Delineating policies.
Governing spaces with no coextensive institutions: metropolitan areas and disadvantaged communities in the United States.

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Abstract

Many policies are spatially targeted: they attempt to foster or incent policy actions in areas meeting specific criteria. The identification and delineation of the spatial reality of interest is a major challenge to spatially targeted policies. In many cases, this spatial reality has an ambiguous meaning and no coterminous governing institution, leading to the need for institutional collaboration around policies.

This project investigates the discrepancy occurring when the functional space relevant for polices and the institutional space of government produced by historical processes do not share the same extent. The research examines two spatial realities of importance for public policies in the United States: metropolitan areas and disadvantaged communities. Because they are the main social unit of urban life, metropolitan areas—such as the San Francisco Bay Area—are the target of housing or economic development policies. Disadvantaged communities are targeted by programs intending to mitigate inequalities between communities. In both cases, specialists and laymen alike have a sense of what these spatial realities are, but charting a robust, actionable definition is problematic.

The three articles of this doctoral project form a coherent path to scrutinize and resolve the spatial reality / institutional space disjunction. The first, *Delineating the space of urban life*, investigates spatial practices of individuals and how, collectively, they cast a unit of urban life, the metropolitan area. The second paper, *On point: designing robust spatial targeting for public policies*, analyzes how these practices can be integrated in a robust policy targeting, taking the example of disadvantaged communities in California. The third paper, *The place and scale of consent* takes a bottom-up approach to show how individuals perceive and express preferences for resolving that discrepancy.

I show that neither of the currently used definitions for metropolitan areas and disadvantaged communities is robust because they use a strict threshold on a continuous metric that is not exhibiting clear breakpoints. Furthermore, definitions are not geographically consistent. A single definition does not capture the same reality of a metropolitan area in a coastal region or in the rural west, or of a disadvantaged community in a large urban region or in a rural county. Therefore, these definitions fail to provide a dependable policy target. Moreover, I show that local preferences for policy collaboration to resolve the discrepancy vary geographically, further undermining the relevance of a one-size-fits-all definition.

I recommend that definitions of spatial targets for policies use a continuous scale instead of a discrete, binary one. These definitions should also be adapted to the geographical context they are applied in. Randomized vignette experiments can be used to understand residents' preferences.

Keywords

metropolitan areas; disadvantaged communities; survey experiments; United States; public policy

Résumé

De nombreuses politiques publiques ont un objectif spatial: elles tentent d'influer sur un territoire dont les contours sont définis par des critères spécifiques. L'identification et la délinéation des réalités spatiales visées est un enjeu majeur des politiques spatiales. Dans de nombreux cas, cette réalité spatiale a un sens ambigu et ne dispose pas d'institution en partageant les contours exacts, ce qui conduit à la nécessité d'une collaboration entre institutions existantes autour de la politique à conduire.

Ce projet de recherche examine l'écart produit lorsque l'espace des pratiques sociales, producteur de réalités spatiales, et l'espace institutionnel de gouvernance ne partage pas la même étendue. J'examine deux réalités spatiales d'importance pour les politiques publiques aux États-Unis: les aires métropolitaines et les communautés désavantagées. Parce qu'elle sont l'unité principale de la vie urbaine, les aires métropolitaines font l'objet de politiques publiques visant le logement ou le développement économique. Les communautés désavantagées sont ciblées par des programmes visant à corriger les inégalités. Dans les deux cas, spécialistes et profanes ont un sens de ce qu'elles recouvrent, mais leur définition précise pose problème.

Les trois articles de ce projet doctoral forment un parcours cohérent pour examiner et résoudre l'écart entre réalités spatiale et institutionnelle. Le premier, *Identifying the space of urban life*, examine la définition officielle des aires métropolitaines à la lumière des mouvements de pendularité. Le second, *On point: designing robust spatial targeting for public policies*, évalue la définition des communautés désavantagées en Californie et comment les pratiques sociales peuvent former la base d'un objectif robuste de politique spatiale. Le troisième, *The place and scale of consent*, part des individus pour montrer comment ils perçoivent et expriment leur préférences pour la collaboration inter-gouvernementale dans les aires métropolitaines pour résoudre cet écart.

Je montre qu'aucune des définitions officielles, aires métropolitaines ou communautés désavantagées, n'est robuste. Ces définitions utilisent un seuil strict appliqué à une métrique continue sans point de rupture clair. Par ailleurs, ces définitions ne sont pas géographiquement stables. Une définition unique ne capture pas la même réalité métropolitaine à l'est ou à l'ouest des États-Unis, ou le même désavantage économique dans une région urbaine ou rurale. Ces définitions échouent à fournir un objectif de politique publique cohérent. Par ailleurs, je montre que les préférences locales pour la collaboration inter-gouvernementale varient géographiquement.

Je recommande que la définition des objectifs géographiques des politiques publiques utilisent une métrique continue plutôt que binaire, et s'adaptent au contexte géographique local. Par ailleurs, la méthode des enquêtes expérimentales peut permettre de mieux comprendre les préférences locales.

Mots-clé

aires métropolitaines; communautés désavantagées; enquêtes expérimentales; États-Unis

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INTRODUCTION

Introduction

Contents

Numerous public policies feature explicit spatial dimensions. Many others bear spatial effects. Understanding and delineating this space is particular challenge for policy makers and scholars alike. This challenge is compounded by a discrepancy between spaces of social life and spaces of institutions tasked with policy definition and implementation.

Spatial realities, forged and enlivened by societies, are complex, fluid, multi-dimensional, sometimes rapidly evolving and seldom obