicited in this work, the 69 years separating 1939 and 2008, weren't sufficient to determine a clear time lag between changing condition and space response. As we said in chapter 9, for what we know, it might be that space is still adjusting to the advent of railways and to the spatial components of the industrial revolution: at this point we can't answer this interrogation. Thus, while this would be of primarily historical interest, an obvious development of this work would be to extend it further back in time, at least towards the first complete business census which was held in 1905, or even possibly all the way back to 1888, which gave the first precise information about the work structure of the country. With several new points in time, such as 1888, 1905, 1920 and 1929, we feel that we might, just might, have a chance to detect accessibility surfaces and job distributions which would indicate the time lag better than we have done. This extension would have a second interest, more purely historical, in that sense that we have already realized most of the tedious jobs needed to integrate in one database the results of the business censuses, 11 of which are considered here, that it would seem fitting to complete the job by integrating the only two business censuses which are missing from the list, as well as trying to extend the database for 1888 and 1920. Thus we would then have a complete territorial database of all business censuses ever held in the country. This particular avenue we certainly intend to explore.

Outside our prime concern of linking accessibility with job quality, many more ideas of new research can be found. To say the least, we haven't used nearly all the data we collected in the course of this work; this data is immensely rich, regardless of the perspective through which we examine them. Here is but a partial catalogue of the things we could do if we had a millennium to devote to them.

In chapter 6 we attempted to look at the structural underpinnings of the economy, however we stayed rather at the surface of things. In particular, for the last seven censuses, since the 1985 one, the branch information is given in great detail and much more could be done of this information. Likewise, we treated this information in a non spatial way, limiting our studies to broad categorical representations of the reality. In particular, we didn't delve into the geography by mapping our results and searching for strictly territorial patterns. This seems, of course, an obvious prolongation of chapter 6 to actually map our results and search for patterns in the same way we achieved in chapters 4 and 5. In the exact same way, we could exploit the data about the command and control structure of the economy, which we did in an aspatial way, by looking at categories and their mutual relationships. For want of time we didn't extend our research at the actual geography of the relations. An obvious extension to chapter 7 would be to extend our research at the geographical scale and to try to see if purely territorial patterns emerge from the matrix-like data we could very easily put into place and exploit afterwards. This precise idea we intend to pursue in research articles in the future.

A chapter is missing in that work which was initially planned and which involved looking at the demographics of companies. From 1985 to 2008 business census data allows the following of companies and establishments as they appear and disappear, as they grow or shrink, as they move or change economic orientation, and as they are bought out or spun off. This information could then have been used to check new hypotheses, most notably the origin of the establishments located in different location types, in particular whether suburban establishments were transplanted from the cities, or directly appeared there. In a sense such concerns have been tangentially answered when looking at the command and control structure of the economy but obviously much could be extracted from a demographic study of the Swiss companies spanning a generation.

Finally, spatial information is more precise than the one we used for the five censuses from 1995 on, for which it is possible to look at the spatial distribution of jobs at the hectometric level – do, then, our finds still hold at such a small scale, or does space, considered at the sub kilometric scale, behave differently than what we have found? At such a scale, do the relationships between accessibility and job density still hold or is this relationship valid at the 4-kilometer scale typical of the communal mesh? In particular, at such a scale does land planning work?

Those are just several examples of studies which could stem from what we have already done. In conclusion of this section, we will affirm for one last time that the richness of our data is extreme and that it hasn't been exploited fully, whether by us, or by other researchers. We are sure that many more fundamental results lie hidden in the mass of data we have gathered and given form to – as we just saw, in many places we had ideas that we didn't pursue for want of time, and this is a PhD thesis. In that respect we really feel like the fabled fisherman sitting on a beach looking at an interesting shell or two, while countless others lie at his feet.

10.4. Does it all matter? The implications of a find

10.4.1. 50 years from now

It is now time to close this work, and we intend to do it in a more reflexive and political way – we think research for its own sake has its merits, but we also think that when findings are made which could have a benevolent impact on public policy, those should be stated. We will close this work in two ways. The first will be to imagine, on the basis of our finds, what the future will look like if the trends we discovered are furthered 50 or 100 years in the future. The second relflexion will be more political and delve on the current practices in terms of territorial development, and what should be done, we think, to modify them.

Throughout this work we have seen, essentially, that the center network account for approximately the same total job share. Edgeless space, as we named it in reference to Lang 2003, is an inert filler, and it should remain so in the future. In short, the spatially organized part of the economy should retain its importance in the next decades. The major changes have indeed happened inside this organized part, inside the then Christallerian urban network, and nowadays inside the metro areas. We expect that this will continue to be the case in the future.

Since 1939, we have witnessed a slow erosion of the urban centers primacy in the urban network. In 1939, urban centers hosted the clear majority of all jobs and the vast majority of the central system. By 2008, this position had been eroded greatly, to the point that by then less than half of all jobs were held in urban centers. This evolution has been slow but rather straightforward, with astonishingly little impact from economic crises – in fact we found that economic crises have an accelerating impact on the urban structure changes, as they have on economic structural ones. This slow decay hasn't been just in relative terms – even more importantly we believe, in recent decades the economic fabric of the city has started to unravel. First low added value activities left, but after a time urban centers seemed engaged in a specialization process which partly deprived them of their Christallerian centrality and made them, in a way, place like others. Very recently, urban centers have specialized in three or four activities: finance, professional services, public services and personal services. The financial concentration in urban centers is well explainable, as this activity bears the most added value and is in need of the most interaction of all economic activities – therefore their exclusive presence in urban centers was expected. Likewise for the professional services which in part closely resembles the bankers: consultants, accountants, creative people, publicists all need the personal interaction they find in cities. That public services are still very much urban isn't a surprise either. As we've showed, government is very slow to react to territorial changes and is very much tied to the urban world, in which to project its power. Then as now, and very probably in the future, government offices and most public services which depend on it will remain in the city no matter what, and in any case public services are shielded from basic economic needs – they are generally protected from eviction or rent rises. Then there is the case of the personal services. Their urban concentration is recent, and perplexing. Some of it is understandable, notably in the larger cultural context: thus, churches, theaters, opera houses, concert halls, art and science museums are all situated in cities, and protected by their structure from economical pressure. But then they do not account for the recent concentration which personal services have marked. We feel that this recent wave of concentration supplements the cultural offer of the city by adding to it the cocooning, the pampering: thus the urban rise in higher-end restaurants, bars, leisure and recreation places, dance clubs, beauty parlors, hair style saloons, gym clubs, sauna clubs, and the like, occupying the places vacated by urban retail which have largely disappeared.

What does it say about the cities? It is as if cities are catering more and more to an urban elite population employed in the financial, professional and public sector and which is in demand of those higher end services. As the city slowly loses its centrality it gains a wealthy young urban elite who needs the urban feel of the place and demands to be pampered there. Urban centers in nowadays Switzerland are slowly evolving to respond to those needs, catering for this new gentry of bankers and architects. We have no indication that this will not continue in the future – actually we think that this transition going to be accelerating in the future. That is, if all goes well. As we showed, most activities except finance and public sectors are in the process of deconcentrating. In the course of time, cities become more and more dependent on financial services. Such dependence on a single economic sector is dangerous: what will happen to our cities if the financial system disappears, which is nor completely outlandish a hypothesis – remembering 2007 and the 60 billion the Confederation had to inject to save our banking system from collapsing? What will remain of them if banks collapse, besides government services?

Meanwhile, most activities are slowly vacating the urban centers, with the glaring exception of the financial services. Industry left long ago, followed by warehousing, transportation and logistics activities, and then by retail trade. Now, several higher end functions are vacating the cities, most notably in the high tech sector, and there are indications that the professional services are beginning to follow suit. All those activities have deconcentrated already, or are in the process of deconcentration. Many of those are now found in suburban centers, which job numbers now are about half of those of urban centers. Thus, as seen in the everyday life, suburban space, that hated contraption of old and new plants, big box retailers, commercial malls, office parks dissected by highways and innerved by the constant flux of internal combustion engine cars is indeed bustling with economic life. More and more critical functions of the everyday life are located there, first of which retail trade – in a way now, the real retail centers are all situated in suburban space. Urban retail does not cater for customers beyond the city anymore – those customers now go to edge cities to shop. But the suburban centers aren't limited anymore to such menial functions. They are now the prime location for the high tech economy. That's where telecom companies, software developers, data analysts, internet providers, server farms, engineering companies, biotech companies, academic start-ups and spin-offs are most likely to be located. In the future this will be even more the case as those domains are likely to carry suburban centers even higher as they are very widely thought to be the motors for tomorrow's economic development. At some point in time, in several decades, the job numbers of suburban centers will become larger than those of urban centers and will become the real economic centers of the metropolitan areas they now serve. At some point in the future this will be noticed by the cultural and the political elite, at which point cities risk to lose their last functions, their cultural and political ones. We surmise that it has in fact already begun – the most prominent art school in Lausanne having moved from the city deep in the suburbs.

The other rising category is the mixed urban-suburban centers, those former urban centers which have become suburban with time. We expect this class of mixed centers to grow as the urban network slowly decays, as the metropolitan areas continue to grow and engulf them to recreate them as such. In 50 or 100 years, mixed urban centers, which look like urban centers but behave like suburban ones, may embody an urban renaissance, and in that sense, even if now they represent only a tiny part of the economy, we should have our eyes on them – after all, 50 years ago, suburban centers were also tiny things. For their part, exurban and touristic centers have remained rather stable during those times as categories, even though there have been many changes in their population, with many disappearances, emergences and flickering going on.

At some point of time in the not too distant future, we surmise that in the currently polycentric metropolitan areas the focus of economic activity is likely to move from the present dominant but eroding form of the classical urban center to a new dominant form located in what we currently describe as suburban belts, much like it has already done in several sprawling north American metropolises like Los Angeles. A metropolitan network of centers is being seemingly put into place, encompassing old urban centers, mixed urban-suburban centers and bona fide edge cities, in no particular order. In some cases edge cities will clearly lead their metro area – tentatively in Lausanne, in other cases urban centers will retain some primacy for longer – Zurich comes to mind, in other places a mesh of urban and suburban centers will be in place in truly polycentric fashion, as is likely in the Lucerne-Zug area. In all cases this will look not terribly different than the current situation, but will seem extremely alien to what we still imagine constitute our cities and countryside.

10.4.2. The role of public policy

Finally, our work showed, among other things, the gap between the land planning community wishes and the situation on the terrain. Most of what has happened in terms of territorial development has happened regardless of the wishes of the planning community, and of the spoken word of the government bodies in charge. As we already said, for a major part this situation is due to the fact that political authorities in Switzerland haven't allowed land planning agencies to play their part comprehensively against other interests groups, most notably the economy. As a consequence, we live today in a vastly different world than the one the land policy advocates, with its bigger, denser cities concentrating all or most of the higher-end functions, in which suburbanization and periurbanization would not have happened the way it has. In particular, suburban job centers would not have developed beyond its initial industrial and warehousing focus. So what happened? How come current Switzerland is so different from the planning community and the territorial developers' ideas of what a balanced spatial development is?

One of the reasons of this inherent weakness is that of unintended consequences. The authorities who planned the highway network back in the late 1950s had no way to know what they were doing – because they were the first to plan in the sense of the term. Nobody foresaw the consequences of their actions. They were trying to remediate to a perceived problematic traffic situation by designing and planning new roads to link major centers. In doing so they ended up completely overhauling the accessibility pattern of the country, unleashing forces they could not have known existed. It can really be said that the people who have had, by far, the most impact during the last 50 years on the way Switzerland spatially developed were the highway planners of the 1950s. It's just that they had no idea that they were doing so.

The Swiss highway planners of the 1950s tried to remediate to one problem but didn't foresee the consequences of the inception of the highway network. Today still, most of the science about the economic impacts of new infrastructure is either hotly debated, or limited to the direct impact infrastructure building has on the local economy. This, we think, stems out of a complete negligence of the unintended consequences a territorial action has on space and the way it functions, on the failure to take into account space as a functioning system.

We strongly believe that we have demonstrated in this work the mighty mechanisms underpinning territorial development. Space indeed functions as a system. When we change part of the system, in our case when we change the way people and things are moving across the territory, when we change the places through which they go from one point to another, the whole system adapts. It has implications not only on how people and wares move, but also on where they will end up coming from, and where they will end up going to. When we change the traffic pattern of a place, we end up changing, in the place and around it, where people will also live and work. Flows of people and wares are just that: flows, which most of the time take the way of least resistance to go from one point to another. Modifying some elements of the system ends up modifying those paths of least resistance and in the end new pathways are created and old ones abandoned. Everything, not just traffic, is going to change, to adapt. In order to be successful at creating the territorial configurations we as a society want to promote, and at avoiding the ones we want to avoid, we need to understand how space works.

At this point, most actors don't. We pretend that authorities lack territorial understanding. Plenty of classical measures taken to alleviate a problem are extremely local in their effect, as if their impact on surrounding areas wasn't taken into account. For instance, closing a street, or a city to automobile traffic, as is currently proposed, is likely to have major, unintended effects that are not foreseen by those taking the decisions. Thinking that it is enough to change the affectation of a zone, or to suppress right of ways or parking spots to reduce the traffic in an area will automatically lead to systemic adaptations in surrounding areas. In fact, it might be already happening. Swiss major centers are taking measures which have major consequences on their economical structure. The fact is that the reversal of urban policies which took place in the 1990s in all major Swiss centers were contemporary with the recent loss of central functions in them, as the policies they replaced – or more correctly the absence thereof – were contemporary to the loss of inhabitants. We haven't shown a link between the two, but the fact is that as urban centers restricted access, especially towards cars, suburban centers at their fringe exploded. Now we are witnessing in cities, at least in economic terms, the slow rise to power of the gentrified urban class, and the furthering of policies which cater to them. Meanwhile, in suburbs, which are not yet affected by the same urban policies, we witness an economic boom. If we want to be able to better control those moves and not end up having boomtowns exploding where we didn't expect them, and classical cities slowly turning into an architect's dream or a policeman's nightmare, we need to profoundly rethink the way we plan our territories, essentially by taking into account its systemic underpinnings. It is our hope that this work ends up contributing to that end: then those four years will not have been spent in vain.

Bibliography

Abt & Elsasser 1971	Abt, Peter, Hans Elsasser (1971): **Siedlungs- und Industrieentwicklung im Birrfeld**, *Geographica Helvetica* 26, pp. 42-4.
Aerni & Egli 1991	Aerni, Klaus, Hans-Rudolf Egli (1991): **Zusammenhänge zwischen Verkehrs- und Siedlungsentwicklung in der Schweiz seit dem Mittelalter**, *Geographica Helvetica* 46, pp. 71-8.
Aguilera & Mignot 2004	Aguilera, Anne, Dominique Mignot (2004): **Urban sprawl, polycentrism and commuting. A comparison of seven French urban areas**, *Urban Public Economic Review* 1, 93-113.
Alderson & Beckfield 2004	Alderson, Arthur S. & Jason Beckfield (2004): **Power and position in the world city system**, *The American Journal of Sociology* 109/4, pp. 811-51.
Alonso 1964	Alonso, William (1964): **Location and land use**, Harvard University Press, Cambridge MA.
Alperovich & Katz 1988	Alperovich, Gershon, Eliakim Katz (1988): **The location decision and employment suburbanization**, *Urban Studies* 25, 243-7.
Anas & Kim 1996	Anas, Alex, Ikki Kim (1996): **General equilibrium models of polycentric urban land use with endogenous congestion and job agglomeration**, *Journal of Urban Economics* 40, pp. 232-56.
Anas et al 1998	Anas, Alex, Richard Arnott, Kenneth A. Small (1998): **Urban spatial structure**, *Journal of Economic Literature* 36/3, pp. 1426-64.
Anselin 1995	Anselin, Luc (1995): **Local indicators of spatial association – LISA**, *Geographical Analysis* 27, 93-115.
ARC 1985	Atlanta Regional Commission (1985): **Transportation problems and strategies for major activity centers in the Atlanta Region**, Atlanta Regional Commission, Atlanta GA.
Archer & Smith 2003	Archer, Wayne R., Marc T. Smith (2003): **Explaining location patterns of suburban offices**, *Real Estate Economics* 31/2, pp. 139-64.
Auray et al 1994	Auray, Jean-Paul, Antoine Bailly, Pierre-Henri Derycke, Jean-Marie Huriot (eds.) (1994) : **Encyclopédie d'économie spatiale, concepts – comportements - organisations**, Economica, Paris (France).
Auxetier 1984	Auxetier, Thomas (1984): **La République Fédérale d'Allemagne**, in *Mény, Yves (ed.): La réforme des collectivités locales en Europe, La Documentation Française, Paris (France),* pp. 31-56.
Axhausen & Hurni 2005	Axhausen, Kay W., Lorenz Hurni (eds.) (2005): **Zeitkarten der Schweiz, 1950-2000**, IVT, ETHZ (Swiss Federal Institute of Technology), Zurich (Swtz.)
Axhausen et al 2004	Axhausen, Kay W., Philipp Fröhlich, Martin Tschopp (2004): **Changes in Swiss accessibility since 1850**, in Gunn, H. (ed.): *Economic impact of changing accessibilities*, Elsevier, Oxford (U.K.)
Baerwald 1978	Baerwald, Thomas J. (1978): **The emergence of a new "Downtown"**, *Geographical Review* 68/3, pp. 308-18.
Bailly 1985	Bailly, Antoine S. (1985): **Le rôle des activités de service dans le développement régional suisse**, *Annales de Géographie* 523, pp. 257-69.
Barbier 1961	Barbier, Jacques (1961): **La banlieue lausannoise définie par l'étude des migrations alternantes de travailleurs**, *Geographica Helvetica* 16, pp. 77-99
Bassand et al 1986	Bassand, Michel, Thérèse Burnier, Pierre Meyer. Robert Stüssi, Léopold Veuve (1986) : **Politique des routes nationales, Acteurs et mise en œuvre**, Presses Polytechniques Romandes, Lausanne (Swtz.).
Bassand et al 1988	Bassand, Michel, Dominique Joye, Martin Schuler (eds.) (1988) : **Les enjeux de l'urbanisation / Agglomerationsprobleme in der Schweiz**, Peter Lang, Bern (Swtz.).

Baumont & Bourdon 2002 — Baumont, Catherine, Françoise Bourdon (2002) : **Centres secondaires et recomposition urbaine des espaces urbains : le cas de la communauté de l'agglomération dijonnaise (1990-1999)**, Paper provided by LATEC, Laboratoire d'Analyse et des Techniques EConomiques, CNRS UMR 5118, Université de Bourgogne (1982-2003) in its series LATEC - Document de travail - Economie with number 2002-04.

Baumont & Le Gallo 1999 — Baumont, Catherine, Julie Le Gallo (1999) : **Les tests empiriques des modèles urbains monocentriques**, Paper provided by LATEC, Laboratoire d'Analyse et des Techniques EConomiques, CNRS UMR 5118, Université de Bourgogne (1982-2003) in its series LATEC - Document de travail - Economie with number 1999-13.

Baumont et al 2000 — Baumont, Catherine, Pierre-Philippe Combes, Pierre-Henri Derycke, Hubert Jayet (eds.) (2000): **Economie géographique, les théories à l'épreuve des faits**, Economica, Paris (France).

Baumont et al 2003 — Baumont, Catherine, Françoise Bourdon, Rachel Guillain (2003) : **Mutations urbaines et logiques de localisation des emplois : le cas de la communauté de l'agglomération dijonnaise (1990-1999)**, Paper provided by LEG, Laboratoire d'Economie et de Gestion, CNRS UMR 5118, Université de Bourgogne in its series LEG - Document de travail - Economie with number 2003-13.

Baumont et al 2004 — Baumont, Catherine, Cem Ertur, Julie Le Gallo (2004): **Spatial analysis of employment and population density: the case of the agglomeration of Dijon, 1999**, *Geographical Analysis* 36, 146-76.

Behrendt & Kruse 2001 — Behrendt, Heiko, Christian Kruse (2001): **Die europäische Metropolregion Zürich: die Entstehung des subpolitischen Raumes**, *Geographica Helvetica* 56, pp. 202-13.

Ben-Akiva 1985 — Ben-Akiva, Moshe: **Discrete choice models**, Transportation series 9, MIT Press, Cambridge MA.

Ben-Akiva & Bierlaire 1999 — Ben-Akiva, Moshe, Michel Bierlaire (1999): **Discrete choice methods and their applications to short term travel decisions**, in *Hall, Randolph W.: Handbook of transportation science, Kluwer, Dordrecht (Neth.)*, pp. 5-34.

Bender & Hwang 1985 — Bender, B., H. Hwang (1985): **Hedonic house price indices and secondary employment centers**, *Journal of Urban Economics* 17/1, 90-107.

Benko 1991 — Benko, Georges (1991) : **Géographie des technopoles**, Masson géographie, Paris (France).

Bergier 1984 — Bergier, François (1984) : **Histoire économique de la Suisse**, Payot, lausanne (Swtz.)

Berroir et al 2004 — Berroir, S., H. Mathian, Th. Saint-Julien, L. Sanders (2004) : **Mobilités et polarisations : vers des métropoles polycentriques, le cas des métropoles francilienne et méditerranéenne**, Contrat PUCA, Prog. de rech. « Mobilités et territoires urbains », UMR Géographie-Cités, CNRS.

Berry & Garrison 1958 — Berry, Brian J. L., William L. Garrison (1958): **The functional base of the central place hierarchy**, *Economic Geography* 34/2, pp. 145-54.

Berry 1961 — Berry, Brian J. L. (1961): **Basic patterns of economic developments**, in *Ginzburg N. (ed.): Atlas of Economic Development*, Chicago University Press, Chicago IL, pp. 110-9.

Bhat 1998 — Bhat, Chandra R. (1998): **Accomodating flexible substitution patterns in multi-dimensional choice modeling: formulation and application to travel mode and departure time choice**, *Transportation Research Part B: Methodological 32/7*, pp. 455-66.

Bickel 1947 — Bickel, W. (1947): **Bevölkerungsgeschichte und Bevölkerungspolitik der Schweiz seit dem Ausgang des Mittelalters**, Büchergilde Gutenberg, Zurich (Swtz.)

Bingham et al 1997 — Bingham, Richard D., William M. Bowen, Yosra A. Amara, Lynn W. Bachelor, Jane Dockery, Jack Dustin, Deborah Kimble, Thomas Maraffa, David L. McKee, Kent P. Schwirian, Gail Gordon Sommers, Howard A. Stafford (1997): **Beyond Edge Cities**, Garland reference Library of the Social Sciences vol. 1180, Garland Publishing, New York NY.

Bochet 2005	Bochet, Béatrice (2005): **Métropolisation, morphogenèse et développement durable: le cas de l'agglomération de Lausanne: analyse des tendances et nouvelles morphologies induites par la métropolisation**, *Geographica Helvetica* 60, pp. 248-59.
Boesch 1996	Boesch, Martin (1996): **Gartenstadt Schweiz: Grossdorf oder Metropole?**, *Geographica Helvetica* 51, pp. 73-6.
Boesch & Schmid-Keller 2003	Boesch, Martin, Susanne Schmid-Keller (2003): **„Committed Geography" – from theory to application: a case study in mobility research and urban planning**, *Geographica Helvetica* 58, pp. 244-52.
Bogart 1998	Bogart, William T. (1998): **The economy of cities and suburbs**, Prentice Hall, Upper Saddle River NJ.
Bogart 2006	Bogart, William T. (2006): **Don't' call it sprawl: metropolitan structure in the twenty-first century**, Cambridge University Press, Cambridge MA.
Bogart & Ferry 1999	Bogart, William T., William C. Ferry (1999): **Employment centres in greater Cleveland: evidence of evolution in a formerly monocentric city**, *Urban Studies* 36/12, pp. 2099-110.
Boiteux & Huriot 2000	Boiteux, Céline, Jean-Marie Huriot (2000): **Services supérieurs et recomposition urbaine**, document de travail du LATEC, accessible at : http://leg.u-bourgogne.fr/documents-de-travail/e2000-02.pdf
Boiteux-Orain & Guillain 2004	Boiteux-Orain, Céline, Rachel Guillain (2004): **Changes in the intra-metropolitan location of producer services in Ile-de-France (1978-1997): do information technologies promote a more dispersed spatial pattern?** *Urban Geography* 25, pp. 550-78.
Bontje & Burdack 2005	Bontje, Marco, Joachim Burdack: **Edge Cities, European style: examples from Paris and the Randstad**, *Cities* 22/4, 317-30.
Bopp 1992	Bopp, Matthias (1992): **Methodische Probleme bei der Suche nach Strukturunterschieden in einem städtischen Raum: detailierte Auflösung versus Regionalisierung**, *Geographica Helvetica* 47, pp. 25-33.
Brans et al 1981	Brans, J.-P., G. Engelen, L. Hubert (1981): **Accessibility to a road network : Definitions and applications**, *The Journal of the Operational Research Society* 32/8, 653-73.
Bridel & Winkler 1958	Bridel, Laurent, Ernst Winkler (1956): **L'expansion des villes et sa neutralisation: contribution Suisse à un problem mondial**, *Geographica Helvetica* 13, pp. 247-55.
Browning & Singelmann 1978	Browning, H. C., J. Singelmann (1978): **The transformation of the US labour force: the interaction of industry and occupation**, *Politics & Society* 8, pp. 481-509.
Brugger 1985	Brugger, Ernst A. (1985): **Regionalwirtschaftliche Entwicklung**, Publikationen des Schweizerischen Nationalfonds aus den Nationalen Forschungsprogrammen 34/4, Haupt, Berne (Swtz.).
Brugger & Frey 1985	Brugger, Ernst A., René L. Frey (1985): **Regionalpolitik Schweiz: Ziele, Probleme, Erfahrungen, Reformen**, Publikationen des Schweizerischen Nationalfonds aus den Nationalen Forschungsprogrammen 34/7, Haupt, Berne (Swtz.).
Brugger & Schuler 1982	Brugger, Ernst A., Martin Schuler (1982): **Zentren und Peripherien in der Schweiz**, *Geographica Helvetica* 37, pp. 30-9.
Brunsdon et al 1998	Brunsdon, Chris, Stewart Fotheringham, Martin Charlton (1998): **Geographically weighted regression – modelling spatial non-stationarity**, *The Statistician* 47/3, pp. 431-43.
Bühler 1992	Bühler, Elisabeth (1992): **Kleinzentren im Städtessystem der Schweiz**, *Geographica Helvetica* 47, pp. 64-70.
Bühler & Dorigo 1995	Bühler, Elisabeth, Guido Dorigo (1995): **Regionale Arbeitsmärkte für höherqualifizierte Frauen und Männer in der Schweiz**, *Geographica Helvetica* 50, pp. 91-8.
Burgess 1925	Burgess, Ernest W. (1925): **The growth of the city, an introduction to a research project**, in Park et al (1925): **The city**, University of Chicago Press, Chicago IL.

Busset 1993 — Busset, Thomas (1993): **L'histoire du recensement fédéral**, OFS, Berne (Swtz.).

Butz 1969 — Butz, Rudolf (1969): **Extreme Entvölkerungsgemeinden in der Schweiz**, *Geographica Helvetica* 24, pp. 111-15.

Calzada & Le Blanc 2005 — Calzada, C., F. Le Blanc (2005) : **Accessibilité aux emplois, mobilité et marché du travail en Île-de-France : quels sont les liens ?**, working paper of the SESP (Service Economie, Statistique et Prospective du Ministère de l'Equipement, France), available online at http://www.statistiques.equipement.gouv.fr/IMG/pdf/DT_Accessibilite_aux_emplois_cle51ecfb.pdf

Cameron 1973 — Cameron, Gordon C. (1973): Intraurban location and the new plant, *Papers in Regional Science*, 31/1, pp. 125-43.

Caprarese 2007a — Caprarese, Marco (2007): Netzwerkbeziehungen im Biotech-Bereich: eine Analyse im Grossraum Zürich, *Geographica Helvetica* 62, pp. 66-74.

Caprarese 2007b — Caprarese, Marco (2007): Räumliche Verteilung der Innovationsleistung in der Schweiz, *Geographica Helvetica* 62, pp. 210-20.

Carol 1946 — Carol, Hans (1946): Begleittext zur wirtschaftsgeographischen Karte der Schweiz, *Geographica Helvetica* 1, pp. 185-245.

Castells 1996 — Castells, Manuel (1996): The information age: economy, society and culture, vol. I: The rise of the network society, Blackwell, Cambridge MA.

Cervero 1989 — Cervero, Robert (1989): America's suburban centers, the land-use transportation link, Unwin Hyman, Boston MA.

Christaller 1933 — Christaller, Walter (1933): **Die zentralen Orte in Süddeutschland**, Fischer, Jena (Germany).

Christaller 1966 — Christaller, Walter (1966): **Central places in southern Germany**, Prentice Hall, Englewood Cliffs NJ.

Clark et al 1974 — Clark, D., W. K. D. Davies, R. T. Johnston (1974) : **The aplication of factor analysis in human geography**, *Journal of the Royal Statistical Society, Series D (The Statistician)* 23/3-4, pp. 259-81.

Clark 1981 — Clark, Gordon L. (1981): **The employment relation and the division of labor: a hypothesis**, *Annals of the Association of American Geographers* 71/3, pp. 412-24

Cliff & Ord 1970 — Cliff, Andrew D., Keith Ord (1970): **Spatial autocorrelation: a review of existing and new methods with applications**, *Economic Geography* 46, supplement: Proceedings, International Geographical Union, Commission on Quantitative Methods June 1970, pp. 269-92.

Cliff & Ord 1973 — Cliff, A.D., Keith Ord (1973): **Spatial autocorrelation**, Pion Press, London (U.K.).

Clifford et al 1989 — Clifford, Peter, Sylvia Richardson, Denis Hemon (1989): **Assessing the significance of the correlation between two spatial processes**, *Biometrics* 45/1, 123-34.

Coffey & Polese 1989 — Coffey, William J., Mario Polèse (1989): **Producer services and regional development: a policy-oriented perspective**, *Papers of the Regional Science Association* 67, pp. 13-27.

Coffey & Shearmur 2002 — Coffey, William J., Richard G. Shearmur (2002): **Agglomeration and dispersion of high-order service employment in the Montreal metropolitan region, 1981-96**, *Urban Studies* 39/3, pp. 359-78.

Converse 1949 — Converse, P. D. (1949): **New laws of retail gravitation**, *The Journal of Marketing* 14/3, pp. 379-84.

Craig & Ng 2001 — Craig, Steven G., Pin T. Ng (2001): **Using quantile smoothing splines to identify employment subcenters in a multicentric urban area**, *Journal of Urban Economics* 49, 100-20.

Cressie 1993 — Cressie, N. A. C. (1993) : **Statistics for spatial data**, Wiley & Sons, New York NY.

Cunha 1988 — Cunha, Antonio (1988): **Centralité, périphéricité et développement territorial: le cas de la Suisse**, *Revue d'Economie Régionale et Urbaine* 2/1988, pp. 293-331.

Cunha 1994 — Cunha, Antonio (1994): **L'avenir de la Suisse urbaine: changement technologique, métropoles informationnelles et développement territorial**, *Geographica Helvetica* 49, pp. 53-62.

Cunha & Bridel 1986 — Cunha, Antonio, Laurent Bridel (1986): **Les disparités régionales des activités tertiaires, nouvel enjeu de la politique régionale**, *Geographica Helvetica* 41, pp. 168-78.

Cunha & Racine 1984 — Cunha, Antonio, Jean-Bernard Racine (1984) : **Le rôle des services aux entreprises dans une économie post-industrielle : technologies nouvelles et décentralisation**, *Revue d'Economie Régionale et Urbaine* 5, pp. 731-56.

Davies 1969 — Davies, R. L. (1969): **A note on centrality and population size**, *The Professional Geographer* 21, pp. 108-12.

De Witte 1984 — De Witte, Bruno (1984): **La Belgique**, in *Mény, Yves (ed.): La réforme des collectivités locales en Europe, La Documentation Française, Paris (France),* pp. 101-22.

Dessemontet 1999 — Dessemontet, Pierre (1999): **Des edge-cities en Suisse?** In *Geographica Helvetica* 54/1, 29-36.

Dessemontet et al 2010 — Dessemontet, Pierre, Vincent Kaufmann, Christophe Jemelin (2010): **Switzerland as a single metropolitan area ? A study of its commuting network**, Urban Studies 47/13, pp. 2785-802.

Dietrich et al 1998 — Dietrich, K., H. P. Lindenmann, Y. Chabot-Zhang (1998): **25 Jahre IVT-Messungen zum Verkehrsablauf auf Autobahnen**, Schriftenreihe 118, IVT, Swiss federal Institute of Technology Zurich, Zurich (Swtz.).

Dimitratos et al 2009 — Dimitratos, Pavlos, Ioanna Liouka, Stephen Young (2009): **Regional location of multinational corporation subsidiaries and economic development contribution: evidence from the UK**, *Journal of World Business* 44, pp. 180-91.

Ding & Bingham 2000 — Ding, Chengri, Richard D. Bingham (2000): **Beyond edge cities: job decentralization and urban sprawl**, *Urban Affairs Review* 35, pp. 837-55.

Disch 1962 — Disch, Friedrich (1962): **Zur Methode des Zentralitätsbestimmung und Erfassung des Bedeutungsgehaltes innerhalb kleiner Landschaftsräume**, *Geographica Helvetica* 17, pp. 81-90.

Disteli 1954 — Disteli, Max Hans (1954): **Der Einfluss der Verstädterung auf die Landschaft einer Dorffraktion**, *Geographica Helvetica* 9, pp. 65-71.

Douglass 1925 — Douglass, H. Paul (1925): **The suburban trend**, Century Co., New York NY.

Dutilleul et al 1993 — Dutilleul, Pierre, Peter Clifford, Sylvia Richardson, Denis Hemon (1993): **Modifying the t-test for assessing the correlation between two spatial processes**, *Biometrics* 49/1, 305-14.

Dutilleul et al 2000 — Dutilleul, Pierre, Jason D. Stockwell, Dominic Frigon, Pierre Legendre (2000) : **The Mantel test versus pearson's correlation analysis : assessment of the differences for biological and environmental studies**, *Journal of Agricultural, Biological and Environmental Statistics* 5/2, pp. 131-50.

Dunphy 1982 — Dunphy, Robert T. (1982): **Defining regional employment centers in an urban area**, *Transportation Research Record* 861, pp. 13-5.

Elsasser 1972 — Elsasser, Hans (1972): **Veränderungen der kantonalen Beschäftigtenstrukturen in Industrie und Handwerk in der Schweiz, 1955-1965**, *Geographica Helvetica* 27, pp. 148-57.

Erickson & Gentry 1985 — Erickson, Rodney A., Marylynn Gentry (1985): **Suburban Nucleations**, *Geographical Review* 75/1, 19-31.

Favez et al 1986 — Favez, Jean-Claude et al (eds.) (1986) : **Nouvelle histoire de la Suisse et des Suisses, 2ème édition revue et augmentée**, Payot, Lausanne (Swtz.).

Fischer 1985a — Fischer, Georges (1985) : **Die Entwicklung der kantonalen Volkswirtschaften seit 1965**, Publikationen des Schweizerischen Nationalfonds aus den Nationalen Forschungsprogrammen, Haupt, Berne (Swtz.).

Fischer 1985b — Fischer, Georges (1985): **Disparités régionales en Suisse**, Publications du Fonds national suisse pour la recherche scientifique dans le cadre des programmes nationaux de recherche 35/3, Presses Polytechniques romandes, Lausanne (Swtz.).

Fischer & Brugger 1985 — Fischer, Georges, Ernst A. Brugger (Eds.) (1985): **Regionalprobleme in der Schweiz**, Publikationen des Schweizerischen Nationalfonds aus den Nationalen Forschungsprogrammen 34/1, Haupt, Berne (Swtz.).

Florida 2004 — Florida, Richard (2004): **The rise of the creative class, and how it's transforming work, leisure, community and everyday life**, Basic Books, New York NY.

Flückiger & Muggli 1985 — Flückiger, Hans, Christoph Muggli (1985): **Siedlungsstruktur: Voraussetzung und Ergebnis regionaler Entwicklung**, Publikationen des Schweizerischen Nationalfonds aus den Nationalen Forschungsprogrammen 34/2, Haupt, Berne (Swtz.).

Forstall & Greene 1997 — Forstall, R., R. Greene (197): **Defining job concentrations: the Los Angeles case**, *Urban Geography* 18, 705-39.

Fotheringham & Charlton 1998 — Fotheringham, A. Stewart, Martin E. Charlton (1998): **Geographically weighted regression: a natural evolution of the expansion method for spatial data analysis**, *Environment and Planning A* 30, pp. 1905-27.

Fotheringham et al 2000 — Fotheringham, A. Stewart, Chris Brunsdon, Martin Charlton (2000): **Quantitative geography, perspectives on spatial data analysis**, Sage, London (U.K.).

Fotheringham et al 2001 — Fotheringham, A. Stewart, Martin Charlton, Chris Brunsdon (2001): **Spatial variations in school performance: a local analysis using geographically weighted regression**, *Geographical & Environmental Modelling* 5/1, pp. 43-66.

Fotheringham et al 2002 — Fotheringham, A. Stewart, Chris Brunsdon, Martin Charlton (2002): **Geographically Weighted Regression: The analysis of spatially varying relationships**, Wiley, Hoboken NJ.

Franscini 1848 — Franscini, Stefano (1848): **Neue Statistik der Schweiz**, Haller, Berne (Swtz.).

Frey 1986 — Frey, René L. (1986): **Räumliche Verteilung von Nutzen und Lasten zentralörtlicher Einrichtungen: zur Frage der Ausbeutung von Kernstädten**, *Schweizer Ingenieur und Architekt* 104, pp. 748-50.

Frey 1990 — Frey, René L. (1990): **Städtewachstum – Städtewandel, eine ökonomische Analyse der schweizerische Agglomerationen**, Helbing Lichtenhahn, Basel (Swtz.) & Frankfurt am Main (Ger.).

Frey 1992 — Frey, René L. (1992): **Die Stadt zwischen Wirtschaftswachstum und Lebensqualität**, *Schweizerische Zeitschrift für Volkswirtschaft und Statistik* 128/3, pp. 227-39.

Fritz et al 1973 — Fritz, Andreas, Urs Kiener, Klaus Vieli (1973): **Bodenpreise und Stadtentwicklung, eine empirische Untersuchung**, *Schweizerische Zeitschrift für Volkswirtschaft und Statistik* 1973/1, pp. 102-15.

Fröhlich & Axhausen 2002 — Fröhlich, Philipp, Kay Axhausen (2002): **Development of car-based accessibility in Switzerland from 1950 through 2000: First results**, Conference paper, *2nd Swiss transport research conference, session 5 accessibility*, *March 2002, Ascon (Swtz).*

Früh 1938 — Früh, J. (1938): **Geographie der Schweiz**, 3 vols., Fehr'sche Buchhandlung, St-Gallen (Swtz.).

Fujita & Ogawa 1982 — Fujita, Masahisa, Hideaki Ogawa (1982): **Multiple equilibria and structural transition of non-monocentric urban configurations**, *Regional Science and Urban Economics* 12, 161-96.

Gächter 1978 — Gächter, Ernst (1978): **Untersuchungen zur kleinräumigen Bevölkerungs-, Wohn- und Arbeitplatzstruktur der Stadt Bern**, *Geographica Helvetica* 33, pp. 1-16.

Garreau 1991 — Garreau, Joel (1991): **Edge City, Life on the new frontier**, Doubleday, New York NY.

Gaschet 2002 — Gaschet, Frédéric (2002): **The new intra-urban dynamics: suburbanization and functional specialization in French cities**, *Papers in Regional Science* 81, pp. 63-81.

Geary 1954 — Geary, R. C. (1954): **The contiguity ratio and statistical mapping**, *The Incorporated Statistician* 5/3, pp. 115-27 & 129-46.

Geiger 1973 — Geiger, Martin (1973): **Die Standortgüte in städtischen Regionen: dans Beziehungspotenzial als ausschlaggebende Variable bei der Standortwahl des Industrie-, Dienstleistungs- und Wohnsektors in der Region Zürich**, Juris Druck + verlag, Zurich (Swtz.)

Getis & Ord 1992 — Getis, A., J.K. Ord (1992), **The analysis of spatial association by use of distance statistics**, *Geographical Analysis* 24/3, 189-206.

Giuliano & Redfearn 2005 — Giuliano, Genevieve, Christian Redfearn (2005): Not all sprawl: evolution of employment concentrations in Los Angeles, 1980-2000, paper presented at ERSA Conference, accessible at http://www.ersa.org/ersaconfs/ersa05/papers/686.pdf

Giuliano & Small 1991 — Giuliano, Genevieve, Kenneth A. Small (1991): **Subcenters in the Los Angeles region**, *Regional Science and Urban Economics* 21, pp. 163-82.

Giuliano & Small 1999 — Giuliano, Genevieve, Kenneth A. Small (1999): **The determinants of growth of employment subcenters**, *Journal of Transport Geography* 7, pp. 189-201.

Giuliano et al 2007 — Giuliano, Genevieve, Christian Redfearn, Ajay Agarwal, Chen Li, Duan Zhang (2007): **Employment concentration in Los Angeles, 1980-2000**, *Environment and Planning A* 39/12, 2935-57.

Glaeser et al 2001 — Glaeser, Edward L., Matthew E. Kahn, Richard Arnott, Christopher Mayer (2001): **Decentralized employment and the transformation of the American city**, *Brookings-Wharton Papers on Urban Affairs* 2001, pp. 1-63.

Gong & Wheeler 2002 — Gong, Hongmian, James O. Wheeler (2002): **The location and suburbanization of business and professional services in the Atlanta metropolitan area**, *Growth and Change* 33/3, pp. 341-69.

Gordon & Richardson 1996 — Gordon, Peter, Harry W. Richardson (1996): **Beyond polycentricity: the dispersed metropolis, Los Angeles, 1970-1990**, *Journal of the American Planning Association* 62/3, 289-95.

Gordon et al 1986 — Gordon P., H. W. Richardson, H. L. Wong (1986): **The distribution of population and employment in a polycentric city: the case of Los Angeles**, *Environment and Planning A* 18, 161-73.

Gordon et al 1989a — Gordon, Peter, Ajay Kumar, Harry W. Richardson (1989): **The influence of metropolitan spatial structure on commuting time**, *Journal of Urban Economics* 26, pp. 138-51.

Gordon et al 1989b — Gordon, Peter, Ajay Kumar, Harry W. Richardson (1989): **Gender differences in metropolitan travel behaviour**, *Regional Studies* 23/6, pp. 499-510.

Gordon et al 1989c — Gordon, Peter, Harry W. Richardson, Genevieve Giuliano (1989): **Travel trends in non-CBD activity centers, Urban Mass Transit Administration**, U.S. Dept. of Trsp., Report Ca-11-0032, Washington DC.

Gordon et al 1991 — Gordon, Peter, Harry W. Richardson, Myung-Jin Jun (1991): **The commuting paradox evidence from the top twenty**, *Journal of the American Planning Association* 57/4, pp.é 416-20.

Gordon et al 2004 — Gordon, Peter, Bumsoo Lee, Harry W. Richardson (2004): **Travel trends in U.S. cities: explaining the 2000 census commuting results**, *Lusk Center for Real Estate*, University of Southern California, Los Angeles CA.

Gottmann 1950 — Gottmann, Jean (1950): **De l'organisation de l'espace: considérations de géographie et d'économie**, *Revue économique* 1/1, pp. 60-71.

Gottmann 1957 — Gottmann, Jean (1957): **Megalopolis or the urbanization of the northeastern seaboard**, *Economic Geography* 33/3, pp. 189-200.

Greene 1980 — Greene, D. L. (1980): **Urban subcenters: recent trends in urban spatial structure**, *Growth and Change* 11/1, pp. 29-40.

Griffith 1981a — Griffith, Daniel A. (1981): **Evaluating the transformation from a monocentric to a polycentric city**, *Professional Geographer* 33, 189-96.

Griffith 1981b — Griffith, Daniel A. (1981): **Modelling urban population density in a multi-centered city**, *Journal of Urban Economics* 9, 298-310.

Guest 1977 — Guest, Avery M. (1977): **The functional reorganization of the metropolis**, *The Pacific Sociological Review* 20/4, pp. 553-67.

Guillain & Le Gallo 2007 — Guillain, Rachel, Julie Le Gallo (2007): **Agglomeration and dispersion of economic activities in Paris and its surroundings: An exploratory spatial data analysis**, Université de Bourgogne, Dijon (France) *LEG – Document de travail – Economie* accessible at http://ungaro.u-bourgogne.fr/pages/Documents%20de%20travail/Economie/e2007-01.pdf

Guillain et al 2004 — Guillain, Rachel, Julie Le Gallo, Céline Boiteux-Orain (2004): **The evolution of the spatial and sectoral patterns in Ile-de-France over 1978-1997**, *ERSA conference papers* ersa04p59, European Regional Science Association.

Guillain et al 2006 — Guillain, Rachel, Julie Le Gallo, Céline Boiteux-Orain (2006) : **Changes in spatial and sectoral patterns of employment in Ile-de-France, 1978-97**, *Urban Studies* 43/11, 2075-98.

Güller et al 1980 — Güller, Peter, Christoph Muggli, Martin Schuler, Tobias Studer (1980): **Entflechtungs- und Vermischungsprozesse in urbanen Räumen, Empirische Untersuchungen in den Agglomerationen Zürich, Basel und Lugano**, National Forschungsprogramm 5 Regionalprobleme in der Schweiz, Arbeitsbericht 12, Berne (Swtz.)

Gumbel 1954 — Gumbel, Emil J. (1954): **Statistical theory of extreme values and some practical applications; a series of lectures**, U.S. Govt. Print. Office, National Bureau of Standards, Applied mathematics series 33, Washington DC.

Gumbel 1958 — Gumbel, Emil j. (1958): **Statistics of extremes**, Columbia University Press, New York NY.

Gutersohn 1958 — Gutersohn, Heinrich (1958-1969): **Geographie der Schweiz in 3 Volumen und 5 Bänden**, Kümmerly-Frey, Berne (Swtz.).

Haggett 1966 — Haggett, Peter: **Locational analysis in human geography**, St. Martins Press, New York NY.

Haining 2003 — Haining, Robert (2003): **Spatial data analysis, theory and practice**, Cambridge University Press, Cambridge MA

Halbert 2005 — Halbert, Ludovic (2005): **Le desserrement intra-métropolitain des emplois de service aux enterprises: une tentative de mesure et d'interprétation dans le cas de la region métropolitaine parisienne**, *Géographie, Economie, Société* 7/1, pp. 1-20.

Hall 1999 — Hall, Peter (1999) : **The future of cities**, *Computers, Environment and Urban Systems* 23, pp. 173-85.

Hall & Pain 2006 — Hall, Peter & Pain Kathy (eds.) (2006): **The polycentric metropolis, learning from mega-city regions in Europe**, Earthscan, London (U.K.)

Hamilton 1982 — Hamilton, Bruce W. (1982): **Wasteful commuting**, *The Journal of Political Economy* 90/5, pp. 1035-53.

Hamilton 1989 — Hamilton, Bruce W. (1989): **Wasteful commuting again**, *The Journal of Political Economy* 97/5, pp. 1497-504.

Hansen 1959 — Hansen, Walter J. (1959): **How accessibility shape land use**, *Journal of the American Planning Association* 25/2, pp. 73-6.

Harris 1943 — Harris, Chauncy D. (1943): **Suburbs**, *The American Journal of Sociology* 49/1, pp. 1-13.

Harris & Ullman 1945 — Harris, Chauncy D., Edward L. Ullman (1945): **The nature of cities**, *Annals of the American Academy of Political and Social Science 242: Building the future city*, pp. 7-17.

Hart 1982 — Hart, John Fraser (1982): **The bypass strip as an ideal landscape**, *Geographical Review* 72/2, pp. 218-23.

Heikkila 1992 — Heikkila, Eric J. (1992): **Describing urban structure: a factor analysis of Los Angeles**, *Review of Urban & Regional Development Studies* 4/1 pp. 84-101.

Heikkila et al 1989 — Heikkila, E. P., J. I. Gordon, R. B. Kim, H. W. Peiser, H. W. Richardson, D. Dale-Johnson (1989): **What happened to the CBD-distance gradient?**

Land values in a polycentric city, *Environment and Planning A* 21, 221-32.

Hoogerwerf 1984 — Hoogerwerf, Andries (1984): **Les Pays-Bas**, in *Mény, Yves (ed.): La réforme des collectivités locales en Europe, La Documentation Française, Paris (France)*, pp. 123-42.

Horwood & Boyce 1959 — Horwood, E. M. & R. R. Boyce (1959): **Studies of central business districts and urban freeway development**, University of Washington Press, Seattle WA.

Houston 1998 — Houston, Donald (1998): **Job proximity and the urban employment problem: do suitable nearby jobs improve neighbourhood employment rates?: a comment**, *Urban Studies* 35/12, pp. 2353-7.

Huang & Leung 2002 — Huang, Yefang, Yee Leung (2002): **Analysing regional industrialisation in Jiangsu province using geographically weighted regression**, *Journal of Geographical Systems* 4, pp. 233-49.

Huff 1963 — Huff, David L. (1963): **A probabilistic analysis of shopping center trade areas**, *Land Economics* 39/1, 81-90.

Huriot & Bourdeau-Lepage 2009 — Huriot, Jean-Marie, Lise Bourdeau-Lepage (2009): **Economie des villes contemporaines**, Economica, Paris (France).

Imhof 1965 — Imhof, Ernst (Dir.) (1965-1978): **Atlas der Schweiz**, Bundesamt für Topographie, Wabern (Swtz.).

Ingram 1971 — Ingram, D. R. (1971): The **concept of accessibility: a search for an operational form**, *Regional Studies* 5, 101-7.

Isard 1956 — Isard, Walter (1956): **Location and space-economy, a general theory related to industrial location, market areas, land use, trade, and urban structure**, MIT Press, Cambridge MA.

Isard 1960 — Isard, Walter (1960): **Methods of regional analysis, an introduction of regional science**, Technology Press of MIT & Wiley, Cambridge MA & New York NY.

Irwin & Hughes 1992 — Irwin, Michael D., Holly L. Hughes (1992): **Centrality and the structure of urban interaction: measures, concepts, and applications**, *Social Forces* 71/1, pp. 17-51.

Jackson 1985 — Jackson, Kenneth E. (1985) : **Crabgrass Frontier, the suburbanization of the United States**, Oxford University Press, New York NY, Oxford (U.K.).

Jara-Díaz & Guevara 2003 — Jara-Díaz, Sergio R., Cristián A. Guevara (2003) : **Behind the subjective value of time travel savings : The perception of work, leisure and travel from an joint mode choice activity model**, *Journal of Transport Economics and Policy 37/I*, pp. 29-46.

Jayet 1993 — Jayet, Hubert (1993): **Analyse spatial quantitative, une introduction**, *Bibliothèque de science régionale*, Economica, Paris (France).

Jenal 1951 — Jenal, Sebastian (1951) : **Pendlerwanderungen in der Schweiz**, *Geographica Helvetica* 6, pp. 1-10.

Joerin & Bozovic 2007 — Joerin, Florent, Goran Bozovic (2005) : **Comment réorganiser le réseau postal suisse ? Une application de l'aide à la décision territoriale**, *The Canadian Geographer / Le Géographe Canadien 51/2*, pp. 202-18.

Joerin et al 2001 — Joerin, Florent, Marius Theriaut, Paul Villeneuve, Frédéric Béguin (2001) : **Une procédure multicritère pour évaluer l'accessibilité aux lieux d'activité**, *Revue Internationale de Géomatique 11/1*, pp. 69-104.

Joye & Schuler 1984 — Joye, Dominique, Martin Schuler (1984) : **Une typologie des cantons suisses**, Rapport de recherches 51, IREC, EPFL, Lausanne (Swtz.).

Joye et al 1988 — Joye, Dominique, Martin Schuler, Rolf Nef, Michel Bassand (1988): **Le système des communes suisses: approche typologique du modèle centre-périphérie**, OFS, Berne (Swtz).

Kampschulte & Strassmann 1999 — Kampschulte, Andreas, Renato Strassmann (1999): **Restrukturierungsprozesse einer Stadt-Umland-Ökonomie: Veränderung der Wirtschaftsstruktur im Agglomerationsraum Basel**, *Geographica Helvetica* 54, pp. 7-17.

Kanevsky & Maignan 2004 — Kanevsky, Mikhail, Michel Maignan (2004) : **Analysis and modelling of spatial environmental data**, EPFL Press, Lausanne (Swtz.).

Keller 1980 — Keller, Theo (1980): **Innerstädtische Betriebverlagerungen am Beispiel von 5 Banken in der Stadt Zürich**, *Geographica Helvetica* 35, pp. 76-83.

Kjellberg & Taylor 1984 — Kjellberg, Francesco, John G. Taylor (1984): **Les pays scandinaves**, *in Mény, Yves (ed.): La réforme des collectivités locales en Europe, La Documentation Française, Paris (France)*, pp. 143-87.

Kotkin 2000 — Kotkin, Joel (2000) : **The new geography: how the digital revolution is reshaping the American landscape**, Random House, New York NY.

Lang 2003 — Lang, Robert E. (2003): **Edgeless cities, exploring the elusive metropolis**, Brookings Institution Press, Washington DC.

Lave 1970 — Lave, Lester B. (1970): **Congestion and urban location**, *Papers and Proceedings of Regional Science Association* 25, 133-49.

Lawless 1995 — Lawless, Paul (1995): **Inner-city and suburban labour markets in a major English conurbation: processes and policy implications**, *Urban Studies* 32/7, pp. 1097-125.

Lee 2001 — Lee, Sang-Il (2001): **Developing a bivariate spatial association measure: an integration of Pearson's R and Moran's I**, *Journal of Geographical Systems* 3, 369-85.

Lee et al 2006 — Lee, Shin, Jong Gook Seo, Chris Webster (2006): **The decentralizing metropolis: economic diversity and commuting in the US suburbs**, *Urban Studies* 43/13, pp. 2525-49.

Legendre 1993 — Legendre, Pierre (1993): **Spatial autocorrelation: trouble or new paradigm?** *Ecology* 74/6, pp. 1659-73.

Legendre 2000 — Legendre, Pierre (2000): **Comparison of permutation methods for the partial correlation and the partial Mantel tests**, *Journal of Statistical Computation and Simulation* 67, pp. 37-73.

Legendre & Fortin 2010 — Legendre, Pierre, Marie-Josée Fortin (2010): **Comparison of the Mantel test and alternative approaches for detecting complex multivariate relationships in the spatial analysis of genetic data**, *Molecular Ecology Resources* 10, pp. 831-44.

Legendre & Legendre 1998 — Legendre, Pierre, Louis Legendre (1998): **Numerical ecology, second English edition**, Elsevier, Amsterdam (Netherlands).

Legendre et al 2002 — Legendre Pierre, Mark R. T. Dale, Marie-Josée Fortin, Jessica Gurevitch, Michael Hohn, Donald Myers (2002) : **The consequences of spatial structures for the design and analysis of ecological field surveys**, *Ecography* 25, pp. 601-15.

Leinberger & Lockwood 1986 — Leinberger, Christopher B., Charles Lockwood (1986): **How business is reshaping America**, *The Atlantic* Oct. 1986, pp. 43-51.

Lemelin & Gatignol 1999 — Lemelin, André, Agnès Gatignol (1999): **La structure des déplacements pendulaires des femmes et des hommes dans la région de Montréal**, *Cahiers de Géographie du Québec* 43/119, pp. 187-210.

Leresche et al 1992 — Leresche, Jean-Philippe, Dominique Joye, Michel Bassand (1992) : **La métropole lémanique et la Suisse romande : synthèse et reccomandations**, IREC, Lausanne (Swtz.).

Levinson & Kumar 1994 — Levinson, David M., Ajay Kumar (1994) : **The rational locator : why travel times have remained stable**, *Journal of the American Planning Association* 60/3, pp. 319-32.

Lévy 2008 — Lévy, Jacques (ed.) (2008): **L'invention du monde, une géographie de la mondialisation**, Presses de Sciences Po, Paris (France).

Lloyd 2007 — Lloyd, Christopher D. (2007): **Local models for spatial analysis**, CRC Press, Boca Raton FL.

Lloyd 2010 — Lloyd, Christopher D. (2010): **Spatial data analysis, an introduction for GIS users**, Oxford University Press, Oxford (U.K.)

Logan 1976 — Logan, John R. (1976): **Industrialization and the stratification of cities in suburban regions**, *The American Journal of Sociology* 82/2, pp.333-48.

Lösch 1940 — Lösch, August (1940): **Die räumliche Ordnung der Wirtschaft**, Fischer, Jena (Germany).

Lösch 1954 — Lösch, August (1954): **The economics of location**, Yale University Press, New Haven CT.

Mahmassani et al 1988 — Mahmassani, Hani S., M. Hadi Baaj, Chee Chung Tong (1988) : **Characterization and evolution of spatial density patterns in urban areas**, *Transportation* 15, 233-56.

Maillat et al 1996 — Maillat, Denis, Giannicola Balin, Florian Németi (1996): **Le paradoxe des régions en déclin**, *Geographica Helvetica* 51, pp. 80-3.

Manners 1974 — Manners, Gerald (1974): **The office in Metropolis: an opportunity for shaping metropolitan America**, *Economic Geography* 50/2, pp. 93-110.

Manly 2007 — Manly, Bryan F. J. (2007): **Randomization, bootstrap and Monte Carlo methods in biology, 3rd ed.**, *Texts in Statistical Science Series*, Chapman & Hall / CRC Press, Boca Raton FL.

Manly 2009 — Manly, Bryan F. J. (2009): **Statistics for Environmental Science and Management, 2nd ed.**, *Applied Environmmental Statistics Series*, Chapman & Hall / CRC Press, Boca Raton FL.

Mantel 1967 — Mantel, Nathan (1967): **The detection of disease clustering and a generalized regression approach**, *Cancer Research* 27/2, pp. 209-20.

McDonald 1987 — McDonald, John F. (1987): **The identification of urban subcenters**, *Journal of Urban Economics* 21, pp. 242-58.

McDonald & McMillen 1990 — McDonald, John F., McMillen Daniel P. (1990): **Employment subcenters and land values in a polycentric urban area: the case of Chicago**, *Environment and Planning A* 22/12, pp. 1561-74.

McDonald & Prather 1994 — McDonald, John F., Paul J. Prather (1994): **Suburban employment centres: the case of Chicago**, *Urban Studies* 31/2, pp. 201-18.

McHone 1986 — **Supply-side considerations in the location of industry in suburban communities: empirical evidence from the Philadelphia SMSA**, *Land Economics* 62/1, pp. 64-73.

McKee & McKee 2001 — McKee, David L., Yosra A. McKee (2001): **Edge cities and the viability of metropolitan economies: contributions to flexibility and external linkages by new urban service environments**, *American Journal of Economics and Sociology* 60/1, pp. 171-84.

McMillen 2001a — McMillen, Daniel P. (2001): **Nonparametric employment subcenter identification**, *Urban Studies* 40/1, 57-69.

McMillen 2001b — McMillen, Daniel P. (2001): **Polycentric urban structure: the case of Milwaukee**, *publication of the Federal Bank Reserve of Chicago, accessible at*: http://www.chicagofed.org/publications/economicperspectives/2001/2qepart2.pdf

McMillen 2003 — McMillen, Daniel P. (2003): **Identifying sub-centres using contiguity matrices**, *Journal of Urban Economics* 50, 448-73.

McMillen & McDonald 1998 — McMillen, Daniel P., John F. McDonald (1998): **Suburban subcenters and employment density in metropolitan Chicago**, *Journal of Urban Economics* 43, pp. 157-80.

McMillen & Smith 2003 — McMillen, Daniel P., Stefani C. Smith (2003): **The number of subcenters in large urban areas**, *Journal of Urban Economics* 53, pp. 321-38.

Mees 2010 — Mees, Paul (2010): **Transport for suburbia: beyond the automobile age**, Earthscan, London (U.K.), Sterling VA.

Meier-Dallach et al 1982 — Meier-Dallach, Hans-Peter, Suzanne Hohermuth, Rolf Nef, René Anliker (1982): **Zwischen Zentren und Hinterland**, Rüegger, Diessenhofen (Swtz.).

Meier 1992 — Meier, Bernhard (1992): **Die Arbeitsplatzentwicklung in der Agglomeration Bern im schweizerischen und regionalen Kontext**, *Geographica Helvetica* 47, pp. 5-12.

Messerli 1996 — Messerli, Paul (1996): **Das Berggebiet und die Neuorientierung der schweizerischen Regionalpolitik**, *Geographica Helvetica* 51, pp. 86-91.

Mieszkowski & Mills 1993 — Mieszkowski, Peter, Edwin S. Mills (1993): **The causes of metropolitan suburbanization**, *The Journal of Economic Perspectives* 7/3, pp. 135-47.

Miller 2005 — Miller, Harvey J. (2005): **Place-based versus people-based accessibility**, in *Levinson, David M. & Kevin J. Krizek (eds): Access to Destinations, Elsevier, Amsterdam (NL),* pp. 63-90.

Mills 1975 — Mills, E. (1975): **Planning and market models in urban models**, in *Grieson R., ed. (1975): Public and urban economics: Essays in honor of William Vickrey*, Heath, Lexington MA.

Moran 1948 — Moran, P. A. P. (1948): **The interpretation of statistical maps**, *Journal of the Royal Statistical Society, Series B (Methodological)* 10/2, pp. 243-51.

Moran 1950 — Moran, P. A. P: (1950): **Notes on continuous stochastic phenomena**, *Biometrika* 37/1-2, pp. 17-23.

Mosenthal & Kirsch 1990 — Mosenthal, Peter B., Irwin S. Kirsch (1990): **Understanding thematic maps**, *Journal of Reading* 34/2, pp. 136-40.

Muller 1997 — Muller, Peter O. (1997): **The suburban transformation of the globalizing American city**, *Annals of the American Academy of Political and Social Science* 551, pp. 44-58.

Murphy & Vance 1954 — Murphy, Raymond E., James E. Vance (1954): **Delimiting the CBD**, *Economic Geography* 30/3, pp. 189-222.

Murphy et al 1955 — Murphy, Raymond E., James E. Vance, Bart J. Epstein (1955): **Internal structure of the CBD**, Economic Geography 31/1, pp. 21-46.

Muth 1969 — Muth, Richard F. (1969): **Cities and housing**, University of Chicago Press, Chicago IL.

Nadarajah & Kotz 2004 — Nadarajah, Saralees, Samuel Kotz (2005): **The beta Gumbel distribution**, *Mathematical Problems in Engineering* 2004/4, pp. 323-32.

Nitsch 2005 — Nitsch, Volker (2004): **Zipf zipped**, in *Journal of Urban Economics* 57, pp. 86-100.

Nurminen 1989 — Nurminen, Eero (1989): **Finland: present and futures in local government**, in *Bennett, Robert (ed.): Territory and administration in Europe, Pinter, London (U.K.)*, pp. 271-83.

Newton 1984 — Newton, Ken (1984): **La Grande-Bretagne**, *in Mény, Yves (ed.): La réforme des collectivités locales en Europe, La Documentation Française, Paris (France)*, pp. 13-29.

Odermatt 1999 — Odermatt, André (1999) : **Räumlich-soziale Entmischung und die Finanzkrise der Kernstädte: das Beispiel Zürich**, *Geographica Helvetica* 54, pp. 18-28

Odland 1978 — Odland, John (1978): **The condition for multi-center cities**, *Economic Geography* 54/3, pp. 234-44.

Ogawa & Fujita 1980 — Ogawa, Hideaki, Masahisa Fujita (1980): **Equilibrium land use patterns in a nonmonocentric city**, *Journal of Regional Science* 20/4, 455-75.

Pacione 2009 — Pacione, Michael (2009): **Urban geography, a global perspective, 3rd ed.**, Routledge, London (U.K.) & New York NY.

Park et al 1925 — Park, Robert E., Ernest W. Burgess, Roderick D. MacKenzie (1925): **The city**, University of Chicago Press, Chicago IL.

Peiser 1982 — Peiser, R. B. (1982): **On the emergence of subcenters in a non-monocentric city**, paper presented at North American Meeting, Regional Science Association, Pittsburgh PA, Nov. 12th.

Perry 2010 — Perry, Martin (2010): **Controversies in local economic development**, Routledge, London (U.K.) & New York NY.

Pfister & Moll 1973 — Pfister, Christian & Martin Moll (1973) : **Landschaftswandel im Bereich von Autobahnanschlüssen: die Bedeutung des neuen Verkehrsträgers für die betriebliche Standortwahl und die Raumordnung am Beispiel des N1 zwischen Bern und Rothrist**, Geographica Helvetica 28, pp. 200-17.

Phelps & Parsons 2003 — Phelps, N. A., N. Parsons (2003): **Edge urban geographies: notes from the margins of Europe's capital cities**, *Urban Studies* 40/9, pp. 1725-49.

Piveteau & Gaudard 1969 — Piveteau, J.-L., G. Gaudard (1969) : **La détermination d'une région économique : l'exemple de la Broye**, *Geographica Helvetica* 24, pp. 8-9.

Piveteau 1982 — Piveteau, jean-Luc : **Industrialisation et urbanisation de la Suisse depuis 1780**, *Geographica Helvetica* 37, pp. 26-9.

Piveteau et al 1968 — Piveteau J.-L., G. Gaudard, J. Pasquier (1968) : **La Veveyse fribourgeoise : étude interdisciplinaire géographico-économique**, *Geographica Helvetica* 23, pp. 72-82.

Pivo 1990 — Pivo, Gary (1990): **The net of mixed beads: suburban office development in six metropolitan regions**, *Journal of the American Planning Association* 56/4, pp. 457-69.

Polèse & Shearmur 2005 — Polèse, Mario, Richard Shearmur (2005): **Economie urbaine et régionale, introduction à la géographie économique**, Economica, Paris (France).

Pumain & Saint-Julien 2010 — Pumain, Denise, Thérèse Saint-Julien (2010) : **Analyse spatiale : les interactions, 2ème édition**, Armand Colin, Paris (France)

Racine 1981 — Racine, Jean-Bernard (1981): **L'analyse mathématique et statistique des données spatiales: quelques réflexions sur les methods d'analyse géographique quantitative d'Hubert Beguin**, *Geographica Helvetica* 36, pp. 22-3.

Racine 1988 — Racine, Jean-Bernard (1988) : **La Suisse dans ses représentations, ses dynamismes et ses horizons économiques, démo-géographiques et urbains**, *Annales de Géographie* 539, pp. 40-83.

Racine 1994 — Racine, Jean-Bernard (1994) : **La Suisse urbaine à l'orée du 3ème millénaire : risques et défis d'un changement non programmé**, Geographica Helvetica 49, pp. 47-52.

Racine & Raffestin 1990 — Racine, Jean-Bernard, Claude Raffestin (eds.) (1990) : **Nouvelle géographie de la Suisse et des Suisses**, 2 vols., Payot, Lausanne (Swtz.).

Rangel et al 2010 — Rangel, T. F. L. V. B., J. A. F. Diniz-Filho, L. M. Bini (2010) : **SAM : a comprehensive application for spatial analysis in macroecology**, *Ecography* 33, pp. 46-50., http://www.ecolevol.ufg.br/sam

Redfearn 2007 — Redfearn, Christian (2007): **The topography of metropolitan employment: identifying centers of employment in a polycentric urban area**, *Journal of Urban Economics* 61, 519-41.

Reilly 1929 — Reilly, W. J. (1929): **Methods of the study of retail relationships**, *University of Texas Bulletin 2944*, Austin TX.

Reilly 1931 — Reilly, W. J. (1931): **The law of retail gravitation**, Pilsbury, New York NY.

Rey 2001 — Rey, Patrick (2001): **Pendlermobilität in der Nordwestschweiz: Entwicklung der Pendlerbeziehungen und der Verkehrsmittelwahl zwischen 1970 und 1990**, *Geographica Helvetica* 56, pp. 107-16.

Richardson & Chang-Hee 2004 — Richardson, Harry W., Christine Bae Chang-Hee (eds.) (2004): **Urban sprawl in Westzern Europe and the United States**, Ashgate, Aldershot (U.K.).

Richardson 1988 — Richardson, Harry W. (1988): **Monocentric vs. polycentric models: the future of urban economics in regional science**, *The Annals of Regional Science* 22/2, pp. 1-12.

Riguelle et al 2004a — Riguelle, François, Marc Servais, Isabelle Thomas, Haike Van Dyck, Ann Verhetsel (2004) : **Activités économiques et ville européenne : les banlieues ont-elles besoin des centres ?** Research report, politique scientifique fédérale 116, http://www.belspo.be/belspo/home/publ/pub_ostc/S3/rS310002_fr.pdf

Riguelle et al 2004b — Riguelle, François, Isabelle Thomas, Ann Verhetsel (2004) : **La distribution spatiale de l'emploi à Liège et dans sa province : test à différentes échelles de la théorie du polycentrisme.** Research report, politique scientifique fédérale 116, http://www.belspo.be/belspo/home/publ/pub_ostc/S3/rS310002_fr.pdf

Riguelle et al 2007 — Riguelle, François, Isabelle Thomas, Ann Verhetsel (2007): **Measuring urban polycentrism: a European case study and its implications**, *Journal of Economic Geography* 7, 193-215.

Robinson 1967 — Robinson, Arthur H. (1967): **The thematic maps of Charles Joseph Minard**, *Imago Mundi* 21, 99. 95-112.

Rodrigue et al 2006	Rodrigue, Jean-Paul, claude Comtois, Brian Slack (2006): **The geography of transport systems**, Routledge, London (U.K.) and New York NY.
Romanos 1977	Romanos, Michael C. (1977) : **Household location in a linear multicenter metropolitan area**, *Regional Science and Urban Economics* 7, 233-50.
Rosenberg 2010	Rosenberg, Michael S. (2001-2010): **PASSaGE Pattern analysis, spatial statistics, and geographical exegesis**, http://www.passagesoftware.net
Rosenberg & Anderson 2011	Rosenbers, Michael S., C. D. Anderson (2011): **PASSaGE Pattern analysis, spatial statistics and geographical exegesis, version 2, methods in ecology and evolution 2**, in press.
Rossi 1979	Rossi, Angelo (1979) : **Sviluppo urbano e politica urbana in Svizzera**, Edizioni Trelingue, Porza & Lugano (Swtz.)
Rossi 1983	Rossi, Angelo (1983): **La décentralisation urbaine en Suisse**, Presses Polytechniques Romandes, Lausanne (Swtz.).
Rossi 1986	Rossi, Angelo (1986): **Importanza del terzario per lo sviluppo regionale : il caso ticinese**, *Geographica Helvetica* 41, pp. 185-90.
Rotach & Ringli 1971	Rotach, Martin, Hellmut Ringli (Eds.) (1971): **Landesplanerische Leitbilder der Schweiz,** Schlussbericht, Institut für Orts- Regional- und Landesplanung an der ETHZ, Zurich (Swtz.).
Roth 1962	Roth, Jörg (1962) : **Mathematische Statistik und Geographie in der Schweiz**, *Geographica Helvetica* 17, pp. 229-36.
Rozenblat & Pumain 1993	Rozenblat, Céline, Denise Pumain (1993): **The location of multinational firms in the European urban system**, *Urban Studies* 30/10, pp. 1691-709.
Rozenblat 1994	Rozenblat, Céline (1994): **The organization of multinational firms in the European urban system**, *Flux* 17, pp. 5-17.
Sassen 1991	Sassen, Saskia (1991): **The global city: New York, London, Tokyo**, Princeton University Press, Princeton NJ.
Sassen 2000	Sassen, Saskia (2000): **Cities in a world economy**, Pine Forge Press, Thousand Oaks CA.
Schärer 1956	Schärer, Walter (1956): **Die suburbane Zone von Zürich**, *Geographica Helvetica* 11, pp. 1-51.
Schnore 1956	Schnore, Leo F. (1956): **The functions of metropolitan suburbs**, *The American Journal of Sociology* 61/5, pp. 453-8.
Schnore 1957a	Schnore, Leo F. (1957): **Satellites and suburbs**, *Social Forces* 36/2, pp. 121-7.
Schnore 1957b	Schnore, Leo F. (1957): **The growth of metropolitan suburbs**, *American Sociological Review* 22/2, pp. 165-73.
Schnore 1963	Schnore, Leo F. (1963): **The social and economic characteristics of American suburbs**, *The Sociological Quarterly* 4/2, pp. 122-34.
Schuler 1984	Schuler, Martin (1984): **Délimitation des agglomérations en Suisse 1980**, OFS, Berne (Swtz.).
Schuler 1992	Schuler, Martin (1992) : **Le recensement de la population en tant qu'observatoire de la démographie historique**, in *OFS, Recensement Fédéral de la Population 1990, Evolution de la population 1850-1990, Population des communes, OFS, Berne (Swtz.).*, pp. VII-XL.
Schuler 1994	Schuler, Martin (1994) : **Les niveaux géographiques de la Suisse**, OFS, Berne (Swtz.).
Schuler 1999	Schuler, Martin (1999) : **Régionalisation et urbanisation : des concepts convergents ?** Thèse de Doctorat No. 1921, EPFL – Département d'Architecture, Lausanne (Swtz.).
Schuler & Bassand 1985	Schuler, Martin, Michel Bassand (1985): **La Suisse, une métropole mondiale?** Rapport de recherche 54, IREC-EPFL, Lausanne (Swtz.).
Schuler & Nef 1983	Schuler, Martin, Rolf Nef (1983) : **Räumliche Typologien des schweizerischen Zentren-Peripherien-Musters**, National Forschungsprogramm 5 Regionalprobleme in der Schweiz, Arbeitsbericht 35, Berne (Swtz.)
Schuler et al 1985	Schuler, Martin, Matthias Bopp, Kurt E. Brassel, Ernst A. Brugger (1985): **Atlas Structurel de la Suisse**, Ex Libris, Zürich (Swtz.).

Schuler et al 1997 — Schuler, Martin, Thérèse Hussoud, Christophe Jemelin, Suzanne Stofer (1997) : **Atlas Structurel de la Suisse**, NZZ Verlag, Zürich (Swtz.).

Schuler et al 2002 — Schuler, Martin, Dominik Ullmann, Werner Haug (2002) : **Evolution de la population des communes 1850-2000**, OFS, Neuchâtel (Swtz.).

Schuler et al 2005 — Schuler, Martin, Pierre Dessemontet, Dominique Joye (2005): **Les niveaux géographiques de la Suisse**, OFS, Neuchâtel (Swtz.).

Schuler et al 2006 — Schuler, Martin, Pierre Dessemontet, Christophe Jemelin, Alain Jarne, Natacha Pache, Werner Haug (2006) : **Atlas des mutations spatiales de la Suisse**, OFS / NZZ, Neuchâtel / Zurich (Swtz).

Schweizer 1986 — Schweizer, Urs (1986) : **Suburbanisierung als Folge fiskalischer Inäquivalanz**, *Schweizerische Zeitschrift für Volkswirtschaft und Statistik* 1/1986, pp. 1-15.

Scott 1982 — Scott, Allen J. (1982): **Locational patterns and dynamics of industrial activity in the modern metropolis**, Urban Studies 1982/19, pp. 111-42.

Scott 1983a — Scott, Allen J. (1983): **Industrial organization and the logic of intra-metropolitan location, I: Theoretical considerations**, *Economic Geography*, 59/3, pp. 233-50.

Scott 1983b — Scott, Allen J. (1983): **Industrial organization and the logic of intra-metropolitan location, II: A case study of the printed circuits industry in the greater Los Angeles region**, *Economic Geography*, 59/4, pp. 343-67.

Scott 1984 — Scott, Allen J. (1984): **Industrial organization and the logic of intra-metropolitan location, III: A case study of the women's dress industry in the greater Los Angeles region**, *Economic Geography*, 60/1, pp. 3-27.

Scott 1986 — Scott, Allen J. (1986): **Industrial organization and location: division of labor, the firm, and spatial processes**, *Economic Geography* 62/3, pp. 215-31.

Servais et al 2004 — Servais, Marc, Isabelle Thomas, Haike Van Dyck, Ann Verhetsel (2004) : **Polycentrisme urbain : une réalité spatialement mesurable ?** *Cybergéo : Revue Européenne de Géographie* 268, 1-21.

SFRO 2010 — Office Fédéral des Routes (2010): **Routes et trafic – Faits et chiffres 2009**, Office Fédéral des Routes, Berne (Swtz.). http://www.astra.admin.ch/dokumentation/00119/00214/index.html?lang=fr

SFSO 1906 — Eidgenössisches Statistisches Bureau (1906) : **Ergebnisse der eidgenössischen Betriebszählung vom 9. August 1905, Band 1: Die Betriebe und die Zahl der darin beschäftigten Personen**, Eidgenössisches Statistisches Bureau, Berne (Swtz.).

SFSO 1912 — Eidgenössisches Statistisches Bureau (1912) : **Schweizerische Arealstatistik, abgeschlossen auf 1. Juli 1912**, Eidgenössisches Statistisches Bureau, Berne (Swtz.).

SFSO 1919 — Eidgenössisches Statistisches Bureau (1919) : **Wohnort und Arbeitsort der schweizerischen Bevölkerung, nach der Volkszählung vom 1. Dezember 1910**, Eidgenössisches Statistisches Bureau, Berne (Swtz.).

SFSO 1920 — Eidgenössisches Statistisches Bureau (1920) : **Die Nebenberufliche Tätigkeit det schweizerischen Bevölkerung, nach der Volkszählung vom 1. Dezember 1910**, Eidgenössisches Statistisches Bureau, Berne (Swtz.).

SFSO 1925 — Eidgenössisches Statistisches Bureau (1925) : **II. Arealstatistik der Schweiz, 1923/1924**, Eidgenössisches Statistisches Bureau, Berne (Swtz.).

SFSO 1930 — Eidgenössisches Statistisches Bureau (1930) : **Schweizerische Fabrikstatistik, Heft 1 der Ergebnisse der eidg. Betriebszählung vom 22. August 1929**, Eidgenössisches Statistisches Bureau, Berne (Swtz.).

SFSO 1931 — Bureau fédéral de statistique (1931) : **Les exploitations industrielles et commerciales en Suisse, 3ème volume des résultats du recense-**

ment des entreprises 1929, Bureau fédéral de statistique, Berne (Swtz.).

SFSO 1933 Eidgenössisches Statistisches Bureau (1933) : **Die Landwirtschaftsbetriebe in der Schweiz, Tabellenteil, Band 6 der eidgenössischen Betriebszählung 1929**, Eidgenössisches Statistisches Bureau, Berne (Swtz.).

SFSO 1940 Bureau fédéral de statistique (1940): **Statistique suisse des fabriques du 16 septembre 1937**, Bureau fédéral de statistique, Berne (Swtz.).

SFSO 1942 Bureau fédéral de statistique (1942) : **Les exploitations industrielles et commerciales en Suisse, Recensement fédéral des entreprises du 24 août 1939, volume 3**, Bureau fédéral de statistique, Berne (Swtz.).

SFSO 1944 Eidgenössisches Statistisches Bureau (1944-1947) : **Eidgenössische Volkszählung, 1. Dezember 1941, Bände 1-19, Kantonen**, Eidgenössisches Statistisches Bureau, Berne (Swtz.).

SFSO 1945 Bureau fédéral de statistique (1945) : **Exploitations agricoles par classe de grandeur, cantons et communes, Recensement fédéral des entreprises du 24 août 1939, volume 6**, Bureau fédéral de statistique, Berne (Swtz.).

SFSO 1946 Eidgenössisches Statistisches Bureau (1946) : **Schweizerische Fabrikstatistik vom 14. September 1944**, Eidgenössisches Statistisches Bureau, Berne (Swtz.).

SFSO 1948 Eidgenössisches Statistisches Bureau (1948) : **Eidgenössische Volkszählung 1970, Band 2: Gemeinden, Demographische Merkmale, Wirtschaftssektoren, Haushaltungen**, Eidgenössisches Statistisches Bureau, Berne (Swtz.).

SFSO 1950 Eidgenössisches Statistisches Bureau (1950) : **Schweizerische Fabrikstatistik vom 15. September 1949**, Eidgenössisches Statistisches Bureau, Berne (Swtz.).

SFSO 1953 Eidgenössisches Statistisches Bureau (1953) : **Arealstatistik der Schweiz, 1952**, Eidgenössisches Statistisches Bureau, Berne (Swtz.).

SFSO 1954 Eidgenössisches Statistisches Bureau (1954) : **Eidgenössische Volkszählung, 1. Dezember 1950, Bände 2-23, Kantonen**, Eidgenössisches Statistisches Bureau, Berne (Swtz.).

SFSO 1959 Bureau fédéral de statistique (1959) : **4ème recensement fédéral des entreprises du 25 août 1955, volume 3**, Bureau fédéral de statistique, Berne (Swtz.).

SFSO 1961 Bureau fédéral de statistique (1961) : **4ème recensement fédéral des entreprises du 25 août 1955, volume 7, Exploitations agricoles par cantons, communes et classes de grandeur**, Bureau fédéral de statistique, Berne (Swtz.).

SFSO 1963 Eidgenössisches Statistisches Bureau (1963-1964) : **Eidgenössische Volkszählung, 1. Dezember 1960, Bände 2-26, Kantonen**, Eidgenössisches Statistisches Bureau, Berne (Swtz.).

SFSO 1967 Bureau fédéral de statistique (1967) : **Recensement fédéral des entreprises, septembre 1965, volume 4 : Exploitations, résultats principaux par commune**, Bureau fédéral de statistique, Berne (Swtz.).

SFSO 1968 Bureau fédéral de statistique (1968) : **Recensement fédéral des entreprises, septembre 1965, Personnes occupées dans les communes, d'après les secteurs économiques**, Bureau fédéral de statistique, Berne (Swtz.).

SFSO 1972a Eidgenössisches Statistisches Bureau (1972) : **Eidgenössische Volkszählung 1970, Band 2: Gemeinden, Demographische Merkmalen, Wirtschaftssektoren, Haushaltungen**, Eidgenössisches Statistisches Bureau, Berne (Swtz.).

SFSO 1972b Eidgenössisches Statistisches Bureau (1972) : **Arealstatistik der Schweiz, 1972**, Eidgenössisches Statistisches Bureau, Berne (Swtz.).

SFSO 1984 Bundesamt für Statistik (1984) : **Eidgenössische Volkszählung 1980, Band 4: Gemeinden, Erwerbstätigkeit**, Bundesamt für Statistik, Berne (Swtz.).

SFSO 1993 — Bundesamt für Statistik (1993) : **Eidgenössische Volkszählung 1990, Erwerbsleben**, Bundesamt für Statistik, Berne (Swtz.).

SFSO 2000 — Office Fédéral de la Statistique (2000) : **Véhicules à moteur en Suisse, effectif au 30.09.2000**, Office Fédéral de la Statistique, Berne (Swtz.)

SFSO 2002 — Office Fédéral de la Statistique (2002) : **NOGA 2002, Nomenclature générale des activités économiques**, Office Fédéral de la Statistique, Neuchâtel (Swtz.).

SFSO 2005 — Office Fédéral de la Statistique (2005) : **Recensement de la population 2000, Vie active, pendularité et formation**, Office Fédéral de la Statistique, Neuchâtel (Swtz.)

SFSO 2008 — Office Fédéral de la Statistique (2008) : **NOGA 2008, Nomenclature générale des activités économiques**, Office Fédéral de la Statistique, Neuchâtel (Swtz.).

SFSO 2010a — Office Fédéral de la Statistique (2010) : **Mobilité et transports 2010**, Office Fédéral de la Statistique, Neuchâtel (Swtz.). http://www.bfs.admin.ch/bfs/portal/fr/index/themen/11/22/publ.html?publicationID=3970

SFSO 2010b — Office Fédéral de la Statistique (2010) : **Productivité du travail, productivité du travail par branches (NOGA A60),** data table, OFS, Neuchâtel (Swtz.), accessed on http://www.bfs.admin.ch/bfs/portal/fr/index/themen/04/03/blank/key/02.html

SFSO 2010c — Office Fédéral de la Statistique (2010) : **Niveaux des salaires, résultats nationaux, économie totale : salaire mensuel brut selon les branches économiques,** data table, OFS, Neuchâtel (Swtz.), accessed on http://www.bfs.admin.ch/bfs/portal/fr/index/themen/03/04/blank/data/01/06_01.html#5

SFSO 2010d — Office Fédéral de la Statistique (2010) : **Productivité du travail, productivité du travail par domaine d'activité,** data table, OFS, Neuchâtel (Swtz.), accessed on http://www.bfs.admin.ch/bfs/portal/fr/index/themen/03/04/blank/data/01/06_01.html#5

Shearmur & Coffey 2002a — Shearmur, Richard G., William J. Coffey (2002): **A tale of four cities: intrametropolitan employment distribution in Toronto, Montreal, Vancouver, and Ottawa-Hull, 1981-1996**, *Environment and Planning A* 34/4, 575-98.

Shearmur & Coffey 2002b — Shearmur, Richard G., William J. Coffey (2002): **Urban employment subcenters and sectoral clustering in Montreal – complementary approaches to the study of urban form**, *Urban Geography* 23, 103-30.

Shearmur et al 2007 — Shearmur, Richard, William Coffey, Christian Dube, Rémy Barbonne (2007): **Intrametropolitan employment structure: polycentricity, scatteration, dispersal and chaos in Toronto, Montreal and Vancouver, 1996-2001**, *Urban Studies* 44/9, pp. 1713-38.

Sieverts 2001 — Sieverts, Thomas (2001): **Zwischenstadt, zwischen Ort und Welt, Raum und Zeit, Stadt und Land**, Birkhäuser, Basle (Swtz.).

Small & Song 1994 — Small, Kenneth A., Shunfeng Song (1994): **Population and employment densities: structure and change**, *Journal of Urban Economics* 36, pp. 292-313.

Smouse et al 1986 — Smouse, Peter E., Jeffrey C. Long, Robert C. Sokal (1986): **Multiple regression and correlation extensions of the Mantel test of matrix correspondence**, *Systematic Zoology* 35/4, pp. 627-32.

Soja 2000 — Soja, Edward W. (2000): **Postmetropolis, critical studies of cities and regions**, Blackwell Publishing, Malden MA.

Stead & Marshall 2001 — Stead, Dominic, Stephen Marshall: **The relationships between urban form and travel patterns, an international review and evaluation**, *European Journal of Transport and Infrastructure Research* 1/2, pp. 113-41.

Steiner 1965 — Steiner, Dieter (1965): **Die Faktorenanalyse: ein moderns statistisches Hilfsmittel des Geographen für die objective Raumgliederung und Typenbildung**, *Geographica Helvetica* 20, pp. 20-34.

Stewart 1947 — Stewart, John Q. (1947): **Empirical mathematical rules concerning the distribution and equilibrium of population**, *Geographical Review* 37/3, 461-85.

Taylor et al 2002 — Taylor, Peter J., David R. F. Walker, Gilda Catalano, Michael Hoyler (2002): **Diversity and power in the world city network**, *Cities* 19/4, pp. 231-41.

Thurston & Yezer 1994 — Thurston, Lawrence, Anthony M. J. Yezer (1994): **Causality in the suburbanization of population and employment**, *Journal of Urban Economics* 35, pp. 105-18.

Tiefbauamt ZH 2000 — Tiefbauamt Kanton Zürich (2000): **Hochleistungsstrassen im Kanton Zürich: Strategie und Elemente**, Tiefbauamt, Baudirektion des Kantons Zürich, Zurich (Swtz.)., http://www.afv.zh.ch/internet/vd/afv/de/infrastruktu/stratHLS.html

Tiefbauamt ZH 2002 — Tiefbauamt Kanton Zürich (2002): **Strategie Hochleistungsstrassen im Kanton Zürich: Evaluation und Umsetzung 2025-2030**, Tiefbauamt, Baudirektion des Kantons Zürich, Zurich (Swtz.)., http://www.afv.zh.ch/internet/vd/afv/de/infrastruktu/stratHLS.html

Tschopp et al 2005 — Tschopp, Martin, Philipp Fröhlich, Kay Axhausen (2005): **Accessibility and spatial development in Switzerland during the last 50 years**, in *Levinson D.M., K.J. Krizek (eds): Access to destinations*, Elsevier, Amsterdam, 361-76.

Tschopp 2007 — Tschopp, Martin (2007): **Verkehrsinfrastruktur und räumliche Entwicklung in der Schweiz, 1950-2000**, PhD Dissertation, IVT-ETHZ (Swiss Federal Institute of Technology), Zurich (Swtz.)

Turcotte 2005 — Turcotte, Martin (2005): **The time it takes to get to work and back**, *General Social Survey on Time Use, Cycle 19*, Statistics Canada, 89-622-XIE, Ottawa ON.

Valarché et al 1970 — Valarché, Jean, Jean-Luc Piveteau, Gaston Gaudard (1970): **Le problème d'une region économique de Suisse occidentale**, *Geographica Helvetica* 25, pp. 59-66.

Vance 1964 — Vance, James E. (1964): **Geography and urban evolution in the San Fransisco Bay area**, Institute of Governmental Studies, Berkeley CA.

Vance 1970 — Vance, James E. (1970): **The merchant's world: the geography of wholesaling**, Prentice-Hall, Englewood Cliffs NJ.

Vance 1990 — Vance, James E. (1990): **The continuing city, urban morphology in western civilization**, The John Hopkins University Press, Baltimore MD, London (U.K.)

Vandersmissen et al 2003 — Vandersmissen, Marie-Hélène, Paul Villeneuve, Marius Thériault (2003): **Analyzing changes in urban form and commuting time**, *The Professional Geographer* 55/4, pp. 446-63.

Volman 2000 — Volman, Rainer (2000): **Suburbanes Wachstum von Bevölkerung und Beschäftigung als Weg zur dezentralen Mischung von Wohnen und Arbeiten? Eine empirische Untersuchung am Beispiel der Nordwestschweiz**, Geographica Helvetica 55, pp. 225-37.

Von Thünen 1842 — Von Thünen, Johann Heinrich (1842): **Der isolierte Staat in Beziehung auf Landwirtschaft und Nationalökonomie**, Gustav Fischer, Jena (Ger.).

Wachs et al 1973 — Wachs, Martin, T. G. Kumagai (1973): **Physical accessibility as a social indicator**, *Socio-Economic Planning Sciences* 7/5, 437-56.

Walker & Greenstreet 1991 — Walker, Robert, David Greenstreet (1991): **The effect of government incentives and assistance on location and job growth in manufacturing**, *Regional Studies* 25/1, pp. 13-30.

Weber 1909 — Weber, Alfred (1909): **Über den Standort der Industrien**, J.C.B. Mohr,Tübingen (Ger.).

Weibull 1976 — Weibull, Jörgen W. (1976): **An axiomatic approach to the measurement of accessibility**, *Regional Science and Urban Economics* 6, 357-79.

White 1976 — White, Michelle J. (1976): **Firm suburbanization and urban subcenters**, *Journal of Urban Economics* 3, pp. 323-43.

Wiesli 1959 — Wiesli, Urs (1959): **Beiträge zur Bestimmung der wirtschaftlichen Einzugsgebiete der Städte Grenchen und Zofingen: Versuch einer Klassenarbeit**, *Geographica Helvetica* 14, pp. 5-11.

Wiesli 1970 — Wiesli, Urs (1970): **Die verkehrsbedingte Entwicklung der Stadt Olten**, *Geographica Helvetica* 25, p. 15

Wilson 1971 — Wilson, A. G. (1971): **A family of spatial interaction models, and associated developments**, *Environment and Planning* 3/1.

Wolff 1992 — Wolff, Jean-Pierre (1992): **La problématique des agglomerations suisses**, *Geographica Helvetica* 47, pp. 13-24.

Würth 1986 — Würth, Markus (1986): **Räumliche Konsequenzen des Strukturwandels innerhalb des tertiären Sektors in der Schweiz**, *Geographica Helvetica* 41, pp. 179-84.

Yu 2006 — Yu, Dan-Lin (2006): **Spatially varying development mechanisms in the Greater Beijing Area: a geographically weighted regression investigation**, *Annals of Regional Science* 40, pp. 173-90.

Zipf 1949 — Zipf, G. K. (1949): **Human behavior and the principle of the least effort**, Addison & Wesley, Cambridge MA.

Annexes

Annex 1: Communal appartenance to units, 1939-2008

Commune ID	Commune Name	Unit 1939	Unit 1955	Unit 1965	Unit 1975	Unit 1985	Unit 1991	Unit 1995	Unit 1998	Unit 2001	Unit 2005	Unit 2008
2	Affoltern am Albis			2	2	2	2					
5	Hedingen					5	5	5	5	5	5	5
9	Mettmenstetten											9
29	Flurlingen	2937	2937	2937	2937							
30	Andelfingen											30
38	Rheinau		38	38	38	38	38	38	38	38	38	38
51	Bachenbülach							51	51	51	51	51
52	Bassersdorf	62	62	62	62	62	62	62	62	62	62	62
53	Bülach	53	53	53	53	53	53	53	53	53	53	53
54	Dietlikon	54	54	54	54	54	54	54	54	54	54	54
55	Eglisau		55	55	55	55	55	55	55			
58	Glattfelden	58	58									
60	Höri						60	60	60	60	60	60
62	Kloten	62	62	62	62	62	62	62	62	62	62	62
66	Opfikon	62	62	62	62	62	62	62	62	62	62	62
67	Rafz			67	67							
69	Wallisellen	69	69	69	69	69	69	69	69	69	69	69
83	Buchs (ZH)			96	96	96	96	96	96	96	96	96
84	Dällikon			96	96	96	96	96	96	96	96	96
86	Dielsdorf			86	86	86	86	86	86	86	86	86
91	Niederweningen		91	91	91	91	91	91	91			
92	Oberglatt						92					92
94	Otelfingen				94	94	94	94	94	94	94	94
96	Regensdorf			96	96	96	96	96	96	96	96	96
97	Rümlang			97	97	97	97	97	97	97	97	97
111	Bäretswil	111										
112	Bubikon	112	112	112	112			112	112	112	112	112
117	Hinwil				117	117	117	117	117	117	117	117
118	Rüti (ZH)	118	118	118	118	118	118	118				
119	Seegräben			119								
120	Wald (ZH)	120	120	120								
121	Wetzikon (ZH)	121			121	121	121	121	121	121	121	121
131	Adliswil						131					131
133	Horgen	133	133	133	133	133	133	133	133	133	133	133
135	Kilchberg (ZH)	135	135	135	135	135	135	135	135	135	135	135
138	Richterswil	138	138	138			139	139	139	139	139	139
139	Rüschlikon			139		139	139	139	139	139	139	139
141	Thalwil	141	141	141			141	141	141	141	141	141
142	Wädenswil	142	142	142	142	142	142	142				
151	Erlenbach (ZH)	151	151	151	151	151						
153	Hombrechtikon			153		153	153	153	153			
154	Küsnacht (ZH)										154	154
155	Männedorf	155		155	155	155	155	155	155	155	155	155
156	Meilen	156	156	156	156	156	156	156	156	156	156	156
157	Oetwil am See						157	157			157	157
158	Stäfa	158		158		158	158	158	158	158	158	158
159	Uetikon am See		159	159			159					
160	Zumikon						160					
161	Zollikon							161		161	161	161
172	Fehraltorf			172			172	172		172	172	172
174	Illnau-Effretikon									174		
176	Lindau	176	176	176		176	176	176	176	176	176	176
177	Pfäffikon	177	177	177	177	177	177	177	177	177	177	177
180	Weisslingen		180									
191	Dübendorf				69	69	69	69	69	69	69	69
193	Fällanden				199	199	199	199	199	199	199	199
194	Greifensee				199	199	199	199	199	199	199	199

Commune ID	Commune Name	Unit 1939	Unit 1955	Unit 1965	Unit 1975	Unit 1985	Unit 1991	Unit 1995	Unit 1998	Unit 2001	Unit 2005	Unit 2008
197	Schwerzenbach			199	199	199	199	199	199	199	199	199
198	Uster	198	198	198								
199	Volketswil				199	199	199	199	199	199	199	199
200	Wangen-Brüttisellen	54	54	54	54	54	54	54	54	54	54	54
217	Elgg					217				217		
224	Pfungen	224	224	224								
227	Seuzach									227	227	227
230	Winterthur	230	230	230	230	230	230	230	230	230	230	230
242	Birmensdorf (ZH)							242				
243	Dietikon				243	243	243	243	243	243	243	243
244	Geroldswil				243	243	243	243	243	243	243	243
247	Schlieren	247	247	247	247	247	247	247	247	247	247	247
250	Urdorf	247	247	247	247	247	247	247	247	247	247	247
251	Weiningen (ZH)	247	247	247	247	247	247	247	247	247	247	247
261	Zürich	261	261	261	261	261	261	261	261	261	261	261
301	Aarberg	301	301	301	301	301	301	301	301	301	301	301
306	Lyss	306	306	306	306	306	306	306	306	306	306	306
324	Bleienbach				342	342	342	342	342	342	342	342
329	Langenthal	329	329	329	329	329	329	329	329	329	329	329
333	Melchnau			333								
337	Roggwil (BE)	337	337	337	337	337				337	337	337
342	Thunstetten				342	342	342	342	342	342	342	342
351	Bern	351	351	351	351	351	351	351	351	351	351	351
355	Köniz					355	355	355	355	355	355	355
356	Muri bei Bern		356	356	356	356	356	356	356	356	356	356
358	Stettlen		358	358	358	358						
361	Zollikofen						361	361	361	361	361	361
362	Ittigen						361	361	361	361	361	361
363	Ostermundigen						363	363	363	363	363	363
371	Biel/Bienne	371	371	371	371	371	371	371	371	371	371	371
383	Büren an der Aare	383	383				383	383	383	383	383	383
387	Lengnau (BE)		387	387	387							
392	Pieterlen		392	392								
404	Burgdorf	404	404	404	404	404	404	404	404	404	404	404
406	Hasle bei Burgdorf	418	418	418								
412	Kirchberg (BE)	412	412	412			412	412	412	412	412	412
415	Lyssach								415	415	415	415
418	Oberburg	418	418	418								
434	Courtelary			434								
443	Saint-Imier	443	443	443	443	443	443	443	443	443	443	443
444	Sonceboz-Sombeval			444	444	444	444	444	444	444	444	444
446	Tramelan	446	446	446							446	446
448	Villeret											448
496	Ins								496			
498	Müntschemier											498
544	Moosseedorf				544	544	544	544	544	544	544	544
546	Münchenbuchsee			544			544	544	544	544	544	544
551	Urtenen						544	544	544	544	544	544
552	Utzenstorf				552		552	552	552	552	552	552
561	Adelboden			561	561	561	561	561		561	561	561
562	Aeschi bei Spiez							562				
563	Frutigen		563	563	563	563	563	563	563	563	563	563
565	Kandersteg			565	565	565	565	565	565	565		
573	Brienz (BE)		573	573	573	573	573	573	573	573	573	573
576	Grindelwald	576	576	576	576	576	576	576	576	576	576	576
581	Interlaken	581	581	581	581	581	581	581	581	581	581	581
584	Lauterbrunnen	584	584	584	584	584	584	584	584	584	584	584
587	Matten bei Interlaken				587							
603	Biglen		603	603								
608	Grosshöchstetten			608	608	608	608	608				
612	Konolfingen	612	612	612			612	612	612	612	612	612

Commune ID	Commune Name	Unit 1939	Unit 1955	Unit 1965	Unit 1975	Unit 1985	Unit 1991	Unit 1995	Unit 1998	Unit 2001	Unit 2005	Unit 2008
616	Münsingen	616	616	616			616	616	616	616	616	616
619	Oberdiessbach			619	619	619	619	619	619	619	619	619
663	Frauenkappelen							663				
667	Laupen	667	667	667	667	667	667					
668	Mühleberg						668	668	668	668	668	668
670	Neuenegg	670	670					670			670	670
682	Bévilard	682	682	682	682	682	682	682	682	682	682	682
690	Court			690			690	690				
697	Malleray	682	682	682	682	682	682	682	682	682	682	682
700	Moutier	700	700	700	700	700	700	700	700	700	700	700
703	Reconvilier	703	703	703	703	703	703	703	703	703		
713	Tavannes	713	713	713	713							
723	La Neuveville		723	723								
733	Brügg			733	733	733	733	733	733	733	733	733
743	Nidau	743	743	743	743	743	743	743	743	743	743	743
749	Studen					749	749	749	749	749	749	749
751	Täuffelen			751	751	751	751		751	751		751
768	Spiez	768	768	768				768				
769	Wimmis		768	768	768	768	768	768	768	768	768	768
782	Guttannen				782							
785	Meiringen	785	785	785	785	785	785	785	785	785	785	785
786	Schattenhalb	785	785	785	785	785	785	785	785	785	785	785
792	Lenk					792	792	792	792	792	792	792
794	Zweisimmen		794	794	794	794	794	794				
843	Saanen	843	843	843	843	843	843	843	843	843	843	843
854	Wahlern				854	854	854	854	854	854	854	
861	Belp							861			861	861
879	Riggisberg			879	879	879	879	879	879	879	879	879
902	Langnau im Emmental	902	902	902	902	902	902	902	902	902	902	902
909	Trubschachen						909		909	909		
938	Sigriswil		938	938	938							
939	Steffisburg						939					
942	Thun	942	942	942	942	942	942	942	942	942	942	942
944	Uetendorf						944	944	944	944	944	944
954	Huttwil	954	954	954	954	954	954	954	954	954	954	954
955	Lützelflüh					955	955	955				
957	Sumiswald	957	957	957	957	957	957	957	957	957	957	957
979	Herzogenbuchsee	979	979	979	979	979	979	979	979	979	979	979
981	Niederbipp						2407	2407	2407	2407	2407	2407
982	Niederönz								982	982	982	982
983	Oberbipp						2407	2407	2407	2407	2407	2407
984	Oberönz								982	982	982	982
992	Wangen an der Aare	992	992	992	992					992	992	992
995	Wiedlisbach						995	995	995	995		995
1002	Entlebuch		1002	1002	1002	1002	1002	1002	1002	1002	1002	
1008	Schüpfheim							1008				
1009	Werthenstein						1009	1009	1009	1009	1009	1009
1024	Emmen		1024	1024	1024	1024	1024	1024	1024	1024	1024	1024
1030	Hitzkirch					1030	1030	1030	1030	1030	1030	1030
1031	Hochdorf	1031	1031	1031	1031	1031	1031	1031	1031	1031	1031	1031
1040	Rothenburg					1040	1040	1040	1040	1040	1040	1040
1051	Adligenswil					1051	1051	1051	1051	1051	1051	
1053	Dierikon			1054	1054	1054	1054	1054	1054	1054	1054	1054
1054	Ebikon			1054	1054	1054	1054	1054	1054	1054	1054	1054
1055	Gisikon	1065	1065	1065	1065	1065	1065	1065	1065	1065	1065	1065
1059	Kriens					1059	1059	1059	1059	1059	1059	1059
1060	Littau		1024	1024	1024	1024	1024	1024	1024	1024	1024	1024
1061	Luzern	1061	1061	1061	1061	1061	1061	1061	1061	1061	1061	1061
1062	Malters					1062	1062	1062	1062	1062	1062	1062
1065	Root	1065	1065	1065	1065	1065	1065	1065	1065	1065	1065	1065
1069	Weggis	1069	1069	1069	1069	1069						1069

Commune ID	Commune Name	Unit 1939	Unit 1955	Unit 1965	Unit 1975	Unit 1985	Unit 1991	Unit 1995	Unit 1998	Unit 2001	Unit 2005	Unit 2008
1082	Büron			1082			1082					1082
1083	Buttisholz						1083	1083	1083	1083	1083	1083
1093	Neuenkirch					1093	1093	1093				
1094	Nottwil						1094	1094	1094	1094	1094	1094
1095	Oberkirch			1095								
1096	Pfeffikon	4139	4139	4139								
1103	Sursee	1103	1103	1103	1103	1103	1103	1103	1103	1103	1103	1103
1104	Triengen			1104	1104	1104	1104	1104	1104	1104	1104	1104
1107	Wolhusen	1107	1107	1107	1107	1107	1107	1107	1107	1107	1107	1107
1123	Altishofen			1125	1125	1125	1125	1125	1125	1125	1125	1125
1125	Dagmersellen			1125	1125	1125	1125	1125	1125	1125	1125	1125
1134	Langnau bei Reiden						1140	1140	1140	1140	1140	1140
1136	Menznau									1136	1136	1136
1137	Nebikon			1125	1125	1125	1125	1125	1125	1125	1125	1125
1139	Pfaffnau			1139	1139	1139	1139	1139	1139	1139	1139	1139
1140	Reiden						1140	1140	1140	1140	1140	1140
1143	Schötz			1125	1125	1125	1125	1125	1125	1125	1125	1125
1146	Wauwil		1146									
1147	Wikon		1140	1140			1140	1140	1140	1140	1140	1140
1148	Willisau Land	1149					1149	1149	1149	1149	1149	1149
1149	Willisau Stadt	1149	1149	1149	1149	1149	1149	1149	1149	1149	1149	1149
1150	Zell (LU)						1150	1150	1150	1150	1150	1150
1201	Altdorf (UR)	1201	1201	1201	1201	1201	1201	1201	1201	1201	1201	1201
1202	Andermatt		1202	1202	1202	1202	1202	1202	1202	1202	1202	1202
1205	Bürglen (UR)	1205	1205	1205				1205	1205	1205		
1206	Erstfeld		1206	1206	1206		1206	1206	1206	1206	1206	
1213	Schattdorf				1213	1213	1213	1213	1213	1213	1213	1213
1301	Einsiedeln	1301	1301	1301								
1322	Freienbach	1322	1322	1322		1322	1322	1322	1322	1322	1322	1322
1323	Wollerau									1323		1323
1331	Küssnacht am Rigi	1331	1331	1331			1331	1331	1331	1331	1331	1331
1341	Altendorf					1341	1341	1341	1341	1341	1341	1341
1342	Galgenen		1342									
1344	Lachen	1344	1344	1344	1344	1344	1344	1344	1344	1344	1344	1344
1346	Schübelbach			1346								
1347	Tuggen							1347				
1362	Arth	1362	1362	1362								
1364	Ingenbohl	1364	1364	1364								
1372	Schwyz	1372	1372	1372	1372	1372	1372	1372	1372	1372	1372	1372
1401	Alpnach		1401	1401								1401
1402	Engelberg	1402	1402	1402	1402	1402	1402	1402				1402
1404	Kerns			1404								
1406	Sachseln			1406	1406	1406	1406	1406	1406	1406	1406	1406
1407	Sarnen		1407	1407	1407	1407	1407	1407	1407	1407	1407	1407
1501	Beckenried				1501							
1505	Ennetbürgen				1505	1505	1505	1505				
1507	Hergiswil (NW)		1507	1507			1507	1507	1507	1507	1507	1507
1509	Stans	1509	1509	1509	1509	1509	1509	1509	1509	1509	1509	1509
1510	Stansstad		1510	1510	1510	1510				1510		
1602	Bilten				1602	1602	1602					1602
1607	Ennenda	1607	1607	1607	1607	1607	1607	1607	1607	1607	1607	1607
1609	Glarus	1609	1609	1609	1609	1609	1609	1609	1609	1609	1609	1609
1611	Hätzingen	1611	1611									
1619	Näfels		1619	1619	1619	1619	1619	1619	1619	1619	1619	1619
1620	Netstal	1620	1620	1620	1620	1620	1620	1620	1620	1620	1620	1620
1622	Niederurnen	1622	1622	1622	1622	1622	1622	1622	1622	1622	1622	1622
1627	Schwanden (GL)	1627	1627	1627	1627	1627	1627	1627	1627	1627	1627	1627
1701	Baar					1701	1701	1701	1701	1701	1701	1701
1702	Cham	1702				1702	1702	1702	1702	1702	1702	1702
1703	Hünenberg						1707	1707	1707	1707	1707	1707
1704	Menzingen	1704	1704	1704								

Commune ID	Commune Name	Unit 1939	Unit 1955	Unit 1965	Unit 1975	Unit 1985	Unit 1991	Unit 1995	Unit 1998	Unit 2001	Unit 2005	Unit 2008
1705	Neuheim					1701	1701	1701	1701	1701	1701	1701
1707	Risch					1707	1707	1707	1707	1707	1707	1707
1708	Steinhausen						1702	1702	1702	1702	1702	1702
1709	Unterägeri	1709	1709									
1711	Zug	1711	1711	1711	1711	1711	1711	1711	1711	1711	1711	1711
2013	Domdidier						2013	2013	2013	2013	2013	2013
2015	Estavayer-le-Lac		2015	2015	2015	2015	2015	2015	2015	2015	2015	2015
2096	Romont (FR)		2096	2096	2096	2096	2096	2096	2096	2096	2096	2096
2124	Broc	2124	2124	2124	2124	2124	2124	2124	2124	2124	2124	
2125	Bulle	2125	2125	2125	2125	2125	2125	2125	2125	2125	2125	2125
2140	Marsens			2148	2148	2148	2148	2148	2148	2148	2148	2148
2148	Riaz			2148	2148	2148	2148	2148	2148	2148	2148	2148
2174	Avry-sur-Matran					2174	2174	2174	2174	2174	2174	2174
2196	Fribourg	2196	2196	2196	2196	2196	2196	2196	2196	2196	2196	2196
2197	Givisiez				2197	2197	2197	2197	2197	2197	2197	2197
2198	Granges-Paccot				2197	2197	2197	2197	2197	2197	2197	2197
2206	Marly					2206	2206	2206		2206	2206	2206
2208	Matran					2174	2174	2174	2174	2174	2174	2174
2228	Villars-sur-Glâne				2228	2228	2228	2228	2228	2228	2228	2228
2254	Courtepin			2254	2254	2254	2254	2254	2254	2254	2254	2254
2275	Murten	2275	2275	2275	2275	2275	2275	2275	2275	2275	2275	2275
2280	Bas-Vully	2280										
2293	Düdingen					2293	2293	2293	2293	2293	2293	2293
2305	Schmitten (FR)				2305	2305	2305	2305	2305	2305	2305	2305
2306	Tafers						2306			2306	2306	2306
2309	Wünnewil-Flamatt	670									670	670
2325	Châtel-Saint-Denis			2325	2325	2325	2325	2325	2325	2325	2325	2325
2401	Egerkingen				2401	2401	2401	2401	2401	2401	2401	2401
2402	Härkingen				2401	2401	2401	2401	2401	2401	2401	2401
2404	Neuendorf				2401	2401	2401	2401	2401	2401	2401	2401
2405	Niederbuchsiten				2401	2401	2401	2401	2401	2401	2401	2401
2407	Oensingen				2407	2407	2407	2407	2407	2407	2407	2407
2422	Balsthal	2422	2422	2422	2422	2422	2422					2422
2428	Mümliswil-Ramiswil		2428									
2429	Welschenrohr		2429	2429								
2471	Bättwil						2476	2476	2476	2476	2476	2476
2473	Dornach	2473	2473	2473	2473	2473	2473	2473	2473	2473	2473	2473
2476	Hofstetten-Flüh						2476	2476	2476	2476	2476	2476
2513	Biberist		2513			2513	2513	2513	2513	2513	2513	2513
2516	Deitingen					2516						
2517	Derendingen	2517	2517					2517	2517	2517		
2519	Gerlafingen	2519	2519	2519	2519							2519
2527	Luterbach									2527	2527	2527
2532	Subingen				2532			2532	2532	2532	2532	2532
2534	Zuchwil	2534	2534	2534	2534	2534	2534	2534	2534	2534	2534	2534
2542	Bellach			2542	2542	2542	2542	2542	2542	2542	2542	2542
2543	Bettlach		2543	2543			2543	2543	2543	2543	2543	2543
2546	Grenchen	2546	2546	2546	2546	2546	2546	2546	2546	2546	2546	2546
2550	Langendorf	2550	2550	2550								
2554	Riedholz	2554	2554	2554	2554	2554	2554					
2556	Selzach					2556	2556	2556	2556	2556	2556	2556
2572	Däniken			2572	2572	2572	2572	2572	2572	2572	2572	2572
2573	Dulliken	2573	2573	2573								
2578	Gunzgen				2578	2578	2578	2578	2578	2578	2578	2578
2579	Hägendorf			2586	2586	2586	2586	2586	2586	2586	2586	2586
2581	Olten	2581	2581	2581	2581	2581	2581	2581	2581	2581	2581	2581
2582	Rickenbach (SO)							2586	2586	2586	2586	2586
2583	Schönenwerd	2583	2583	2583	2583	2583	2583	2583	2583			
2586	Wangen bei Olten	2586	2586	2586	2586	2586	2586	2586	2586	2586	2586	2586
2601	Solothurn	2601	2601	2601	2601	2601	2601	2601	2601	2601	2601	2601
2613	Breitenbach	2613	2613	2613	2613	2613	2613	2613	2613	2613	2613	2613

Commune ID	Commune Name	Unit 1939	Unit 1955	Unit 1965	Unit 1975	Unit 1985	Unit 1991	Unit 1995	Unit 1998	Unit 2001	Unit 2005	Unit 2008
2621	Nunningen						2621					
2701	Basel	2701	2701	2701	2701	2701	2701	2701	2701	2701	2701	2701
2761	Aesch (BL)			2773	2773	2773	2773	2773	2773	2773	2773	2773
2762	Allschwil		2762	2762		2762	2762	2762	2762	2762	2762	2762
2763	Arlesheim	2769	2769	2769			2769	2769	2769	2769	2769	2769
2765	Binningen							2765	2765	2765	2765	2765
2766	Birsfelden			2766	2766	2766	2766	2766	2766	2766	2766	2766
2769	Münchenstein	2769	2769	2769	2769	2769	2769	2769	2769	2769	2769	2769
2770	Muttenz		2770	2770	2770	2770	2770	2770	2770	2770	2770	2770
2773	Reinach (BL)						2773	2773	2773	2773	2773	2773
2775	Therwil						2775					
2786	Grellingen		2786	2786								
2787	Laufen	2787	2787	2787	2787	2787	2787	2787	2787	2787	2787	2787
2788	Liesberg											2788
2793	Zwingen		2793	2793	2793	2793	2793	2793	2793	2793		
2822	Augst				4252	4252	4252	4252	4252	4252	4252	4252
2823	Bubendorf				2823	2823	2823	2823	2823	2823	2823	2823
2828	Lausen	2828	2828	2828	2828	2828						
2829	Liestal	2829	2829	2829	2829	2829	2829	2829	2829	2829	2829	2829
2831	Pratteln	2770	2770	2770	2770	2770	2770	2770	2770	2770	2770	2770
2846	Gelterkinden	2846	2846	2846								
2849	Itingen									2849	2849	2849
2861	Sissach	2861	2861	2861	2861	2861	2861	2861	2861	2861	2861	2861
2886	Hölstein	2886	2886	2886	2886							
2892	Oberdorf (BL)			2892	2892	2892		2892	2892	2892	2892	2892
2895	Waldenburg	2895	2895	2895	2895	2895	2895					
2920	Thayngen	2920	2920	2920	2920	2920	2920	2920	2920	2920	2920	2920
2932	Beringen			2932	2932	2932	2932	2932	2932	2932	2932	2932
2937	Neuhausen am Rheinfall	2937	2937	2937	2937	2937	2937	2937	2937	2937	2937	2937
2939	Schaffhausen	2939	2939	2939	2939	2939	2939	2939	2939	2939	2939	2939
2963	Ramsen											2963
2964	Stein am Rhein	2964	2964	2964	2964	2964	2964	2964	2964	2964	2964	2964
3001	Herisau	3001	3001	3001	3001	3001	3001	3001	3001	3001	3001	3001
3006	Urnäsch	3006										
3021	Bühler			3021			3021	3021				
3024	Teufen (AR)								3024	3024	3024	3024
3025	Trogen								3025	3025	3025	3025
3032	Heiden	3032	3032	3032	3032	3032	3032	3032	3032	3032	3032	3032
3037	Walzenhausen			3037	3037	3037	3037	3037	3037	3037		
3101	Appenzell	3101	3101	3101	3101	3101	3101	3101	3101	3101	3101	3101
3203	St.Gallen	3203	3203	3203	3203	3203	3203	3203	3203	3203	3203	3203
3204	Wittenbach											3204
3213	Goldach						3213	3213	3213	3213	3213	3213
3215	Rorschach	3215	3215	3215	3215	3215	3215	3215	3215	3215	3215	3215
3216	Rorschacherberg		3216	3216								
3217	Steinach					3217	3217	3217	3217	3217	3217	3217
3218	Tübach						3213	3213	3213	3213	3213	3213
3231	Au (SG)	3231	3231	3231	3231	3231	3231	3231	3231	3231	3231	3231
3232	Balgach	3232	3232	3232	3232	3232	3232	3232	3232	3232	3232	3232
3233	Berneck	3231	3231	3231	3231	3231	3231	3231	3231	3231	3231	3231
3234	Diepoldsau		3234	3234		3234	3234	3234	3234	3234	3234	3234
3235	Rheineck	3237	3237	3237	3237	3237	3237	3237	3237	3237	3237	3237
3236	St.Margrethen	3236	3236	3236	3236	3236	3236	3236	3236	3236	3236	3236
3237	Thal	3237	3237	3237	3237	3237	3237	3237	3237	3237	3237	3237
3238	Widnau	3238	3238	3238	3238	3238	3238					
3251	Altstätten		3251	3251	3251	3251	3251	3251	3251	3251	3251	3251
3254	Oberriet (SG)					3254	3254	3254	3254	3254	3254	3254
3255	Rebstein	3232	3232	3232	3232	3232	3232	3232	3232	3232	3232	3232
3256	Rüthi (SG)					3256	3256	3256	3256	3256	3256	3256
3271	Buchs (SG)	3271	3271	3271	3271	3271	3271	3271	3271	3271	3271	3271
3273	Grabs							3273	3273	3273	3273	3273

Commune ID	Commune Name	Unit 1939	Unit 1955	Unit 1965	Unit 1975	Unit 1985	Unit 1991	Unit 1995	Unit 1998	Unit 2001	Unit 2005	Unit 2008
3274	Sennwald		3274	3274	3274	3274	3274	3274	3274	3274	3274	3274
3275	Sevelen		3275	3275		3275	3275	3275	3275	3275	3275	3275
3276	Wartau			3276	3276	3276	3276	3276	3276	3276	3276	3276
3291	Bad Ragaz	3291	3291	3291	3291	3291	3291	3291	3291	3291	3291	3291
3292	Flums				3292	3292	3292	3292	3292	3292	3292	3292
3293	Mels		3293		3293	3293	3293	3293				
3294	Pfäfers						3294	3294	3294	3294	3294	3294
3295	Quarten	3295	3295									
3296	Sargans	3296	3296	3296	3296	3296	3296	3296	3296	3296	3296	3296
3297	Vilters-Wangs			3297		3297	3297	3297				
3298	Walenstadt	3298	3298	3298	3298							
3332	Eschenbach (SG)		3332	3332				3332	3332	3332	3332	3332
3335	Jona					3335	3335	3335	3335	3335	3335	3335
3336	Rapperswil (SG)	3336	3336	3336	3336	3336	3336	3336	3336	3336	3336	3336
3338	Schmerikon		3338	3338				3338				
3339	Uznach	3339	3339	3339	3339	3339	3339	3339	3339	3339	3339	3339
3352	Ebnat-Kappel		3352	3352								
3354	Krummenau		3355				3355	3355	3355	3355	3355	3355
3355	Nesslau		3355				3355	3355	3355	3355	3355	3355
3374	Lichtensteig	3374	3374	3374	3374							
3377	Wattwil	3377	3377	3377	3377	3377	3377	3377	3377	3377	3377	3377
3391	Bütschwil	3391	3391	3391		3391	3391	3391	3391		3391	3391
3392	Kirchberg (SG)		3392			3392	3392	3392	3392	3392	3392	3392
3401	Degersheim	3401	3401			3401	3401	3401	3401	3401	3401	3401
3402	Flawil	3402	3402	3402			3402					
3405	Jonschwil					3405					3405	3405
3407	Oberuzwil						3407					
3408	Uzwil	3408	3408	3408	3408	3408	3408	3408	3408	3408	3408	3408
3421	Bronschhofen										3421	3421
3422	Niederbüren					3424	3424	3424	3424	3424	3424	3424
3424	Oberbüren					3424	3424	3424	3424	3424	3424	3424
3425	Wil (SG)	3425	3425	3425	3425	3425	3425	3425	3425	3425	3425	3425
3426	Zuzwil (SG)					3426	3426					
3443	Gossau (SG)				3443	3443	3443	3443	3443	3443	3443	3443
3506	Vaz/Obervaz			3506	3506	3506	3506	3506	3506	3506	3506	3506
3561	Poschiavo	3561	3561	3561	3561	3561	3561	3561	3561	3561	3561	3561
3574	Ilanz	3574	3574	3574	3574	3574	3574	3574	3574	3574	3574	3574
3575	Laax						3575					
3603	Vals		3603				3603					
3651	Safien		3651									
3661	Cazis										3668	3668
3668	Thusis		3668	3668	3668	3668	3668	3668	3668	3668	3668	3668
3721	Bonaduz					3721	3721	3721	3721	3721	3721	3721
3722	Domat/Ems		3722	3722	3722	3722	3722	3722	3722	3722	3722	3722
3732	Flims		3732	3732	3732	3732	3732	3732	3732			
3752	Samnaun						3752	3752	3752	3752	3752	3752
3762	Scuol	3762	3762	3762	3762	3762	3762	3762	3762	3762	3762	3762
3782	Celerina/Schlarigna									3782		
3784	Pontresina	3784	3784	3784	3784	3784	3784	3784	3784	3784	3784	3784
3786	Samedan	3786	3786	3786	3786	3786	3786	3786	3786	3786	3786	3786
3787	St.Moritz	3787	3787	3787	3787	3787	3787	3787	3787	3787	3787	3787
3789	Sils im Engadin/Segl					3789	3789	3789	3789	3789	3789	3789
3790	Silvaplana						3790	3790				
3822	Mesocco			3822								
3851	Davos	3851	3851	3851	3851	3851	3851	3851	3851	3851	3851	3851
3871	Klosters-Serneus	3871	3871	3871	3871	3871	3871	3871	3871	3871	3871	3871
3901	Chur	3901	3901	3901	3901	3901	3901	3901	3901	3901	3901	3901
3921	Arosa	3921	3921	3921	3921	3921	3921	3921		3921		
3942	Igis	3942	3942	3942	3942	3942	3942	3942	3942	3942	3942	3942
3945	Trimmis						3945	3945	3945	3945	3945	3945
3946	Untervaz						3945	3945	3945	3945	3945	3945

Commune ID	Commune Name	Unit 1939	Unit 1955	Unit 1965	Unit 1975	Unit 1985	Unit 1991	Unit 1995	Unit 1998	Unit 2001	Unit 2005	Unit 2008
3961	Grüsch						3961	3961	3961	3961	3961	3961
3962	Schiers			3962			3962	3962	3962	3962	3962	3962
3972	Seewis im Prättigau						3961	3961	3961	3961	3961	3961
3982	Disentis/Mustér				3982	3982	3982	3982				
3986	Tujetsch			3986								
3987	Trun		3987	3987	3987							
4001	Aarau	4001	4001	4001	4001	4001	4001	4001	4001	4001	4001	4001
4003	Buchs (AG)	4003		4003	4003	4003	4003	4003	4003	4003	4003	4003
4006	Gränichen						4006	4006	4006	4006	4006	4006
4010	Oberentfelden	4010		4010	4010	4010	4010	4010	4010	4010	4010	4010
4012	Suhr	4003		4003	4003	4003	4003	4003	4003	4003	4003	4003
4013	Unterentfelden	4010		4010	4010	4010	4010	4010	4010	4010	4010	4010
4021	Baden	4021	4021	4021	4021	4021	4021	4021	4021	4021	4021	4021
4023	Bergdietikon			243	243	243	243	243	243	243	243	243
4026	Ennetbaden	4038	4038	4038								
4030	Killwangen			243	243	243	243	243	243	243	243	243
4032	Mägenwil				4032	4032	4032	4032	4032	4032	4032	4032
4033	Mellingen	4033	4033	4033								
4035	Niederrohrdorf			4035								
4038	Obersiggenthal	4038	4038									
4040	Spreitenbach			243	243	243	243	243	243	243	243	243
4042	Turgi	4042	4042		4042	4042	4042	4042	4042	4042	4042	4042
4044	Untersiggenthal				4044	4044	4044	4044	4044	4044	4044	4044
4045	Wettingen	4045					4045	4045	4045	4045	4045	4045
4047	Würenlingen			4047	4047	4047	4047	4047	4047	4047	4047	4047
4048	Würenlos						4048			4048	4048	4048
4063	Bremgarten (AG)	4063	4063	4063	4063	4063	4063	4063	4063	4063	4063	4063
4065	Dottikon					4065	4065				4065	4065
4080	Villmergen	4080	4080	4080	4080	4080	4080	4080	4080	4080	4080	4080
4082	Wohlen (AG)	4082	4082	4082	4082	4082	4082					
4092	Birr			4092	4092	4092	4092	4092	4092	4092	4092	4092
4095	Brugg	4095	4095	4095	4095	4095	4095	4095	4095	4095	4095	4095
4104	Lupfig			4104	4104	4104	4104	4104	4104	4104	4104	4104
4114	Schinznach Bad				4114	4114	4114	4114	4114	4114	4114	4114
4121	Villigen				4047	4047	4047	4047	4047	4047	4047	4047
4123	Windisch	4123	4123		4123	4123	4123	4123	4123	4123	4123	4123
4131	Beinwil am See	4131	4131	4131								
4133	Burg (AG)	4139	4139	4139								
4135	Gontenschwil	4135	4135	4135	4135	4135						4135
4139	Menziken	4139	4139	4139								
4141	Reinach (AG)	4141	4141	4141		4141	4141	4141	4141			
4144	Schöftland	4144	4144	4144		4144			4144			
4145	Teufenthal (AG)	4145	4145	4145	4145	4145	4145	4145				
4146	Unterkulm						4146	4146	4146	4146	4146	4146
4161	Eiken			4260	4260	4260	4260	4260	4260	4260	4260	4260
4163	Frick	4163	4163	4163	4163	4163	4163	4163	4163	4163	4163	4163
4169	Kaisten					4169	4169	4169	4169	4169	4169	
4170	Laufenburg	4170	4170	4170	4170	4170	4170	4170	4170	4170	4170	4170
4172	Münchwilen (AG)			4260	4260	4260	4260	4260	4260	4260	4260	4260
4177	Sisseln			4260	4260	4260	4260	4260	4260	4260	4260	4260
4193	Brunegg				4032	4032	4032	4032	4032	4032	4032	4032
4194	Dintikon								4194	4194	4194	4194
4199	Holderbank (AG)	4206	4206	4206					4203			
4200	Hunzenschwil				4207	4207	4207	4207	4207	4207	4207	4207
4201	Lenzburg	4201	4201	4201	4201	4201	4201	4201	4201	4201	4201	4201
4203	Möriken-Wildegg	4206	4206	4206					4203			
4204	Niederlenz	4204	4204				4204					
4205	Othmarsingen				4032	4032	4032	4032	4032	4032	4032	4032
4206	Rupperswil	4206	4206	4206	4206	4206	4206	4206	4206	4206	4206	4206
4207	Schafisheim				4207	4207	4207	4207	4207	4207	4207	4207
4209	Seon						4209	4209				

Commune ID	Commune Name	Unit 1939	Unit 1955	Unit 1965	Unit 1975	Unit 1985	Unit 1991	Unit 1995	Unit 1998	Unit 2001	Unit 2005	Unit 2008
4234	Merenschwand					4234	4234					4234
4236	Muri (AG)	4236	4236	4236					4236	4236	4236	4236
4239	Sins					4239	4239	4239	4239	4239	4239	4239
4252	Kaiseraugst				4252	4252	4252	4252	4252	4252	4252	4252
4254	Möhlin	4254				4254	4254	4254				
4258	Rheinfelden	4258	4258	4258	4258	4258	4258	4258	4258	4258	4258	4258
4260	Stein (AG)			4260	4260	4260	4260	4260	4260	4260	4260	4260
4271	Aarburg	4271	4271	4271	4271	4271	4271	4271	4271	4271		
4279	Murgenthal	4279	4279	4279								
4280	Oftringen											4280
4282	Rothrist			4282		4282	4282	4282	4282	4282	4282	4282
4283	Safenwil				4283	4283	4283	4283	4283	4283	4283	4283
4285	Strengelbach	4285	4285		4285							
4289	Zofingen	4289	4289	4289	4289	4289	4289	4289	4289	4289	4289	4289
4304	Döttingen	4304	4304	4304	4304	4304	4304	4304	4304	4304	4304	4304
4309	Klingnau	4304	4304	4304	4304	4304	4304					
4311	Leibstadt					4311	4311	4311	4311	4311	4311	4311
4323	Zurzach	4323	4323	4323	4323	4323	4323	4323	4323	4323	4323	4323
4401	Arbon	4401	4401	4401	4401	4401	4401	4401	4401	4401	4401	4401
4411	Egnach						4411	4411	4411	4411	4411	4411
4416	Hefenhofen							4416				
4421	Horn	4421	4421	4421	4421	4421	4421	4421				
4431	Roggwil (TG)											4431
4436	Romanshorn	4436	4436	4436	4436	4436	4436	4436	4436	4436	4436	4436
4461	Amriswil	4461	4461	4461								
4471	Bischofszell	4471	4471	4471		4471	4471	4471	4471	4471	4471	4471
4476	Erlen			4476	4476	4476	4476	4476	4476	4476	4476	4476
4501	Kradolf-Schönenberg	4501										
4506	Sulgen			4506		4506	4506	4506	4506	4506	4506	4506
4511	Zihlschlacht-Sitterdorf	4471	4471	4471		4471	4471	4471	4471	4471	4471	4471
4545	Diessenhofen			4545		4545	4545	4545	4545	4545	4545	4545
4546	Schlatt (TG)			4546								
4551	Aadorf					4551	4551	4551	4551	4551	4551	4551
4561	Felben-Wellhausen					4561	4561	4561	4561	4561	4561	4561
4566	Frauenfeld	4566	4566	4566	4566	4566	4566	4566	4566	4566	4566	4566
4591	Matzingen						4591					
4646	Ermatingen	4646	4646	4646								
4671	Kreuzlingen	4671	4671	4671	4671	4671	4671	4671	4671	4671	4671	4671
4691	Münsterlingen		4691	4691	4691	4691	4691	4691	4691	4691	4691	4691
4696	Tägerwilen						4696	4696	4696	4696	4696	4696
4711	Affeltrangen		4711	4711			4711	4711	4711	4711	4711	4711
4724	Eschlikon					4724	4724	4724	4724			4724
4746	Münchwilen (TG)	4746	4746	4746	4746	4746	4746	4746	4746	4746	4746	4746
4761	Sirnach	4761	4761	4761								
4776	Tobel-Tägerschen		4711	4711			4711	4711	4711	4711	4711	4711
4781	Wängi (TG)	4781	4781	4781			4781	4781	4781	4781	4781	4781
4864	Steckborn	4864	4864	4864	4864	4864	4864	4864	4864	4864	4864	
4891	Berg (TG)									4891	4891	4891
4911	Bürglen (TG)	4911	4911	4911		4911	4911	4911				
4946	Weinfelden	4946	4946	4946	4946	4946	4946	4946	4946	4946	4946	4946
4951	Wigoltingen		4951	4951								
5001	Arbedo-Castione		5001	5001	5001	5001	5001	5001				5001
5002	Bellinzona	5002	5002	5002	5002	5002	5002	5002	5002	5002	5002	5002
5003	Cadenazzo			5017	5017	5017	5017	5017	5017	5017	5017	5017
5004	Camorino		5005	5005	5005	5005	5005	5005	5005	5005	5005	5005
5005	Giubiasco		5005	5005	5005	5005	5005	5005	5005	5005	5005	5005
5017	Sant'Antonino			5017	5017	5017	5017	5017	5017	5017	5017	5017
5061	Airolo			5061	5061	5061	5061	5061	5061	5061	5061	5061
5064	Bodio		5064	5064			5064					
5072	Faido			5072	5072	5072	5072	5072				
5073	Giornico			5073	5073							

Commune ID	Commune Name	Unit 1939	Unit 1955	Unit 1965	Unit 1975	Unit 1985	Unit 1991	Unit 1995	Unit 1998	Unit 2001	Unit 2005	Unit 2008
5091	Ascona	5091	5091	5091	5091	5091	5091	5091	5091	5091	5091	5091
5097	Brissago	5097	5097	5097	5097	5097	5097	5097	5097	5097	5097	5097
5101	Contone			5017	5017	5017	5017	5017	5017	5017	5017	5017
5107	Gerra (Verzasca)			5107	5107	5107	5107	5107	5107	5107	5107	5107
5108	Gordola			5107	5107	5107	5107	5107	5107	5107	5107	5107
5112	Lavertezzo			5107	5107	5107	5107	5107	5107	5107	5107	5107
5115	Losone			5115	5115	5115	5115	5115	5115	5115	5115	5115
5116	Magadino			5017	5017	5017	5017	5017	5017	5017	5017	5017
5118	Minusio			5118		5118						
5120	Muralto	5120	5120	5120	5120	5120	5120	5120	5120	5120	5120	5120
5121	Orselina	5120	5120	5120	5120	5120	5120	5120	5120	5120	5120	5120
5131	Tenero-Contra			5107	5107	5107	5107	5107	5107	5107	5107	5107
5139	Locarno-Magadino			5107	5107	5107	5107	5107	5107	5107	5107	5107
5141	Agno			5141	5141	5141	5141	5141	5141	5141	5141	5141
5147	Barbengo			5147	5147	5147	5147	5147	5147	5147	5147	5147
5148	Bedano			5194	5194	5194	5194	5194	5194	5194	5194	5194
5151	Bioggio			5141	5141	5141	5141	5141	5141	5141	5141	5141
5153	Bironico					5217	5217	5217	5217			5217
5162	Cadempino			5194	5194	5194	5194	5194	5194	5194	5194	5194
5167	Canobbio					5167	5167	5167	5167	5167	5167	5167
5171	Caslano			5171	5171	5171	5171	5171	5171	5171	5171	5171
5176	Comano					5167	5167	5167	5167	5167	5167	5167
5186	Grancia			5147	5147	5147	5147	5147	5147	5147	5147	5147
5187	Gravesano			5194	5194	5194	5194	5194	5194	5194	5194	5194
5192	Lugano	5192	5192	5192	5192	5192	5192	5192	5192	5192	5192	5192
5194	Manno			5194	5194	5194	5194	5194	5194	5194	5194	5194
5195	Maroggia		5195	5195			5195					
5196	Massagno		5196	5196	5196	5196	5196	5196	5196	5196	5196	5196
5197	Melano		5195	5195			5195					
5198	Melide			5198								
5199	Mezzovico-Vira						5199	5199	5199	5199	5199	5199
5201	Montagnola							5201	5201	5201	5201	5201
5205	Muzzano			5141	5141	5141	5141	5141	5141	5141	5141	5141
5209	Pambio-Noranco			5147	5147	5147	5147	5147	5147	5147	5147	5147
5210	Paradiso			5210	5210	5210	5210	5210	5210	5210	5210	5210
5211	Pazzallo			5210	5210	5210	5210	5210	5210	5210	5210	5210
5213	Ponte Tresa			5171	5171	5171	5171	5171	5171	5171	5171	5171
5215	Pregassona		5215	5215	5215	5215	5215	5215	5215	5215	5215	5215
5217	Rivera					5217	5217	5217	5217			5217
5221	Savosa		5196	5196	5196	5196	5196	5196	5196	5196	5196	5196
5225	Sorengo						5225	5225	5225	5225	5225	5225
5227	Torricella-Taverne			5194	5194	5194	5194	5194	5194	5194	5194	5194
5231	Vezia			5194	5194	5194	5194	5194	5194	5194	5194	5194
5234	Viganello		5215	5215	5215	5215	5215	5215	5215	5215	5215	5215
5241	Arzo			5241	5241							
5242	Balerna	5242	5242	5242	5242	5242	5242	5242	5242	5242	5242	5242
5247	Capolago			5247	5247	5247	5247	5247				
5249	Castel San Pietro					5249	5249					
5250	Chiasso	5250	5250	5250	5250	5250	5250	5250	5250	5250	5250	5250
5251	Coldrerio											5251
5252	Genestrerio		5266	5266	5266	5266	5266	5266	5266	5266	5266	5266
5253	Ligornetto		5266	5266	5266	5266	5266	5266	5266	5266	5266	5266
5254	Mendrisio	5254	5254	5254	5254	5254	5254	5254	5254	5254	5254	5254
5257	Morbio Inferiore			5257	5257	5257	5257					
5260	Novazzano				5260	5260	5260	5260	5260	5260	5260	5260
5262	Rancate					5262	5262	5262	5262	5262	5262	5262
5263	Riva San Vitale			5247	5247	5247	5247	5247				
5266	Stabio		5266	5266	5266	5266	5266	5266	5266	5266	5266	5266
5281	Biasca		5281	5281	5281	5281	5281	5281	5281	5281	5281	5281
5401	Aigle	5401	5401	5401	5401	5401	5401	5401	5401	5401	5401	5401
5405	Gryon	5409	5409	5409	5409	5409						

Commune ID	Commune Name	Unit 1939	Unit 1955	Unit 1965	Unit 1975	Unit 1985	Unit 1991	Unit 1995	Unit 1998	Unit 2001	Unit 2005	Unit 2008
5408	Noville			5414	5414	5414	5414	5414	5414	5414	5414	5414
5409	Ollon	5409	5409	5409	5409	5409	5409					
5412	Rennaz			5414	5414	5414	5414	5414	5414	5414	5414	5414
5413	Roche (VD)			5414		5414	5414	5414	5414	5414	5414	5414
5414	Villeneuve (VD)			5414	5414	5414	5414	5414	5414	5414	5414	5414
5422	Aubonne	5422		5422	5422	5422	5422	5422	5422	5422	5422	5422
5451	Avenches			5451			5451	5451			5451	5451
5480	Daillens								5482	5482	5482	5482
5482	Eclépens								5482	5482	5482	5482
5489	Mex (VD)						5489	5489	5489	5489	5489	5489
5495	Penthalaz		5495	5495	5495	5495	5495	5495	5495	5495		
5497	Pompaples			5497	5497	5497	5497	5497	5497	5497	5497	5497
5498	La Sarraz			5497	5497	5497	5497	5497	5497	5497	5497	5497
5518	Echallens						5518					5518
5521	Etagnières				5582	5582	5582	5582	5582	5582	5582	5582
5568	Sainte-Croix	5568	5568	5568	5568		5568	5568	5568	5568	5568	5568
5582	Cheseaux-sur-Lausanne				5582	5582	5582	5582	5582	5582	5582	5582
5583	Crissier		5583	5583	5583	5583	5583	5583	5583	5583	5583	5583
5586	Lausanne	5586	5586	5586	5586	5586	5586	5586	5586	5586	5586	5586
5587	Le Mont-sur-Lausanne				5587	5587	5587	5587	5587	5587	5587	5587
5588	Paudex						5590	5590	5590	5590	5590	5590
5589	Prilly	5591	5591	5591	5591	5591	5591	5591	5591	5591	5591	5591
5590	Pully						5590	5590	5590	5590	5590	5590
5591	Renens (VD)	5591	5591	5591	5591	5591	5591	5591	5591	5591	5591	5591
5592	Romanel-sur-Lausanne						5592					
5602	Cully						5592					
5607	Puidoux						5607	5607	5607	5607	5607	5607
5621	Aclens						5621	5621	5621	5621	5621	5621
5624	Bussigny-près-Lausanne		5583	5583	5583	5583	5583	5583	5583	5583	5583	5583
5627	Chavannes-près-Renens			5635	5635	5635	5635	5635	5635	5635	5635	5635
5632	Denges							5638	5638	5638	5638	5638
5633	Echandens							5638	5638	5638	5638	5638
5635	Ecublens (VD)			5635	5635	5635	5635	5635	5635	5635	5635	5635
5636	Etoy	5422		5422	5422	5422	5422	5422	5422	5422	5422	5422
5637	Lavigny	5422		5422	5422	5422	5422	5422	5422	5422	5422	5422
5638	Lonay							5638	5638	5638	5638	5638
5642	Morges	5642	5642	5642	5642	5642	5642	5642	5642	5642	5642	5642
5646	Saint-Prex			5646	5646							5646
5647	Saint-Saphorin-sur-Morges						5621	5621	5621	5621	5621	5621
5648	Saint-Sulpice (VD)			5635	5635	5635	5635	5635	5635	5635	5635	5635
5649	Tolochenaz								5649	5649	5649	5649
5651	Villars-Sainte-Croix		5583	5583	5583	5583	5583	5583	5583	5583	5583	5583
5675	Lucens		5675	5675								5675
5678	Moudon	5678	5678	5678	5678	5678	5678	5678	5678	5678	5678	5678
5707	Chavannes-de-Bogis							5707	5707	5707	5707	5707
5721	Gland				5721			5721	5721	5721	5721	5721
5724	Nyon	5724	5724	5724	5724	5724	5724	5724	5724	5724	5724	5724
5725	Prangins				5725	5725	5725	5725	5725	5725	5725	5725
5732	Vich				5721			5721	5721	5721	5721	5721
5744	Ballaigues							5744	5744	5744	5744	5744
5757	Orbe	5757	5757	5757	5757	5757	5757			5757	5757	5757
5764	Vallorbe	5764	5764	5764	5764	5764	5764	5764	5764	5764	5764	5764
5822	Payerne	5822	5822	5822	5822	5822	5822	5822	5822	5822	5822	5822
5841	Château-d'Oex		5841	5841	5841	5841	5841	5841				
5851	Allaman	5422		5422	5422	5422	5422	5422	5422	5422	5422	5422
5861	Rolle	5861	5861	5861	5861	5861	5861	5861				5861
5871	L'Abbaye				5871	5871	5871	5871	5871	5871	5871	5871
5872	Le Chenit	5872	5872	5872	5872	5872	5872	5872	5872	5872	5872	5872
5873	Le Lieu				5871	5871	5871	5871	5871	5871	5871	5871
5884	Corsier-sur-Vevey						5884					

Commune ID	Commune Name	Unit 1939	Unit 1955	Unit 1965	Unit 1975	Unit 1985	Unit 1991	Unit 1995	Unit 1998	Unit 2001	Unit 2005	Unit 2008
5886	Montreux	5886	5886	5886	5886	5886	5886	5886	5886	5886	5886	5886
5889	La Tour-de-Peilz	5889	5889	5889		5889	5889		5889			
5890	Vevey	5890	5890	5890	5890	5890	5890	5890	5890	5890	5890	5890
5922	Montagny-près-Yverdon								5922	5922	5922	5922
5938	Yverdon-les-Bains	5938	5938	5938	5938	5938	5938	5938	5938	5938	5938	5938
6002	Brig-Glis	6002	6002	6002	6002	6002	6002	6002	6002	6002	6002	6002
6007	Naters			6007		6007	6007					
6023	Conthey			6023	6023						6023	
6031	Bagnes		6031	6031	6031	6031	6031	6031	6031	6031	6031	6031
6034	Orsières				6034							
6082	Ayent		6082									
6107	Gampel			6200	6200	6200	6200	6200	6200	6200	6200	6200
6111	Leukerbad			6111	6111	6111	6111	6111	6111	6111	6111	6111
6135	Leytron									6135		
6136	Martigny	6136	6136	6136	6136	6136	6136	6136	6136	6136	6136	6136
6139	Riddes		6139									
6141	Saxon						6141					
6152	Collombey-Muraz			6152								
6153	Monthey	6153	6153	6153	6153	6153	6153	6153	6153	6153	6153	6153
6158	Vionnaz											6158
6159	Vouvry				6159	6159	6159	6159	6159	6159	6159	6159
6200	Steg			6200	6200	6200	6200	6200	6200	6200	6200	6200
6217	Saint-Maurice	6217	6217	6217	6217	6217	6217	6217	6217	6217	6217	6217
6234	Chermignon	6243	6243	6243	6243	6243	6243	6243	6243	6243		
6235	Chippis	6235	6235	6235	6235	6235	6235		6235	6235		
6237	Grimentz		6237									
6240	Lens	6243	6243	6243	6243	6243	6243	6243	6243	6243		
6243	Montana	6243	6243	6243	6243	6243	6243	6243	6243	6243	6243	6243
6244	Randogne	6243	6243	6243	6243	6243	6243	6243	6243	6243	6243	6243
6248	Sierre	6248	6248	6248	6248	6248	6248	6248	6248	6248	6248	6248
6266	Sion	6266	6266	6266	6266	6266	6266	6266	6266	6266	6266	6266
6290	Saas Fee			6290	6290	6290	6290	6290	6290	6290	6290	6290
6292	St.Niklaus		6292				6292	6292	6292	6292	6292	6292
6297	Visp	6297	6297	6297	6297	6297	6297	6297	6297	6297	6297	6297
6298	Visperterminen			6298								
6300	Zermatt	6300	6300	6300	6300	6300	6300	6300	6300	6300	6300	6300
6402	Bevaix							6402				
6404	Boudry	6404	6404	6404		6404	6404	6404	6404	6404	6404	6404
6407	Corcelles-Cormondrèche										6406	
6408	Cortaillod	6404	6404	6404		6404	6404	6404	6404	6404	6404	6404
6412	Peseux		6412	6412	6412	6412	6412	6412	6412	6412	6412	6412
6414	Saint-Aubin-Sauges		6414	6414	6414	6414						
6421	La Chaux-de-Fonds	6421	6421	6421	6421	6421	6421	6421	6421	6421	6421	6421
6431	Les Brenets								6431	6431	6431	6431
6436	Le Locle	6436	6436	6436	6436	6436	6436	6436	6436	6436	6436	6436
6452	Cressier (NE)				6452	6452	6452	6452	6452	6452	6452	6452
6457	Marin-Epagnier		6457	6457	6457	6457	6457	6457	6457	6457	6457	6457
6458	Neuchâtel	6458	6458	6458	6458	6458	6458	6458	6458	6458	6458	6458
6459	Saint-Blaise		6457	6457	6457	6457	6457	6457	6457	6457	6457	6457
6472	Cernier	6478	6478	6478	6478		6478				6478	6478
6478	Fontainemelon	6478	6478	6478	6478	6478	6478	6478	6478	6478	6478	6478
6480	Les Geneveys-sur-Coffrane			6480	6480	6480	6480	6480	6480	6480	6480	6480
6505	Couvet	6505	6505	6505	6505	6505	6505	6505	6505			6505
6506	Fleurier	6506	6506	6506	6506	6506	6506			6506	6506	6506
6606	Bellevue											6606
6608	Carouge (GE)	6608	6608	6608	6608	6608	6608	6608	6608	6608	6608	6608
6613	Chêne-Bourg			6613	6613	6613	6613	6613	6613	6613	6613	6613
6616	Collonge-Bellerive										6616	6616
6621	Genève	6621	6621	6621	6621	6621	6621	6621	6621	6621	6621	6621
6623	Le Grand-Saconnex			6630	6630	6630	6630	6630	6630	6630	6630	6630

Commu-ne ID	Commune Name	Unit 1939	Unit 1955	Unit 1965	Unit 1975	Unit 1985	Unit 1991	Unit 1995	Unit 1998	Unit 2001	Unit 2005	Unit 2008
6628	Lancy	6608	6608	6608	6608	6608	6608	6608	6608	6608	6608	6608
6630	Meyrin		6630	6630	6630	6630	6630	6630	6630	6630	6630	6630
6632	Perly-Certoux			6633	6633	6633	6633	6633	6633	6633	6633	6633
6633	Plan-les-Ouates			6633	6633	6633	6633	6633	6633	6633	6633	6633
6638	Satigny			6630	6630	6630	6630	6630	6630	6630	6630	6630
6640	Thônex			6613	6613	6613	6613	6613	6613	6613	6613	6613
6643	Vernier	6630	6630	6630	6630	6630	6630	6630	6630	6630	6630	6630
6644	Versoix			6644								
6701	Bassecourt		6701	6701	6701	6701	6701	6701	6701	6701	6701	6701
6702	Boécourt					6714	6714	6714	6714	6714	6714	6714
6708	Courrendlin	6708	6708	6708	6708	6708	6708	6708	6708			
6711	Delémont	6711	6711	6711	6711	6711	6711	6711	6711	6711	6711	6711
6714	Glovelier					6714	6714	6714	6714	6714	6714	6714
6743	Les Breuleux		6743							6743	6743	6743
6754	Le Noirmont						6754	6754	6754	6754	6754	6754
6757	Saignelégier		6757	6757		6757	6757	6757	6757	6757	6757	6757
6771	Alle		6771	6771	6771	6771	6771	6771	6771	6771	6771	6771
6774	Boncourt			6774	6774	6774	6774	6774	6774	6774	6774	6774
6784	Courgenay				6784							
6800	Porrentruy	6800	6800	6800	6800	6800	6800	6800	6800	6800	6800	6800
6804	Saint-Ursanne		6804	6804								

Only communes which are part at some point of a unit are reported here. If a commune isn't included in the list, it has always remained in edgeless space.

Annex 2: Unit – Cluster - Supercluster relationships

Supercluster	Cluster	Unit
0002 Affoltern	0002 Affoltern am Albis	0002 Affoltern am Albis
	0005 Hedingen	0005 Hedingen
	0009 Mettmenstetten	0009 Mettmenstetten
0030 Andelfingen	0030 Andelfingen	0030 Andelfingen
0038 Rheinau	0038 Rheinau	0038 Rheinau
0053 Bülach	0051 Bachenbülach	0051 Bachenbülach
	0053 Bülach	0053 Bülach
	0060 Höri	0060 Höri
0055 Eglisau	0055 Eglisau	0055 Eglisau
		0058 Glattfelden
0067 Rafz	0067 Rafz	0067 Rafz
0086 Dielsdorf	0086 Dielsdorf	0086 Dielsdorf
0091 Niederweningen	0091 Niederweningen	0091 Niederweningen
0094 Otelfingen	0094 Otelfingen	0094 Otelfingen
0112 Bubikon	0112 Bubikon	0112 Bubikon
0118 Rüti	0118 Rüti	0118 Rüti
0120 Wald ZH	0120 Wald ZH	0120 Wald ZH
0121 Wetzikon	0111 Bäretswil	0111 Bäretswil
	0117 Hinwil	0117 Hinwil
	0119 Seegräben	0119 Seegräben
	0121 Wetzikon ZH	0121 Wetzikon ZH
0133 Horgen	0133 Horgen	0133 Horgen
	0138 Richterswil	0138 Richterswil
	0142 Wädenswil	0142 Wädenswil
0142 Goldküste	0142 Goldküste	0155 Männedorf
		0156 Meilen
		0158 Stäfa
		0159 Uetikon ZH
	0153 Hombrechtikon-Oetwil	0153 Hombrechtikon
		0157 Oetwil a/S
0151 Erlenbach ZH	0151 Erlenbach ZH	0151 Erlenbach ZH
0176 Lindau	0176 Lindau	0174 Effretikon (Kemptthal)
		0176 Lindau
0177 Pfäffikon	0172 Fehraltorf	0172 Fehraltorf
	0177 Pfäffikon ZH	0177 Pfäffikon ZH
0180 Weisslingen	0180 Weisslingen	0180 Weisslingen
0198 Uster	0198 Uster	0198 Uster
0230 Winterthur	0224 Pfungen	0224 Pfungen
	0227 Seuzach	0227 Seuzach
	0230 Winterthur	0230 Winterthur

Supercluster	Cluster	Unit
0261 Zürich	0062 Glattal	0054 Dietlikon-Brüttisellerkreuz
		0062 Kloten-Lower Glattal
		0069 Wallisellen-Middle Glattal
		0092 Oberglatt
		0097 Rümlang
		0199 Volketswil-Upper Glattal
	0096 Furttal	0083 Buchs ZH
		0084 Dällikon
		0096 Regensdorf-Furttal
	0135 Linke Seeufer	0131 Adliswil
		0135 Kilchberg ZH
		0139 Rüschlikon
		0141 Thalwil
	0154 Küsnacht ZH	0154 Küsnacht ZH
	0160 Zumikon	0160 Zumikon
	0161 Zollikon	0161 Zollikon
	0247 Limmattal	0242 Birmensdorf
		0243 Dietikon-Unterlimmat
		0247 Schlieren-Mittlerlimmat
		4048 Würenlos
	0261 Zürich	0261 Zürich
0306 Lyss-Aarberg	0301 Aarberg	0301 Aarberg
	0306 Lyss	0306 Lyss
0329 Langenthal	0329 Langenthal	0329 Langenthal
	0337 Roggwil	0337 Roggwil
	0342 Thunstetten	0342 Thunstetten
0333 Melchnau	0333 Melchnau	0333 Melchnau
0351 Bern	0351 Bern	0351 Bern
	0355 Wangental	0355 Köniz
		0670 Neuenegg-Flamatt
	0362 Ostring	0356 Muri BE
		0358 Stettlen
		0362 Ittigen-Grauholz
		0363 Ostermundigen
		0544 Moosseedorf-Schönbühl
		0544 Moosseedorf-Schönbühl
	0663 Frauenkappelen	0663 Frauenkappelen
0371 Biel/Bienne	0371 Biel/Bienne	0371 Biel/Bienne
	0733 Zihlkanal	0733 Brügg
		0743 Nidau
0383 Büren a/A	0383 Büren a/A	0383 Büren a/A
0404 Burgdorf	0404 Burgdorf	0404 Burgdorf
	0415 Lyssach-Kirchberg	0412 Kirchberg
		0415 Lyssach
	0418 Oberburg-Hasle	0418 Oberburg-Hasle
0434 Courtelary	0434 Courtelary	0434 Courtelary
0443 St-Imier	0443 St-Imier	0443 St-Imier
	0448 Villeret	0448 Villeret
0444 Sonceboz	0444 Sonceboz	0444 Sonceboz
0446 Tramelan	0446 Tramelan	0446 Tramelan
0496 Ins	0496 Ins	0496 Ins
0498 Müntschemier	0498 Müntschemier	0498 Müntschemier
0552 Utzenstorf	0552 Utzenstorf	0552 Utzenstorf
0561 Adelboden	0561 Adelboden	0561 Adelboden
0563 Frutigen	0563 Frutigen	0563 Frutigen
0565 Kandersteg	0565 Kandersteg	0565 Kandersteg
0573 Brienz	0573 Brienz	0573 Brienz
0576 Grindelwald	0576 Grindelwald	0576 Grindelwald
0581 Interlaken	0581 Interlaken	0581 Interlaken
	0587 Matten	0587 Matten
0584 Lauterbrunnen (Wengen-Mürren)	0584 Lauterbrunnen (Wengen-Mürren)	0584 Lauterbrunnen (Wengen-Mürren)

Supercluster	Cluster	Unit
0603 Biglen	0603 Biglen	0603 Biglen
0612 Konolfingen	0608 Grosshöchstetten	0608 Grosshöchstetten
	0612 Konolfingen	0612 Konolfingen
0616 Münsingen	0616 Münsingen	0616 Münsingen
0619 Oberdiessbach	0619 Oberdiessbach	0619 Oberdiessbach
0667 Laupen	0667 Laupen	0667 Laupen
0668 Mühleberg	0668 Mühleberg	0668 Mühleberg
0682 Bévilard-Malleray	0682 Bévilard-Malleray	0682 Bévilard-Malleray
0690 Court	0690 Court	0690 Court
0700 Moutier	0700 Moutier	0700 Moutier
0703 Reconvilier	0703 Reconvilier	0703 Reconvilier
0713 Tavannes	0713 Tavannes	0713 Tavannes
0723 La Neuveville	0723 La Neuveville	0723 La Neuveville
0749 Studen	0749 Studen	0749 Studen
0751 Täuffelen	0751 Täuffelen	0751 Täuffelen
0768 Spiez	0562 Aeschi	0562 Aeschi
	0768 Spiez	0768 Spiez
	0769 Wimmis	0769 Wimmis
0782 Guttannen	0782 Guttannen	0782 Guttannen
0785 Meiringen-Schattenhalb	0785 Meiringen-Schattenhalb	0785 Meiringen-Schattenhalb
0792 Lenk	0792 Lenk	0792 Lenk
0794 Zweisimmen	0794 Zweisimmen	0794 Zweisimmen
0843 Saanen (Gstaad)	0843 Saanen (Gstaad)	0843 Saanen (Gstaad)
0854 Schwarzenburg	0854 Schwarzenburg	0854 Schwarzenburg
0861 Belp	0861 Belp	0861 Belp
0879 Riggisberg	0879 Riggisberg	0879 Riggisberg
0902 Langnau	0902 Langnau BE	0902 Langnau BE
	0909 Trubschachen	0909 Trubschachen
0938 Sigriswil	0938 Sigriswil	0938 Sigriswil
0942 Thun	0939 Steffisburg	0939 Steffisburg
	0942 Thun	0942 Thun
	0944 Uetendorf	0944 Uetendorf
0954 Huttwil	0954 Huttwil	0954 Huttwil
0955 Lützelflüh	0955 Lützelflüh	0955 Lützelflüh
0957 Sumiswald	0957 Sumiswald	0957 Sumiswald
0979 Herzogenbuchsee	0979 Herzogenbuchsee	0979 Herzogenbuchsee
	0982 Oenz	0982 Oenz
0992 Wangen a/A	0992 Wangen a/A	0992 Wangen a/A
1002 Entlebuch	1002 Entlebuch	1002 Entlebuch
1008 Schüpfheim	1008 Schüpfheim	1008 Schüpfheim
1030 Hitzkirch	1030 Hitzkirch	1030 Hitzkirch
1031 Hochdorf	1031 Hochdorf	1031 Hochdorf
1061 Luzern	1024 Reusstal	1024 Emmen-Emmenbrücke
		1040 Rothenburg
	1054 Rotsee	1051 Adligenswil
		1054 Ebikon-Rontal
		1065 Root-Gisikon
	1059 Kriens	1059 Kriens
	1061 Luzern	1061 Luzern
	1062 Malters	1062 Malters
1069 Weggis	1069 Weggis	1069 Weggis
1083 Buttisholz	1083 Buttisholz	1083 Buttisholz
1093 Neuenkirch (Sempach-Station)	1093 Neuenkirch (Sempach-Station)	1093 Neuenkirch (Sempach-Station)
1094 Nottwil	1094 Nottwil	1094 Nottwil
1103 Sursee	1095 Oberkirch	1095 Oberkirch
	1103 Sursee	1103 Sursee
1104 Triengen	1082 Büron	1082 Büron
	1104 Triengen	1104 Triengen
1107 Wolhusen	1009 Werthenstein	1009 Werthenstein
	1107 Wolhusen	1107 Wolhusen
1136 Menznau	1136 Menznau	1136 Menznau
1139 Pfaffnau	1139 Pfaffnau	1139 Pfaffnau

Supercluster	**Cluster**	**Unit**
1146 Wauwil	1146 Wauwil	1146 Wauwil
1149 Willisau	1149 Willisau	1149 Willisau
1150 Zell LU	1150 Zell LU	1150 Zell LU
1201 Altdorf	1201 Altdorf	1201 Altdorf
	1205 Bürglen UR	1205 Bürglen UR
	1213 Schattdorf	1213 Schattdorf
1202 Andermatt	1202 Andermatt	1202 Andermatt
1206 Erstfeld	1206 Erstfeld	1206 Erstfeld
1301 Einsiedeln	1301 Einsiedeln	1301 Einsiedeln
1322 Pfäffikon SZ	1322 Freienbach (Pfäffikon SZ)	1322 Freienbach (Pfäffikon SZ)
	1323 Wollerau	1323 Wollerau
1331 Küssnacht	1331 Küssnacht	1331 Küssnacht
1344 Lachen	1341 Altendorf	1341 Altendorf
	1342 Galgenen	1342 Galgenen
	1344 Lachen	1344 Lachen
1346 Schübelbach	1346 Schübelbach	1346 Schübelbach
1347 Tuggen	1347 Tuggen	1347 Tuggen
1362 Arth (Goldau)	1362 Arth (Goldau)	1362 Arth (Goldau)
1364 Ingenbohl (Brunnen)	1364 Ingenbohl (Brunnen)	1364 Ingenbohl (Brunnen)
1372 Schwyz	1372 Schwyz	1372 Schwyz
1401 Alpnach	1401 Alpnach	1401 Alpnach
1402 Engelberg	1402 Engelberg	1402 Engelberg
1407 Sarnen	1404 Kerns	1404 Kerns
	1406 Sachseln	1406 Sachseln
	1407 Sarnen	1407 Sarnen
1501 Beckenried	1501 Beckenried	1501 Beckenried
1507 Hergiswil	1507 Hergiswil	1507 Hergiswil
1509 Stans	1505 Ennetbürgen	1505 Ennetbürgen
	1509 Stans	1509 Stans
	1510 Stansstad	1510 Stansstad
1602 Bilten	1602 Bilten	1602 Bilten
1609 Glarus	1607 Ennenda	1607 Ennenda
	1609 Glarus	1609 Glarus
	1620 Netstal	1620 Netstal
1611 Hätzingen	1611 Hätzingen	1611 Hätzingen
1619 Näfels	1619 Näfels	1619 Näfels
1622 Niederurnen	1622 Niederurnen	1622 Niederurnen
1627 Schwanden GL	1627 Schwanden GL	1627 Schwanden GL
1704 Menzingen	1704 Menzingen	1704 Menzingen
1709 Unterägeri	1709 Unterägeri	1709 Unterägeri
1711 Zug	1702 Zugersee	1701 Baar-Sihlbrugg
		1702 Cham-Blegi
		1707 Risch-Rotkreuz
	1711 Zug	1711 Zug
2013 Domdidier	2013 Domdidier	2013 Domdidier
2015 Estavayer	2015 Estavayer	2015 Estavayer
2096 Romont	2096 Romont	2096 Romont
2124 Broc	2124 Broc	2124 Broc
2125 Bulle	2125 Bulle	2125 Bulle
	2148 Riaz-Marsens	2148 Riaz-Marsens
2196 Fribourg	2196 Fribourg	2196 Fribourg
	2197 Fribourg-Nord	2174 Avry-Matran
		2197 Givisiez-Fribourg Nord
		2228 Villars FR
	2206 Marly	2206 Marly
2254 Courtepin	2254 Courtepin	2254 Courtepin
2275 Murten	2275 Murten	2275 Murten
2280 Bas-Vully	2280 Bas-Vully	2280 Bas-Vully
2293 Düdingen	2293 Düdingen	2293 Düdingen
2305 Schmitten FR	2305 Schmitten FR	2305 Schmitten FR
2306 Tafers	2306 Tafers	2306 Tafers
2325 Châtel	2325 Châtel	2325 Châtel

Supercluster	Cluster	Unit
2422 Balsthal	2422 Balsthal	2422 Balsthal
2428 Mümliswil-Ramiswil	2428 Mümliswil-Ramiswil	2428 Mümliswil-Ramiswil
2429 Welschenrohr	2429 Welschenrohr	2429 Welschenrohr
2476 Bättwil-Flüh	2476 Bättwil-Flüh	2476 Bättwil-Flüh
2516 Deitingen	2516 Deitingen	2516 Deitingen
2533 Subingen	2533 Subingen	2532 Subingen
2546 Grenchen	0387 Lengnau-Pieterlen	0387 Lengnau
		0392 Pieterlen
	2543 Bettlach	2543 Bettlach
	2546 Grenchen	2546 Grenchen
2554 Riedholz	2554 Riedholz	2554 Riedholz
2556 Selzach	2556 Selzach	2556 Selzach
2572 Gösgen	2572 Gösgen	2572 Däniken
		2573 Dulliken
2581 Olten	2407 Gäu	0995 Wiedlisbach
		2401 Egerkingen-Gäu
		2407 Oensingen-Gäu
		2586 Wangen-Untergäu
	2581 Olten	2581 Olten
2583 Schönenwerd	2583 Schönenwerd	2583 Schönenwerd
2601 Solothurn	2534 Unteremmental	2513 Biberist
		2517 Derendingen
		2519 Gerlafingen
		2527 Luterbach
		2534 Zuchwil
	2550 Weissenstein	2542 Bellach
		2550 Langendorf
	2601 Solothurn	2601 Solothurn
2613 Breitenbach	2613 Breitenbach	2613 Breitenbach
2621 Nunningen	2621 Nunningen	2621 Nunningen
2701 Basel	2701 Basel	2701 Basel
	2762 Allschwil	2762 Allschwil
	2765 Binningen	2765 Binningen
	2766 Birsfelden	2766 Birsfelden
	2769 Birstal	2473 Dornach
		2769 Münchenstein-Unterbirstal
		2773 Reinach-Oberbirstal
	2770 Schweizerhalle	2770 Muttenz-Schweizerhalle
		4252 Kaiseraugst-Augusta
2775 Therwil	2775 Therwil	2775 Therwil
2786 Grellingen	2786 Grellingen	2786 Grellingen
2787 Laufen	2787 Laufen	2787 Laufen
	2793 Zwingen	2793 Zwingen
2788 Liesberg	2788 Liesberg	2788 Liesberg
2823 Bubendorf	2823 Bubendorf	2823 Bubendorf
2829 Liestal	2828 Lausen	2828 Lausen
	2829 Liestal	2829 Liestal
2846 Gelterkinden	2846 Gelterkinden	2846 Gelterkinden
2861 Sissach	2849 Itingen	2849 Itingen
	2861 Sissach	2861 Sissach
2886 Hölstein	2886 Hölstein	2886 Hölstein
2892 Oberdorf BL	2892 Oberdorf BL	2892 Oberdorf BL
2895 Waldenburg	2895 Waldenburg	2895 Waldenburg
2920 Thayngen	2920 Thayngen	2920 Thayngen
2939 Schaffhausen	2932 Beringen	2932 Beringen
	2937 Neuhausen	2937 Neuhausen
	2939 Schaffhausen	2939 Schaffhausen
2963 Ramsen	2963 Ramsen	2963 Ramsen
2964 Stein a/R	2964 Stein a/R	2964 Stein a/R
3006 Urnäsch	3006 Urnäsch	3006 Urnäsch
3021 Bühler	3021 Bühler	3021 Bühler
3024 Teufen AR	3024 Teufen AR	3024 Teufen AR

Supercluster	**Cluster**	**Unit**
3025 Trogen	3025 Trogen	3025 Trogen
3032 Heiden	3032 Heiden	3032 Heiden
3037 Walzenhausen	3037 Walzenhausen	3037 Walzenhausen
3101 Appenzell	3101 Appenzell	3101 Appenzell
3203 St.Gallen	3001 Herisau	3001 Herisau
	3203 St.Gallen	3203 St.Gallen
	3204 Wittenbach	3204 Wittenbach
	3443 Gossau	3443 Gossau
3215 Rorschach	3213 Goldach-Tübach	3213 Goldach-Tübach
	3215 Rorschach	3215 Rorschach
	3216 Rorschacherberg	3216 Rorschacherberg
	4421 Horn	4421 Horn
3232 Heerbrugg	3231 Au-Unterheerbrugg	3231 Au-Unterheerbrugg
	3232 Balgach-Oberheerbrugg	3232 Balgach-Oberheerbrugg
	3238 Widnau	3238 Widnau
3234 Diepoldsau	3234 Diepoldsau	3234 Diepoldsau
3236 St.Margrethen	3236 St.Margrethen	3236 St.Margrethen
3237 Thal-Rheineck	3237 Thal-Rheineck	3237 Thal-Rheineck
3251 Altstätten	3251 Altstätten	3251 Altstätten
3254 Oberriet	3254 Oberriet	3254 Oberriet
3256 Rüthi SG	3256 Rüthi SG	3256 Rüthi SG
3271 Buchs	3271 Buchs	3271 Buchs
	3273 Grabs	3273 Grabs
	3275 Sevelen	3275 Sevelen
3274 Sennwald	3274 Sennwald	3274 Sennwald
3276 Wartau	3276 Wartau	3276 Wartau
3291 Bad Ragaz	3291 Bad Ragaz	3291 Bad Ragaz
	3294 Pfäfers	3294 Pfäfers
3292 Flums	3292 Flums	3292 Flums
3295 Quarten	3295 Quarten	3295 Quarten
3296 Sargans	3293 Mels	3293 Mels
	3296 Sargans	3296 Sargans
	3297 Vilters	3297 Vilters
3298 Walenstadt	3298 Walenstadt	3298 Walenstadt
3332 Eschenbach	3332 Eschenbach	3332 Eschenbach
3336 Rapperswil	3335 Jona	3335 Jona
	3336 Rapperswil	3336 Rapperswil
3339 Uznach	3338 Schmerikon	3338 Schmerikon
	3339 Uznach	3339 Uznach
3352 Ebnat-Kappel	3352 Ebnat-Kappel	3352 Ebnat-Kappel
3355 Nesslau-Krummenau	3355 Nesslau-Krummenau	3355 Nesslau-Krummenau
3374 Lichtensteig	3374 Lichtensteig	3374 Lichtensteig
3377 Wattwil	3377 Wattwil	3377 Wattwil
3391 Bütschwil	3391 Bütschwil	3391 Bütschwil
3392 Kirchberg (Bazenheid)	3392 Kirchberg (Bazenheid)	3392 Kirchberg (Bazenheid)
3401 Degersheim	3401 Degersheim	3401 Degersheim
3402 Flawil	3402 Flawil	3402 Flawil
3405 Jonschwil	3405 Jonschwil	3405 Jonschwil
3408 Uzwil	3408 Uzwil	3407 Oberuzwil
		3408 Uzwil
		3424 Büren-Thurau
3425 Wil	3421 Bronschhofen	3421 Bronschhofen
	3425 Wil SG	3425 Wil SG
	3426 Zuzwil	3426 Zuzwil
	4746 Murgtal	4591 Matzingen
		4746 Münchwilen TG
		4761 Sirnach
		4781 Wängi TG
3506 Vaz/Obervaz (Lenzerheide)	3506 Vaz/Obervaz (Lenzerheide)	3506 Vaz/Obervaz (Lenzerheide)
3561 Poschiavo	3561 Poschiavo	3561 Poschiavo
3574 Ilanz	3574 Ilanz	3574 Ilanz
3575 Laax	3575 Laax	3575 Laax

Supercluster	**Cluster**	**Unit**
3603 Vals	3603 Vals	3603 Vals
3651 Safien	3651 Safien	3651 Safien
3668 Thusis-Cazis	3668 Thusis-Cazis	3668 Thusis-Cazis
3721 Bonaduz	3721 Bonaduz	3721 Bonaduz
3732 Flims (Waldhaus)	3732 Flims (Waldhaus)	3732 Flims (Waldhaus)
3752 Samnaun	3752 Samnaun	3752 Samnaun
3762 Scuol	3762 Scuol	3762 Scuol
3784 Pontresina	3784 Pontresina	3784 Pontresina
3787 St.Moritz	3786 Samedan	3782 Celerina
		3786 Samedan
	3787 St.Moritz	3787 St.Moritz
	3789 Lejs	3789 Sils
		3790 Silvaplana
3822 Mesocco	3822 Mesocco	3822 Mesocco
3851 Davos	3851 Davos	3851 Davos
3871 Klosters	3871 Klosters	3871 Klosters
3901 Chur	3722 Domat/Ems	3722 Domat/Ems
	3901 Chur	3901 Chur
	3945 Trimmis-Untervaz	3945 Trimmis-Untervaz
3921 Arosa	3921 Arosa	3921 Arosa
3942 Igis (Landquart)	3942 Igis (Landquart)	3942 Igis (Landquart)
3961 Grüsch-Seewis	3961 Grüsch-Seewis	3961 Grüsch-Seewis
3962 Schiers	3962 Schiers	3962 Schiers
3982 Disentis	3982 Disentis	3982 Disentis
3986 Tujetsch	3986 Tujetsch	3986 Tujetsch
3987 Trun	3987 Trun	3987 Trun
4001 Aarau	4001 Aarau	4001 Aarau
	4003 Wynental	4003 Buchs-Suhr
		4006 Gränichen
	4010 Entfelden	4010 Entfelden
4021 Baden	4021 Baden	4021 Baden
	4038 Obersiggenthal-Ennetbaden	4038 Obersiggenthal-Ennetbaden
	4042 Aare-Reuss-Limmatt	4042 Turgi
		4044 Untersiggenthal
	4045 Wettingen	4045 Wettingen
4033 Mellingen	4033 Mellingen	4033 Mellingen
4035 Niederrohrdorf	4035 Niederrohrdorf	4035 Niederrohrdorf
4047 Würenlingen-Beznau	4047 Würenlingen-Beznau	4047 Würenlingen-Beznau
4063 Bremgarten	4063 Bremgarten	4063 Bremgarten
4082 Wohlen	4080 Bünztal	4065 Dottikon
		4194 Dintikon
	4080 Villmergen	4080 Villmergen
	4082 Wohlen	4082 Wohlen
4092 Birrfeld	4092 Birrfeld	4032 Mägenwil-Brunegg
		4092 Birr-Birrfeld
4095 Brugg	4095 Brugg	4095 Brugg
	4123 Windisch	4123 Windisch
4114 Schinznach Bad	4114 Schinznach Bad	4114 Schinznach Bad
4131 Beinwil am See	4131 Beinwil am See	4131 Beinwil am See
4141 Reinach	4135 Gontenschwil	4135 Gontenschwil
	4139 Menziken-Reinach Süd	4139 Menziken-Reinach Süd
	4141 Reinach	4141 Reinach
4144 Schöftland	4144 Schöftland	4144 Schöftland
4145 Teufenthal	4145 Teufenthal	4145 Teufenthal
4146 Kulm	4146 Kulm	4146 Kulm
4163 Frick	4163 Frick	4163 Frick
4170 Laufenburg	4169 Kaisten	4169 Kaisten
	4170 Laufenburg	4170 Laufenburg

Supercluster	Cluster	Unit
4201 Lenzburg	4201 Lenzburg	4201 Lenzburg
	4203 Holderbank-Wildegg	4203 Holderbank-Wildegg
	4204 Niederlenz	4204 Niederlenz
	4207 Lenzburg-West	4206 Rupperswil-Wildegg
		4207 Schafisheim-Hunzenschwil
4209 Seon	4209 Seon	4209 Seon
4234 Merenschwand	4234 Merenschwand	4234 Merenschwand
4236 Muri AG	4236 Muri AG	4236 Muri AG
4239 Sins	4239 Sins	4239 Sins
4258 Rheinfelden	4254 Möhlin	4254 Möhlin
	4258 Rheinfelden	4258 Rheinfelden
4260 Stein-Sisslerfeld	4260 Stein-Sisslerfeld	4260 Stein-Sisslerfeld
4271 Aarburg-Wigger	4271 Aarburg-Wigger	4271 Aarburg
		4280 Oftringen
		4282 Rothrist
4279 Murgenthal	4279 Murgenthal	4279 Murgenthal
4283 Safenwil	4283 Safenwil	4283 Safenwil
4289 Zofingen	1125 Wiggertal	1125 Dagmersellen-Oberwiggertal
		1140 Reiden-Unterwiggertal
	4285 Strengelbach	4285 Strengelbach
	4289 Zofingen	4289 Zofingen
4304 Döttingen-Klingnau	4304 Döttingen-Klingnau	4304 Döttingen-Klingnau
4311 Leibstadt	4311 Leibstadt	4311 Leibstadt
4323 Bad Zurzach	4323 Bad Zurzach	4323 Bad Zurzach
4401 Arbon	3217 Steinach	3217 Steinach
	4401 Arbon	4401 Arbon
	4431 Roggwil TG	4431 Roggwil TG
4411 Egnach	4411 Egnach	4411 Egnach
4436 Romanshorn	4436 Romanshorn	4436 Romanshorn
4461 Amriswil	4416 Hefenhofen	4416 Hefenhofen
	4461 Amriswil	4461 Amriswil
4471 Bischofszell-Sittertal	4471 Bischofszell-Sittertal	4471 Bischofszell-Sittertal
4476 Erlen	4476 Erlen	4476 Erlen
4506 Sulgen-Thurtal	4506 Sulgen-Thurtal	4501 Kradolf
		4506 Sulgen
4545 Diessenhofen	4545 Diessenhofen	4545 Diessenhofen
4546 Schlatt TG	4546 Schlatt TG	4546 Schlatt TG
4551 Aadorf	0217 Elgg	0217 Elgg
	4551 Aadorf	4551 Aadorf
4566 Frauenfeld	4561 Felben	4561 Felben
	4566 Frauenfeld	4566 Frauenfeld
4646 Ermatingen	4646 Ermatingen	4646 Ermatingen
4671 Kreuzlingen	4671 Kreuzlingen	4671 Kreuzlingen
	4696 Tägerwilen	4696 Tägerwilen
4691 Münsterlingen	4691 Münsterlingen	4691 Münsterlingen
4711 Affeltrangen-Tobel	4711 Affeltrangen-Tobel	4711 Affeltrangen-Tobel
4724 Eschlikon	4724 Eschlikon	4724 Eschlikon
4864 Steckborn	4864 Steckborn	4864 Steckborn
4946 Weinfelden	4891 Berg TG	4891 Berg TG
	4911 Bürglen TG	4911 Bürglen TG
	4921 Bussnang	4921 Bussnang
	4946 Weinfelden	4946 Weinfelden
4951 Wigoltingen	4951 Wigoltingen	4951 Wigoltingen
5002 Bellinzona	5001 Arbedo-Castione	5001 Arbedo-Castione
	5002 Bellinzona	5002 Bellinzona
	5017 Magadino Sud	5005 Giubiasco-Camorino
		5017 Sant'Antonino-Magadino Sud
5061 Airolo	5061 Airolo	5061 Airolo
5064 Bodio	5064 Bodio	5064 Bodio
5072 Faido	5072 Faido	5072 Faido
5073 Giornico	5073 Giornico	5073 Giornico
5097 Brissago	5097 Brissago	5097 Brissago

Supercluster	**Cluster**	**Unit**
5112 Gerra-Magadino Nord	5112 Gerra-Magadino Nord	5112 Gerra-Magadino Nord
5113 Locarno	5091 Ascona	5091 Ascona
	5113 Locarno	5113 Locarno
	5115 Losone	5115 Losone
	5120 Locarno Est	5118 Minusio
		5120 Muralto-Orselina
5171 Caslano-Tresa	5171 Caslano-Tresa	5171 Caslano-Tresa
5192 Lugano	5167 Canobbio-Comano	5167 Canobbio-Comano
	5192 Lugano	5192 Lugano
	5194 Vedeggio	5141 Agno-Val d'Agno Inf.
		5194 Manno-Val d'Agno Med.
	5196 Massagno-Savosa	5196 Massagno-Savosa
	5201 Collina-Scairolo	5147 Barbengo-Scairolo
		5201 Montagnola
		5210 Paradiso-Pazzallo
		5221 Sorengo
	5215 Pregassona-Viganello	5215 Pregassona-Viganello
5195 Maroggia-Melano	5195 Maroggia-Melano	5195 Maroggia-Melano
5198 Melide	5198 Melide	5198 Melide
5199 Mezzovico Vira	5199 Mezzovico Vira	5199 Mezzovico Vira
5217 Rivera-Bironico	5217 Rivera-Bironico	5217 Rivera-Bironico
5241 Arzo	5241 Arzo	5241 Arzo
5250 Chiasso	5242 Chiasso-Ovest	5242 Balerna
		5257 Morbio Inf.
		5260 Novazzano
	5250 Chiasso	5250 Chiasso
5254 Mendrisio	5249 Castel	5249 Castel
	5251 Coldrerio	5251 Coldrerio
	5254 Mendrisio	5254 Mendrisio
	5262 Laveggio	5262 Rancate
		5263 Riva-Capolago
	5268 Stabio-Laveggio	5268 Stabio-Laveggio
5281 Biasca	5281 Biasca	5281 Biasca
5401 Aigle	5401 Aigle	5401 Aigle
5402 Bex	5402 Bex	5402 Bex
5407 Leysin	5407 Leysin	5407 Leysin
5409 Ollon-Villars	5409 Ollon-Villars	5409 Ollon-Villars
5414 Villeneuve-Grangettes	5414 Villeneuve-Grangettes	5414 Villeneuve-Grangettes
5422 Littoral	5422 Littoral	5422 Aubonne-Littoral Parc
		5622 St-Prex
5451 Avenches	5451 Avenches	5451 Avenches
5482 Eclépens-Daillens	5482 Eclépens-Daillens	5482 Eclépens-Daillens
5495 Penthalaz	5495 Penthalaz	5495 Penthalaz
5497 Pompaples-Milieu du Monde	5497 Pompaples-Milieu du Monde	5497 Pompaples-Milieu du Monde
5518 Echallens	5518 Echallens	5518 Echallens
5568 Ste-Croix	5568 Ste-Croix	5568 Ste-Croix
5586 Lausanne	5586 Lausanne	5586 Lausanne
	5587 Nord Lausannois	5587 Le Mont
		5592 Romanel s/L
	5590 Pully-Est Lausannois	5590 Pully-Est Lausannois
	5591 Ouest Lausannois	5489 Mex
		5582 Cheseaux-Etagnières
		5583 Crissier-Westside
		5591 Renens-Malley
		5635 Ecublens-Hautes Ecoles
		5638 Lonay-Venoge
	5642 Morges*	5642 Morges*
	5649 Morges-Ouest*	5649 Tolochenaz*
5602 Cully	5602 Cully	5602 Cully
5607 Puidoux	5607 Puidoux	5607 Puidoux
5621 Aclens-Moulin du Choc	5621 Aclens-Moulin du Choc	5621 Aclens-Moulin du Choc
5675 Lucens	5675 Lucens	5675 Lucens

Supercluster	Cluster	Unit
5678 Moudon	5678 Moudon	5678 Moudon
5707 Chavannes de Bogis	5707 Chavannes de Bogis	5707 Chavannes de Bogis
5724 Nyon	5721 Nyon-Est	5721 Gland-Vich
		5725 Prangins
	5724 Nyon	5724 Nyon
5744 Ballaigues	5744 Ballaigues	5744 Ballaigues
5757 Orbe	5757 Orbe	5757 Orbe
5764 Vallorbe	5764 Vallorbe	5764 Vallorbe
5822 Payerne	5822 Payerne	5822 Payerne
5841 Château d'Oex	5841 Château d'Oex	5841 Château d'Oex
5861 Rolle	5861 Rolle	5861 Rolle
5872 Vallée de Joux	5872 Vallée de Joux	5871 L'Abbaye-Le Pont
		5872 Le Chenit
5886 Montreux	5886 Montreux	5886 Montreux
5890 Vevey	5884 Corsier	5884 Corsier
	5889 La Tour	5889 La Tour
	5890 Vevey	5890 Vevey
5938 Yverdon	5922 Montagny	5922 Montagny
	5938 Yverdon	5938 Yverdon
6002 Brig	6002 Brig	6002 Brig
	6007 Naters	6007 Naters
6031 Bagnes (Verbier)	6031 Bagnes (Verbier)	6031 Bagnes (Verbier)
6034 Orsières	6034 Orsières	6034 Orsières
6082 Ayent	6082 Ayent	6082 Ayent
6111 Leukerbad	6111 Leukerbad	6111 Leukerbad
6135 Leytron	6135 Leytron	6135 Leytron
6136 Martigny	6136 Martigny	6136 Martigny
6139 Riddes	6139 Riddes	6139 Riddes
6141 Saxon	6141 Saxon	6141 Saxon
6153 Monthey	6152 Collombey-Muraz	6152 Collombey-Muraz
	6153 Monthey	6153 Monthey
6158 Vionnaz	6158 Vionnaz	6158 Vionnaz
6159 Vouvry	6159 Vouvry	6159 Vouvry
6200 Steg-Gampel	6200 Steg-Gampel	6200 Steg-Gampel
6217 St-Maurice	6217 St-Maurice	6217 St-Maurice
6237 Grimentz	6237 Grimentz	6237 Grimentz
6243 Montana	6243 Montana	6243 Montana
6248 Sierre	6235 Chippis	6235 Chippis
	6248 Sierre	6248 Sierre
6266 Sion	6023 Conthey	6023 Conthey
	6266 Sion	6266 Sion
6290 Saas Fee	6290 Saas Fee	6290 Saas Fee
6292 St.Niklaus	6292 St.Niklaus	6292 St.Niklaus
6297 Visp	6297 Visp	6297 Visp
6298 Visperterminen	6298 Visperterminen	6298 Visperterminen
6300 Zermatt	6300 Zermatt	6300 Zermatt
6404 Areuse	6404 Areuse	6402 Bevaix
		6404 Boudry-Cortaillod
		6406 Colombier
6414 St-Aubin	6414 St-Aubin	6414 St-Aubin
6421 La Chaux-Le Locle	6421 La Chaux-de-Fonds	6421 La Chaux-de-Fonds
	6436 Le Locle-Les Brenets	6431 Les Brenets
		6436 Le Locle
6452 Cressier NE	6452 Cressier NE	6452 Cressier NE
6457 Marin-Tène	6457 Marin-Tène	6457 Marin-Tène
6458 Neuchâtel	6407 Corcelles	6407 Corcelles
	6412 Peseux	6412 Peseux
	6458 Neuchâtel	6458 Neuchâtel
6478 Fontainemelon-Vue des Alpes	6478 Fontainemelon-Vue des Alpes	6478 Fontainemelon-Vue des Alpes
6480 Les Geneveys	6480 Les Geneveys	6480 Les Geneveys
6505 Couvet	6505 Couvet	6505 Couvet
6506 Fleurier	6506 Fleurier	6506 Fleurier

Supercluster	Cluster	Unit
6621 Genève	6608 Praille	6608 Carouge-Praille
		6633 Plan-ZIPLO
	6613 Chênes	6613 Chênes
	6616 Collonges-Bellerive	6616 Collonges-Bellerive
	6621 Genève	6621 Genève
	6630 Cointrin	6606 Bellevue
		6630 Meyrin-Cointrin
6644 Versoix	6644 Versoix	6644 Versoix
6701 Haute-Sorne	6701 Haute-Sorne	6701 Bassecourt
		6714 Glovelier-Boécourt
6708 Delémont	6708 Courrendlin	6708 Courrendlin
	6711 Delémont	6711 Delémont
6743 Les Breuleux	6743 Les Breuleux	6743 Les Breuleux
6754 Le Noirmont	6754 Le Noirmont	6754 Le Noirmont
6757 Saignelégier	6757 Saignelégier	6757 Saignelégier
6771 Alle	6771 Alle	6771 Alle
6774 Boncourt	6774 Boncourt	6774 Boncourt
6784 Courgenay	6784 Courgenay	6784 Courgenay
6800 Porrentruy	6800 Porrentruy	6800 Porrentruy
6804 St-Ursanne	6804 St-Ursanne	6804 St-Ursanne

Before 1995, 5642 Morges formed an independent supercluster. It was then incorporated into the Lausanne supercluster. The situation reflected in the table is the current, 2008 situation.

Annex 3: Unit location

Unit	Loc. 1939	Loc. 1955	Loc. 1965	Loc. 1975	Loc. 1985	Loc. 1991	Loc. 1995	Loc. 1998	Loc. 2001	Loc. 2005	Loc. 2008
0002 Affoltern am Albis			Urb.	Urb.	Urb.	Urb.					Mix.
0005 Hedingen					Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0009 Mettmenstetten											Sub.
0030 Andelfingen											Urb.
0038 Rheinau		Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
0051 Bachenbülach							Sub.	Sub.	Sub.	Sub.	Sub.
0053 Bülach	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Mix.	Mix.	Mix.	Mix.	Mix.
0054 Dietlikon-Brüttisellerkreuz	Ex.	Ex.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0055 Eglisau		Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.			
0058 Glattfelden	Ex.	Ex.									
0060 Höri						Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0062 Kloten-Lower Glattal	Ex.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0067 Rafz			Ex.	Ex.							
0069 Wallisellen-Middle Glattal	Ex.	Ex.	Ex.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0083 Buchs ZH				Sub.							
0084 Dällikon						Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0086 Dielsdorf			Urb.	Mix.	Mix.	Mix.	Mix.	Mix.	Mix.	Mix.	Mix.
0091 Niederweningen		Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Sub.			
0092 Oberglatt						Sub.					Sub.
0094 Otelfingen				Ex.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0096 Regensdorf-Furttal			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0097 Rümlang			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0111 Bäretswil	Ex.										
0112 Bubikon	Ex.	Ex.	Ex.	Ex.			Sub.	Sub.	Sub.	Sub.	Sub.
0117 Hinwil				Urb.	Urb.	Urb.	Mix.	Mix.	Mix.	Mix.	Mix.
0118 Rüti	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.				
0119 Seegräben			Ex.								
0120 Wald ZH	Ex.	Ex.	Ex.								
0121 Wetzikon ZH	Urb.			Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0131 Adliswil						Sub.					Sub.
0133 Horgen	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Mix.	Mix.
0135 Kilchberg ZH	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0138 Richterswil	Ex.	Ex.	Ex.			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0139 Rüschlikon			Sub.		Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0141 Thalwil	Ex.	Ex.	Ex.			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0142 Wädenswil	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.				
0151 Erlenbach ZH	Ex.	Ex.	Ex.	Ex.	Ex.						
0153 Hombrechtikon			Ex.		Ex.	Ex.	Ex.	Ex.			
0154 Küsnacht ZH										Sub.	Sub.
0155 Männedorf	Ex.		Ex.	Ex.	Ex.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0156 Meilen	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0157 Oetwil a/S						Ex.	Ex.			Sub.	Sub.
0158 Stäfa	Ex.		Ex.		Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0159 Uetikon ZH		Ex.	Ex.			Sub.					
0160 Zumikon						Sub.					
0161 Zollikon							Sub.		Sub.	Sub.	Sub.
0172 Fehraltorf			Ex.			Sub.	Sub.		Sub.	Sub.	Sub.
0174 Effretikon (Kemptthal)									Sub.		
0176 Lindau	Ex.	Ex.	Ex.		Ex.	Ex.	Ex.	Sub.	Sub.	Sub.	Sub.
0177 Pfäffikon ZH	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.		Urb.
0180 Weisslingen		Ex.									
0198 Uster	Urb.	Urb.	Urb.								
0199 Volketswil-Upper Glattal			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0217 Elgg					Ex.				Ex.		
0224 Pfungen	Ex.	Ex.	Ex.								
0227 Seuzach									Sub.	Sub.	Sub.
0230 Winterthur	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0242 Birmensdorf							Sub.				
0243 Dietikon-Unterlimmat			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.

Unit	Loc. 1939	Loc. 1955	Loc. 1965	Loc. 1975	Loc. 1985	Loc. 1991	Loc. 1995	Loc. 1998	Loc. 2001	Loc. 2005	Loc. 2008
0247 Schlieren-Mittlerlimmat	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0261 Zürich	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0301 Aarberg	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0306 Lyss	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0329 Langenthal	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0333 Melchnau			Ex.								
0337 Roggwil	Ex.	Ex.	Ex.	Ex.	Ex.				Ex.	Ex.	Ex.
0342 Thunstetten				Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
0351 Bern	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0355 Köniz					Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0356 Muri BE		Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0358 Stettlen		Sub.	Sub.	Sub.	Sub.						
0362 Ittigen-Grauholz						Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0363 Ostermundigen						Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0371 Biel/Bienne	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0383 Büren a/A	Urb.	Urb.				Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0387 Lengnau		Ex.	Ex.	Ex.							
0392 Pieterlen		Ex.	Ex.								
0404 Burgdorf	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0412 Kirchberg	Ex.	Ex.	Ex.			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0415 Lyssach								Sub.	Sub.	Sub.	Sub.
0418 Oberburg-Hasle	Sub.	Sub.	Sub.								
0434 Courtelary			Urb.								
0443 St-Imier	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0444 Sonceboz			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
0446 Tramelan	Ex.	Ex.	Ex.							Ex.	Ex.
0448 Villeret											Ex.
0496 Ins								Ex.			
0498 Müntschemier											Ex.
0544 Moosseedorf-Schönbühl		Sub.									
0544 Moosseedorf-Schönbühl			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0552 Utzenstorf				Ex.		Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
0561 Adelboden			Tour.	Tour.	Tour.	Tour.	Tour.		Tour.	Tour.	Tour.
0562 Aeschi							Tour.				
0563 Frutigen		Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0565 Kandersteg			Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.		
0573 Brienz		Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0576 Grindelwald	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
0581 Interlaken	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0584 Lauterbrunnen (Wengen-Mürren)	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
0587 Matten				Ex.							
0603 Biglen		Ex.	Ex.								
0608 Grosshöchstetten			Ex.	Ex.	Ex.	Ex.	Sub.				
0612 Konolfingen	Urb.	Urb.	Urb.			Urb.	Urb.	Mix.	Mix.	Mix.	Mix.
0616 Münsingen	Ex.	Ex.	Ex.			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0619 Oberdiessbach			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
0663 Frauenkappelen							Sub.				
0667 Laupen	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.					
0668 Mühleberg						Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
0670 Neuenegg-Flamatt	Ex.	Ex.					Sub.			Sub.	Sub.
0682 Bévilard-Malleray	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
0690 Court			Ex.			Ex.	Ex.				
0700 Moutier	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0703 Reconvilier	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.		
0713 Tavannes	Ex.	Ex.	Ex.	Ex.							
0723 La Neuveville		Urb.	Urb.						Urb.	Urb.	Urb.
0733 Brügg			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0743 Nidau	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0749 Studen					Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0751 Täuffelen			Ex.	Ex.	Ex.	Ex.		Ex.	Ex.		Ex.

Unit	Loc. 1939	Loc. 1955	Loc. 1965	Loc. 1975	Loc. 1985	Loc. 1991	Loc. 1995	Loc. 1998	Loc. 2001	Loc. 2005	Loc. 2008
0768 Spiez	Urb.	Urb.	Urb.				Mix.				
0769 Wimmis		Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
0782 Guttannen				Tour.							
0785 Meiringen-Schattenhalb	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0792 Lenk				Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
0794 Zweisimmen				Ex.	Ex.	Ex.	Ex.				
0843 Saanen (Gstaad)	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0854 Schwarzenburg				Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	
0861 Belp							Sub.			Sub.	Sub.
0879 Riggisberg			Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
0902 Langnau BE	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0909 Trubschachen						Ex.		Ex.	Ex.		
0938 Sigriswil		Tour.	Tour.	Tour.							
0939 Steffisburg						Sub.					
0942 Thun	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0944 Uetendorf						Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
0954 Huttwil	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0955 Lützelflüh					Ex.	Ex.	Ex.				
0957 Sumiswald	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
0979 Herzogenbuchsee	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
0982 Oenz								Ex.	Ex.	Ex.	Ex.
0992 Wangen a/A	Urb.	Urb.	Urb.	Urb.					Urb.	Urb.	Urb.
0995 Wiedlisbach						Tour.	Tour.	Tour.	Tour.		Tour.
1002 Entlebuch		Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	
1008 Schüpfheim							Ex.				
1009 Werthenstein						Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
1024 Emmen-Emmenbrücke		Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
1030 Hitzkirch						Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
1031 Hochdorf	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
1040 Rothenburg					Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
1051 Adligenswil					Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	
1054 Ebikon-Rontal			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
1059 Kriens					Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
1061 Luzern	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
1062 Malters					Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
1065 Root-Gisikon	Ex.	Ex.	Ex.	Ex.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
1069 Weggis	Tour.	Tour.	Tour.	Tour.	Tour.						Tour.
1082 Büron			Ex.			Ex.					Ex.
1083 Buttisholz						Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
1093 Neuenkirch (Sempach-Station)					Ex.	Ex.	Ex.				
1094 Nottwil						Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
1095 Oberkirch			Ex.				Ex.	Ex.	Ex.		
1103 Sursee	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
1104 Triengen			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
1107 Wolhusen		Ex.	Ex.	Ex.	Ex.						Ex.
1125 Dagmersellen-Oberwiggertal			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
1136 Menznau									Ex.	Ex.	Ex.
1139 Pfaffnau			Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
1140 Reiden-Unterwiggertal		Ex.	Ex.			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
1146 Wauwil		Ex.									
1149 Willisau	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
1150 Zell LU						Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
1201 Altdorf	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
1202 Andermatt		Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
1205 Bürglen UR	Ex.	Ex.	Ex.				Ex.	Ex.	Ex.		
1206 Erstfeld		Ex.	Ex.	Ex.		Ex.	Ex.	Ex.	Ex.	Ex.	
1213 Schattdorf				Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
1301 Einsiedeln			Urb.								
1322 Freienbach (Pfäffikon SZ)	Urb.	Urb.	Urb.		Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
1323 Wollerau									Sub.		Sub.

Unit	Loc. 1939	Loc. 1955	Loc. 1965	Loc. 1975	Loc. 1985	Loc. 1991	Loc. 1995	Loc. 1998	Loc. 2001	Loc. 2005	Loc. 2008
1331 Küssnacht	Urb.	Urb.	Urb.			Urb.	Mix.	Mix.	Mix.	Mix.	Mix.
1341 Altendorf					Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
1342 Galgenen		Ex.									
1344 Lachen	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
1346 Schübelbach			Ex.								
1347 Tuggen							Sub.				
1362 Arth (Goldau)	Ex.	Ex.	Ex.								
1364 Ingenbohl (Brunnen)	Ex.	Ex.	Ex.								
1372 Schwyz	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
1401 Alpnach		Ex.	Ex.								Ex.
1402 Engelberg	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.				Tour.
1404 Kerns			Tour.								
1406 Sachseln			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
1407 Sarnen		Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
1501 Beckenried				Ex.							
1505 Ennetbürgen				Ex.	Ex.	Ex.	Ex.				
1507 Hergiswil		Ex.	Ex.			Ex.	Ex.	Ex.	Ex.	Sub.	Sub.
1509 Stans	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
1510 Stansstad		Ex.	Ex.	Ex.	Ex.				Sub.		
1602 Bilten				Ex.	Ex.	Ex.					Ex.
1607 Ennenda	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
1609 Glarus	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
1611 Hätzingen	Ex.	Ex.									
1619 Näfels		Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
1620 Netstal	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
1622 Niederurnen	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
1627 Schwanden GL	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
1701 Baar-Sihlbrugg					Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
1702 Cham-Blegi	Ex.				Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
1704 Menzingen	Tour.	Tour.	Tour.								
1707 Risch-Rotkreuz					Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
1709 Unterägeri	Ex.	Ex.									
1711 Zug	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
2013 Domdidier						Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
2015 Estavayer		Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
2096 Romont		Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
2124 Broc	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	
2125 Bulle	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
2148 Riaz-Marsens			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Sub.	Sub.
2174 Avry-Matran					Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
2196 Fribourg	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
2197 Givisiez-Fribourg Nord				Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
2206 Marly					Sub.	Sub.	Sub.		Sub.	Sub.	Sub.
2228 Villars FR				Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
2254 Courtepin			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Sub.	Sub.	Sub.
2275 Murten	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
2280 Bas-Vully	Ex.										
2293 Düdingen					Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
2305 Schmitten FR				Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
2306 Tafers						Sub.			Sub.	Sub.	Sub.
2325 Châtel			Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
2401 Egerkingen-Gäu				Ex.	Ex.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
2407 Oensingen-Gäu				Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
2422 Balsthal	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.					Urb.
2428 Mümliswil-Ramiswil		Ex.									
2429 Welschenrohr		Ex.	Ex.								
2473 Dornach	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
2476 Bättwil-Flüh						Sub.	Sub.	Sub.	Sub.		
2513 Biberist		Ex.			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
2516 Deitingen					Ex.						
2517 Derendingen	Ex.	Ex.					Sub.	Sub.	Sub.		

Unit	Loc. 1939	Loc. 1955	Loc. 1965	Loc. 1975	Loc. 1985	Loc. 1991	Loc. 1995	Loc. 1998	Loc. 2001	Loc. 2005	Loc. 2008
2519 Gerlafingen	Ex.	Ex.	Ex.	Ex.							Sub.
2527 Luterbach									Sub.	Sub.	Sub.
2532 Subingen				Ex.			Sub.	Sub.	Sub.	Sub.	Sub.
2534 Zuchwil	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
2542 Bellach			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
2543 Bettlach		Sub.	Sub.			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
2546 Grenchen	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
2550 Langendorf	Sub.	Sub.	Sub.								
2554 Riedholz	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.					
2556 Selzach					Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
2572 Däniken			Ex.	Ex.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
2573 Dulliken	Ex.	Ex.	Sub.								
2581 Olten	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
2583 Schönenwerd	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.			
2586 Wangen-Untergäu	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
2601 Solothurn	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
2613 Breitenbach	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
2621 Nunningen						Ex.					
2701 Basel	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
2762 Allschwil		Sub.	Sub.		Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
2765 Binningen							Sub.	Sub.	Sub.	Sub.	Sub.
2766 Birsfelden			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
2769 Münchenstein-Unterbirstal	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
2770 Muttenz-Schweizerhalle	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
2773 Reinach-Oberbirstal			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
2775 Therwil						Sub.					
2786 Grellingen		Ex.	Ex.								
2787 Laufen	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
2788 Liesberg											Ex.
2793 Zwingen		Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.		
2823 Bubendorf				Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Sub.
2828 Lausen	Ex.	Ex.	Ex.	Ex.	Ex.						
2829 Liestal	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
2846 Gelterkinden	Ex.	Ex.	Ex.								
2849 Itingen									Sub.	Sub.	Sub.
2861 Sissach	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
2886 Hölstein	Ex.	Ex.	Ex.	Ex.							
2892 Oberdorf BL			Ex.	Ex.	Ex.		Sub.	Sub.	Sub.	Sub.	Sub.
2895 Waldenburg	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.					
2920 Thayngen	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
2932 Beringen			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
2937 Neuhausen	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
2939 Schaffhausen	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
2963 Ramsen											Ex.
2964 Stein a/R	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3001 Herisau	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3006 Urnäsch	Ex.										
3021 Bühler			Ex.			Ex.	Ex.				
3024 Teufen AR								Mix.	Mix.	Mix.	Mix.
3025 Trogen								Ex.	Ex.	Ex.	Ex.
3032 Heiden	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3037 Walzenhausen			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.		
3101 Appenzell	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3203 St.Gallen	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3204 Wittenbach											Sub.
3213 Goldach-Tübach						Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
3215 Rorschach	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3216 Rorschacherberg		Sub.	Sub.								
3217 Steinach					Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
3231 Au-Unterheerbrugg	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3232 Balgach-Oberheerbrugg	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.

Unit	Loc. 1939	Loc. 1955	Loc. 1965	Loc. 1975	Loc. 1985	Loc. 1991	Loc. 1995	Loc. 1998	Loc. 2001	Loc. 2005	Loc. 2008
3234 Diepoldsau		Ex.	Ex.		Ex.	Ex.	Sub.	Sub.	Sub.	Sub.	Sub.
3236 St.Margrethen	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
3237 Thal-Rheineck	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
3238 Widnau	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.					
3251 Altstätten		Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3254 Oberriet					Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
3256 Rüthi SG					Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
3271 Buchs	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3273 Grabs							Sub.	Sub.	Sub.	Sub.	Sub.
3274 Sennwald		Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
3275 Sevelen		Ex.	Ex.		Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
3276 Wartau			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
3291 Bad Ragaz	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
3292 Flums				Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
3293 Mels		Ex.		Ex.	Ex.	Ex.	Ex.				
3294 Pfäfers						Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
3295 Quarten	Ex.	Ex.									
3296 Sargans	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3297 Vilters			Ex.		Ex.	Ex.	Ex.				
3298 Walenstadt	Ex.	Ex.	Ex.	Ex.							
3332 Eschenbach		Ex.	Ex.				Sub.	Sub.	Sub.	Sub.	Sub.
3335 Jona					Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
3336 Rapperswil	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3338 Schmerikon		Ex.	Ex.				Ex.				
3339 Uznach	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
3352 Ebnat-Kappel		Ex.	Ex.								
3355 Nesslau-Krummenau		Tour.				Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
3374 Lichtensteig	Ex.	Ex.	Ex.	Ex.							
3377 Wattwil	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3391 Bütschwil	Ex.	Ex.	Ex.		Ex.	Ex.	Ex.	Ex.		Ex.	Ex.
3392 Kirchberg (Bazenheid)		Urb.			Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3401 Degersheim	Ex.	Ex.			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
3402 Flawil	Ex.	Ex.	Ex.			Ex.					
3405 Jonschwil					Ex.					Ex.	Ex.
3407 Oberuzwil						Ex.					
3408 Uzwil	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Mix.	Mix.	Mix.	Mix.
3421 Bronschhofen										Sub.	Sub.
3424 Büren-Thurau					Ex.	Ex.	Sub.	Sub.	Sub.	Sub.	Sub.
3425 Wil SG	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3426 Zuzwil					Ex.	Ex.					Sub.
3443 Gossau				Mix.	Mix.	Mix.	Mix.	Mix.	Mix.	Mix.	Mix.
3506 Vaz/Obervaz (Lenzerheide)			Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
3561 Poschiavo	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3574 Ilanz	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3575 Laax						Tour.					
3603 Vals		Tour.									
3651 Safien		Ex.									
3668 Thusis-Cazis		Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3721 Bonaduz					Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
3722 Domat/Ems		Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
3732 Flims (Waldhaus)		Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.			
3752 Samnaun						Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
3762 Scuol	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3782 Celerina									Tour.		
3784 Pontresina	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
3786 Samedan	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Sub.	Sub.	Sub.	Sub.	Sub.
3787 St.Moritz	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3789 Sils					Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
3790 Silvaplana						Tour.	Tour.				
3822 Mesocco			Ex.								
3851 Davos	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.

Unit	Loc. 1939	Loc. 1955	Loc. 1965	Loc. 1975	Loc. 1985	Loc. 1991	Loc. 1995	Loc. 1998	Loc. 2001	Loc. 2005	Loc. 2008
3871 Klosters	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
3901 Chur	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
3921 Arosa	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.		Tour.		
3942 Igis (Landquart)	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
3945 Trimmis-Untervaz						Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
3961 Grüsch-Seewis						Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
3962 Schiers			Ex.			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
3982 Disentis				Urb.	Urb.	Urb.	Urb.				
3986 Tujetsch			Tour.								
3987 Trun		Ex.	Ex.	Ex.							
4001 Aarau	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
4003 Buchs-Suhr	Ex.		Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
4006 Gränichen						Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
4010 Entfelden	Ex.		Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
4021 Baden	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
4032 Mägenwil-Brunegg				Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
4033 Mellingen	Ex.	Ex.	Ex.								
4035 Niederrohrdorf			Sub.								
4038 Obersiggenthal-Ennetbaden	Ex.	Ex.									
4042 Turgi	Ex.	Ex.		Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
4044 Untersiggenthal				Sub.	Sub.	Sub.	Sub.	Sub.	Sub.		
4045 Wettingen						Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
4047 Würenlingen-Beznau			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
4048 Würenlos						Sub.			Sub.	Sub.	Sub.
4063 Bremgarten	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Mix.	Mix.	Mix.	Mix.	Mix.
4065 Dottikon					Ex.	Ex.				Ex.	Ex.
4080 Villmergen	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Sub.	Sub.	Sub.	Sub.	Sub.
4082 Wohlen	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.					
4092 Birr-Birrfeld			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Sub.	Sub.
4095 Brugg	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
4114 Schinznach Bad				Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
4123 Windisch	Ex.	Sub.		Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
4131 Beinwil am See	Ex.	Ex.	Ex.								
4135 Gontenschwil	Ex.	Ex.	Ex.	Ex.	Ex.						
4139 Menziken-Reinach Süd	Ex.	Ex.	Ex.								
4141 Reinach	Urb.	Urb.	Urb.		Urb.	Urb.	Urb.	Urb.			
4144 Schöftland	Ex.	Ex.	Ex.		Ex.			Sub.			
4145 Teufenthal	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.				
4146 Kulm	Ex.	Ex.	Ex.			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
4163 Frick	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
4169 Kaisten					Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	
4170 Laufenburg	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
4194 Dintikon								Ex.	Ex.	Ex.	Ex.
4201 Lenzburg	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
4203 Holderbank-Wildegg	Ex.	Ex.	Ex.					Sub.			
4204 Niederlenz	Ex.	Ex.				Sub.					
4206 Rupperswil-Wildegg	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Sub.	Sub.	Sub.	Sub.	Sub.
4207 Schafisheim-Hunzenschwil				Ex.	Ex.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
4209 Seon	Ex.					Ex.	Ex.				Ex.
4234 Merenschwand					Ex.	Ex.				Ex.	Ex.
4236 Muri AG	Urb.	Urb.	Urb.					Urb.	Urb.	Urb.	Urb.
4239 Sins					Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
4252 Kaiseraugst-Augusta				Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
4254 Möhlin	Ex.				Sub.	Sub.	Sub.				
4258 Rheinfelden	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
4260 Stein-Sisslerfeld			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
4271 Aarburg	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Sub.	Sub.		
4279 Murgenthal	Ex.	Ex.	Ex.								
4280 Oftringen											Sub.
4282 Rothrist			Ex.		Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
4283 Safenwil				Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.

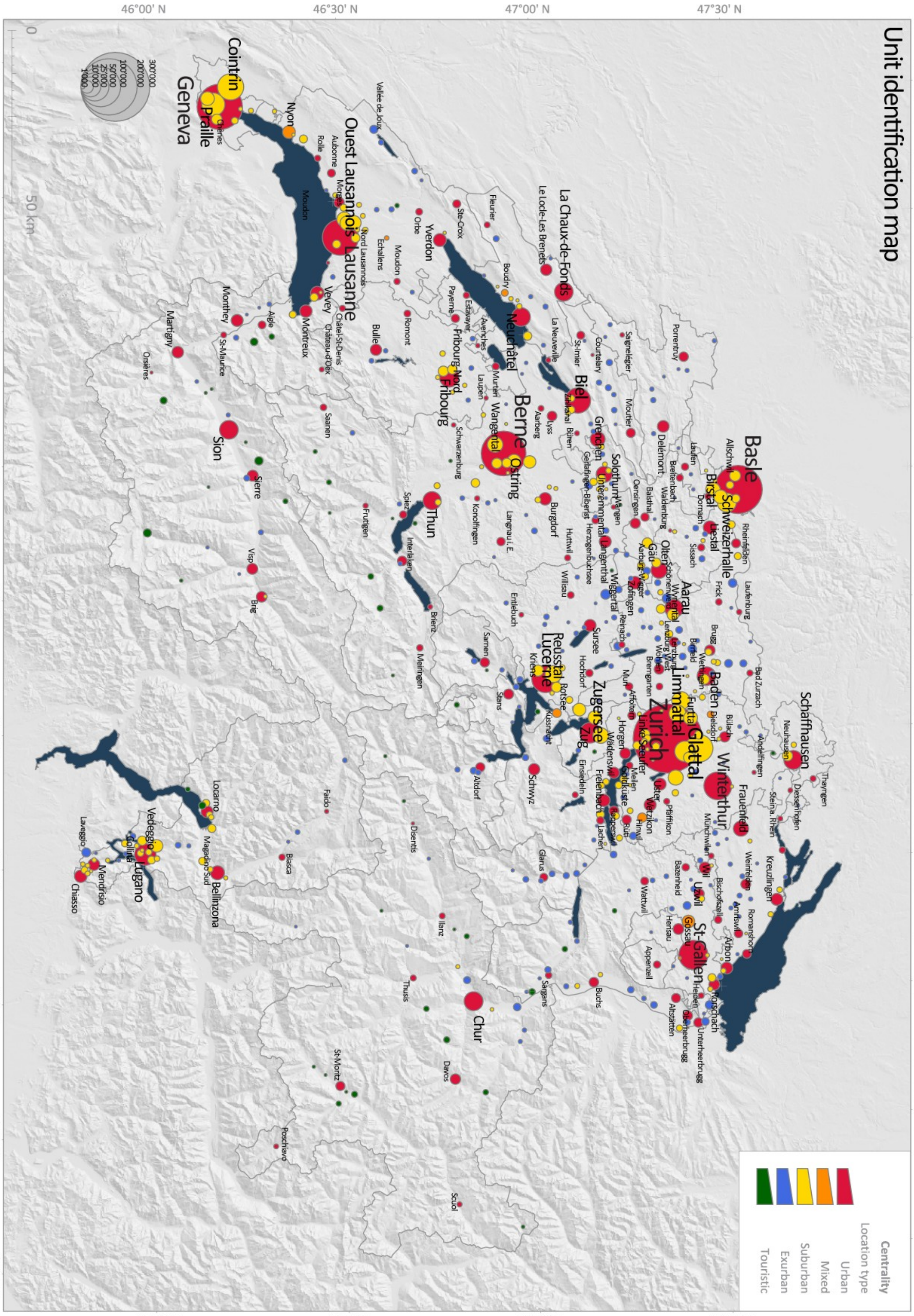
Unit	Loc. 1939	Loc. 1955	Loc. 1965	Loc. 1975	Loc. 1985	Loc. 1991	Loc. 1995	Loc. 1998	Loc. 2001	Loc. 2005	Loc. 2008
4285 Strengelbach	Ex.	Ex.		Sub.							
4289 Zofingen	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
4304 Döttingen-Klingnau	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
4311 Leibstadt					Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
4323 Bad Zurzach	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
4401 Arbon	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
4411 Egnach						Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
4416 Hefenhofen							Sub.				
4421 Horn	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.				
4431 Roggwil TG											Sub.
4436 Romanshorn	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
4461 Amriswil	Urb.	Urb.	Urb.								
4471 Bischofszell-Sittertal	Urb.	Urb.	Urb.		Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
4476 Erlen			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
4501 Kradolf	Ex.										
4506 Sulgen			Ex.		Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
4545 Diessenhofen			Urb.		Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
4546 Schlatt TG			Ex.								
4551 Aadorf					Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
4561 Felben					Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
4566 Frauenfeld	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
4591 Matzingen						Ex.					
4646 Ermatingen	Ex.	Ex.	Ex.								
4671 Kreuzlingen	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
4691 Münsterlingen			Ex.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
4696 Tägerwilen						Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
4711 Affeltrangen-Tobel		Ex.	Ex.			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
4724 Eschlikon					Ex.	Ex.	Ex.	Ex.			Sub.
4746 Münchwilen TG	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Mix.	Mix.	Mix.	Mix.
4761 Sirnach	Ex.	Ex.	Ex.								
4781 Wängi TG	Ex.	Ex.	Ex.			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
4864 Steckborn	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	
4891 Berg TG									Ex.	Ex.	Ex.
4911 Bürglen TG	Ex.	Ex.	Ex.		Ex.	Ex.	Ex.				
4921 Bussnang										Ex.	Ex.
4946 Weinfelden	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
4951 Wigoltingen		Ex.	Ex.								
5001 Arbedo-Castione		Sub.	Sub.	Sub.	Sub.	Sub.	Sub.				Sub.
5002 Bellinzona	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
5005 Giubiasco-Camorino		Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5017 Sant'Antonino-Magadino Sud			Ex.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5061 Airolo			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
5064 Bodio		Ex.	Ex.			Ex.					
5072 Faido			Urb.	Urb.	Urb.	Urb.	Urb.				
5073 Giornico			Ex.	Ex.							
5091 Ascona	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
5097 Brissago	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
5112 Gerra-Magadino Nord		Ex.	Ex.	Ex.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5113 Locarno	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
5115 Losone			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5118 Minusio			Sub.		Sub.						
5120 Muralto-Orselina	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5141 Agno-Val d'Agno Inf.			Ex.	Ex.	Ex.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5147 Barbengo-Scairolo			Ex.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5167 Canobbio-Comano					Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5171 Caslano-Tresa			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
5192 Lugano	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
5194 Manno-Val d'Agno Med.			Ex.	Ex.	Ex.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5195 Maroggia-Melano		Ex.	Ex.			Sub.					
5196 Massagno-Savosa		Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5198 Melide			Ex.								

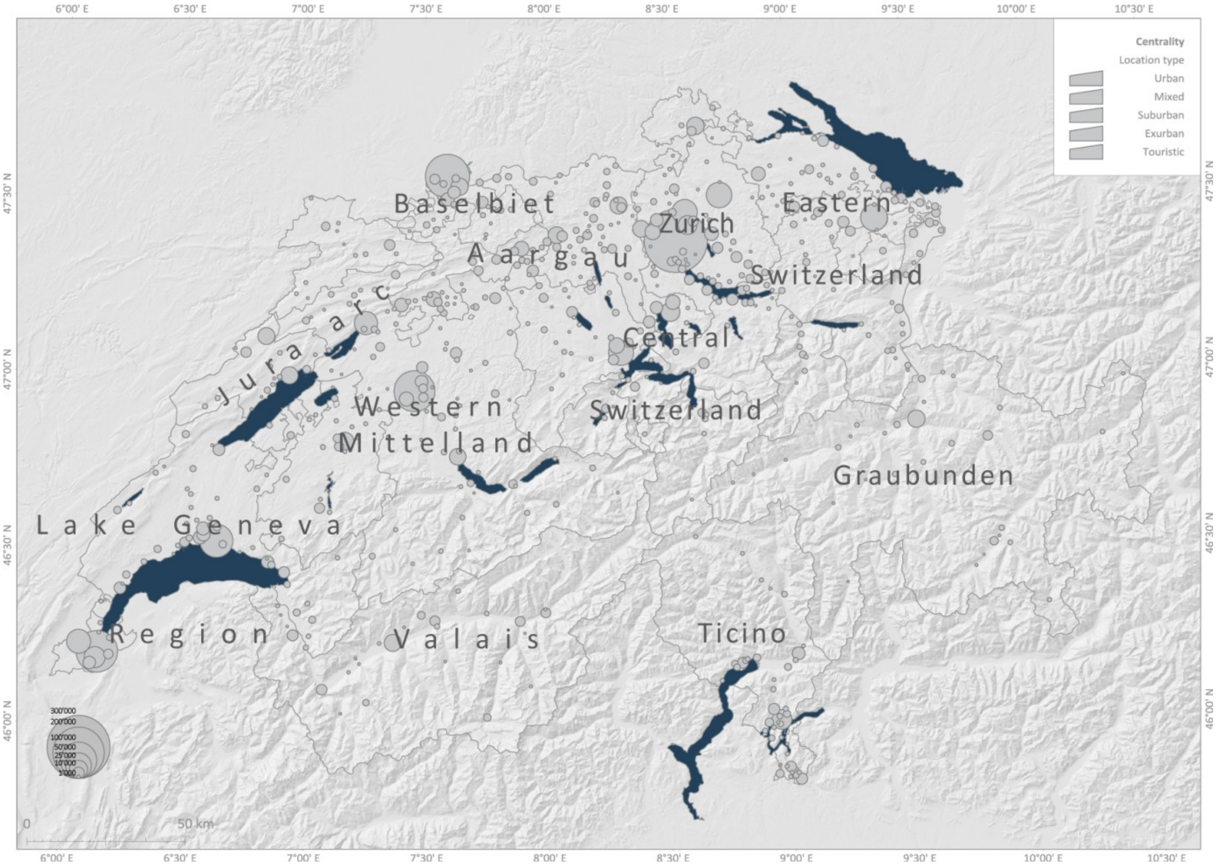
Unit	Loc. 1939	Loc. 1955	Loc. 1965	Loc. 1975	Loc. 1985	Loc. 1991	Loc. 1995	Loc. 1998	Loc. 2001	Loc. 2005	Loc. 2008
5199 Mezzovico Vira						Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
5201 Montagnola							Sub.	Sub.	Sub.	Sub.	Sub.
5210 Paradiso-Pazzallo		Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5215 Pregassona-Viganello		Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5217 Rivera-Bironico					Ex.	Ex.	Ex.	Ex.			Ex.
5221 Sorengo						Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5241 Arzo			Ex.	Ex.							
5242 Balerna	Ex.	Ex.	Ex.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5249 Castel					Sub.	Sub.					
5250 Chiasso	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
5251 Coldrerio											Sub.
5254 Mendrisio	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
5257 Morbio Inf.			Ex.	Sub.	Sub.	Sub.					
5260 Novazzano				Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5262 Rancate					Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5263 Riva-Capolago			Ex.	Sub.	Sub.	Sub.	Sub.				
5268 Stabio-Laveggio		Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
5281 Biasca		Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
5401 Aigle	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
5402 Bex		Ex.	Ex.						Ex.	Ex.	Ex.
5407 Leysin	Tour.	Tour.	Tour.			Tour.					Tour.
5409 Ollon-Villars	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.					
5414 Villeneuve-Grangettes			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5422 Aubonne-Littoral Parc	Urb.		Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Mix.
5451 Avenches			Urb.			Urb.	Urb.			Urb.	Urb.
5482 Eclépens-Daillens								Ex.	Ex.	Ex.	Ex.
5489 Mex						Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5495 Penthalaz		Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Sub.	Sub.		
5497 Pompaples-Milieu du Monde			Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
5518 Echallens						Mix.					Mix.
5568 Ste-Croix	Urb.	Urb.	Urb.	Urb.		Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
5582 Cheseaux-Etagnières				Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5583 Crissier-Westside		Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5586 Lausanne	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
5587 Le Mont				Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5590 Pully-Est Lausannois						Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5591 Renens-Malley	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5592 Romanel s/L						Sub.					
5602 Cully						Urb.					
5607 Puidoux						Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
5621 Aclens-Moulin du Choc						Sub.			Sub.	Sub.	Sub.
5622 St-Prex			Ex.	Ex.							Sub.
5635 Ecublens-Hautes Ecoles			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5638 Lonay-Venoge							Sub.	Sub.	Sub.	Sub.	Sub.
5642 Morges	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
5649 Tolochenaz								Sub.	Sub.	Sub.	Sub.
5675 Lucens		Ex.	Ex.								Ex.
5678 Moudon		Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
5707 Chavannes de Bogis							Sub.	Sub.	Sub.	Sub.	Sub.
5721 Gland-Vich				Ex.			Sub.	Sub.	Sub.	Sub.	Sub.
5724 Nyon	Urb.	Urb.	Urb.	Urb.	Mix.	Mix.	Mix.	Mix.	Mix.	Mix.	Mix.
5725 Prangins				Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
5744 Ballaigues							Ex.	Ex.	Ex.	Ex.	Ex.
5757 Orbe	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.			Urb.	Urb.	Urb.
5764 Vallorbe	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
5822 Payerne	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
5841 Château d'Oex		Urb.	Urb.	Urb.	Urb.	Urb.	Urb.				Urb.
5861 Rolle	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.				Urb.
5871 L'Abbaye-Le Pont				Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
5872 Le Chenit	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
5884 Corsier						Sub.					Sub.

Unit	Loc. 1939	Loc. 1955	Loc. 1965	Loc. 1975	Loc. 1985	Loc. 1991	Loc. 1995	Loc. 1998	Loc. 2001	Loc. 2005	Loc. 2008
5886 Montreux	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
5889 La Tour	Sub.	Sub.	Sub.		Sub.	Sub.		Sub.			
5890 Vevey	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
5922 Montagny								Sub.	Sub.	Sub.	Sub.
5938 Yverdon	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
6002 Brig	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
6007 Naters			Ex.		Sub.	Sub.					
6023 Conthey			Ex.	Ex.						Sub.	
6031 Bagnes (Verbier)		Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
6034 Orsières				Urb.							
6082 Ayent		Tour.									
6111 Leukerbad			Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
6135 Leytron									Tour.		
6136 Martigny	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
6139 Riddes		Tour.									
6141 Saxon						Ex.					
6152 Collombey-Muraz			Ex.								
6153 Monthey	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
6158 Vionnaz											Ex.
6159 Vouvry				Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
6200 Steg-Gampel			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
6217 St-Maurice	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
6235 Chippis	Ex.	Ex.	Ex.	Ex.	Ex.	Sub.		Sub.	Sub.		
6237 Grimentz		Tour.									
6243 Montana	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
6248 Sierre		Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
6266 Sion	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
6290 Saas Fee			Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
6292 St.Niklaus		Ex.				Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
6297 Visp	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
6298 Visperterminen			Ex.								
6300 Zermatt	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.	Tour.
6402 Bevaix							Sub.				
6404 Boudry-Cortaillod	Urb.	Urb.	Urb.		Mix.	Mix.	Mix.	Mix.	Mix.	Mix.	Mix.
6406 Colombier										Sub.	
6407 Corcelles						Sub.					
6412 Peseux		Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
6414 St-Aubin		Ex.	Ex.	Ex.	Ex.						
6421 La Chaux-de-Fonds	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
6431 Les Brenets								Ex.	Ex.	Ex.	Ex.
6436 Le Locle	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
6452 Cressier NE				Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
6457 Marin-Tène		Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
6458 Neuchâtel	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
6478 Fontainemelon-Vue des Alpes	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
6480 Les Geneveys			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
6505 Couvet	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.			Ex.
6506 Fleurier	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.			Urb.	Urb.	Urb.
6606 Bellevue											Sub.
6608 Carouge-Praille	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
6613 Chênes			Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
6616 Collonges-Bellerive										Sub.	Sub.
6621 Genève	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
6630 Meyrin-Cointrin	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
6633 Plan-ZIPLO				Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.	Sub.
6644 Versoix			Sub.								
6701 Bassecourt		Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
6708 Courrendlin	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Sub.	Sub.			
6711 Delémont	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
6714 Glovelier-Boécourt					Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
6743 Les Breuleux		Ex.							Ex.	Ex.	Ex.

Unit	Loc. 1939	Loc. 1955	Loc. 1965	Loc. 1975	Loc. 1985	Loc. 1991	Loc. 1995	Loc. 1998	Loc. 2001	Loc. 2005	Loc. 2008
6754 Le Noirmont						Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
6757 Saignelégier		Urb.	Urb.		Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
6771 Alle		Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
6774 Boncourt			Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.	Ex.
6784 Courgenay				Ex.							
6800 Porrentruy	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.	Urb.
6804 St-Ursanne		Ex.	Ex.								

Annex 4: Identification maps




Centrality
Location type
Urban
Mixed
Suburban
Exurban
Touristic
Baselbiet
Aargau
Zurich
Eastern
Switzerland
Jura arc
Central
Switzerland
Western
Mittelland
Graubunden
Lake Geneva
Region
Valais
Ticino
300'000
200'000
100'000
50'000
25'000
10'000
1'000
0
50 km
6°00' E
6°30' E
7°00' E
7°30' E
8°00' E
8°30' E
9°00' E
9°30' E
10°00' E
10°30' E
47°30' N
47°00' N
46°30' N
46°00' N

Curriculum Vitae

Pierre Dessemontet was born on March 20th, 1969, in Payerne VD, Switzerland. He pursued his education in Payerne, Crissier, Chavannes-près-Renens and Lausanne where he graduated from high school in 1988 with a science-oriented federal maturity, and a class prize.

He pursued his college education at the Faculty of Arts of the University of Lausanne, where he obtained his Master's degree in 1995 with special honours, majoring in geography and minoring in history and geology. His Master's memoir was firmly rooted in urban economics and quantitative geography, studying the reinvention and spatial deployment of the private economy in post-socialist Europe, based on the example of the city and county of Cluj in Romania. For this work, he lived in Cluj-Napoca, Romania, for four months in the summer of 1994.

Pierre Dessemontet started his professionnal and academic career with Prof. Jean-Bernard Racine, who headed urban and economic geography at the Institute of Geography of the University of Lausanne, and with whom he worked from 1992 to 1995 as a student-assistant, and from 1995 to 1998 as a graduate assistant. In parallel, he helped create a private company in 1996, microGIS Ltd., active in the domains of geographical information, geodata and geomarketing, in which he worked part-time from 1996 to 1998, and full-time from 1998 to 1999.

In 1999, he and his newly wed wife took the opportunity to move to Houston TX, both to pursue a professional career in the oil & gas information industry, at IHS Energy (now IHS). From 2000 to 2003, he assumed the functions of senior data analyst, then lead data analyst, and played a pivotal role in implementing geographical databases for areas newly covered by the company in frontier North American areas (Alaska and canadian territories, then deepwater Gulf of Mexico).

Pierre Dessemontet came back in Switzerland in 2003 to resume a dual career, returning at microGIS Ltd. as project and data products manager, while separately joining the EPFL to work with Prof. Martin Schuler on various projects, the most important of which was the Atlas of Spatial Mutations of Switzerland, on which he worked part-time for two and a half year, managing the whole data side of the operation, and ultimately writing six chapters out of sixteen of the work. It is at the end of this endeavour, in 2006, that Pierre Dessemontet and Prof. Martin Schuler agreed on a doctoral thesis.

Pierre Dessemontet lives in Yverdon-les-Bains with his wife and young son. He has been active in politics since about 20 years, first in the student's union, then in the socialist party, for which he was briefly a communal counsellor in Lausanne (1998-1999), and again in Yverdon-les-Bains since 2008, assuming various functions in the local and cantonal party. His hobbies are classical and modern music as well as amateur astronomy – space, always.

Publications

Dessemontet, Racine (1996): **Villes et campagnes suisses**, in *Geographica Helvetica* 51/4, pp. 143-68.

Dessemontet (1999): **Des edge-cities en Suisse?** in *Geographica Helvetica* 54/1, pp. 29-36.

Schuler, Dessemontet, Torgashova, Abubakirova, Minbaev (2004) : **Mountain Atlas of Kyrgyzstan**, National Statistical Committee, Bishkek (Kyrgyzstan), 206 p.

Dessemontet (2005): **Révolution orange, la fracture ukrainienne**, in *espacetemps.net, mensuelles, janvier 2005*.

Schuler, Dessemontet, Joye (2005): **Les niveaux géographiques de la Suisse**, OFS, Neuchâtel (Swtz.), 236 p.

Schuler, Dessemontet, Jemelin, Jarne, Pache, Haug (2006) : **Atlas des mutations spatiales de la Suisse**, OFS / NZZ, Neuchâtel / Zurich (Swtz), 416 p.

Ourednik, Dessemontet (2007): **Interaction maximization and the observed distribution of urban population : an agent-based model of humanity's metric condition**, conference paper, ECTQG 2007, Montreux.

Schuler, Jarne, Dessemontet (2008): **L'espace transfrontalier du Genevois dans un contexte européen**, Publication de l'Observatoire Statistique Transfrontalier de l'Espace Franco-Valdo-Genevois, 32 p.

Schuler, Dessemontet, Jarne (2009) : **Forum des 100 – 2009 : Suisse romande, les facettes d'une région affirmée**, L'Hebdo, CEAT, Lausanne, 30 p.

Schuler, Dessemontet (2009): **Différenciations territoriales, contextuelles et environnementales dans les agglomérations suisses**, in Pattaroni, Kaufmann, Rabinovitch (eds.) (2009) : Habitat en devenir, enjeux territoriaux, politiques et sociaux du logement en Suisse, PPUR, Lausanne, pp. 53-68.

Dessemontet, Kaufmann, Jemelin (2010): **Switzerland as a single metropolitan area ? A study of its commuting network**, *Urban Studies* 47/13, pp. 2785-802.

Chételat, Dessemontet, Mix & Remix (2010): **Géographie de la Suisse**, LEP, Le Mont (Swtz.), 184 p.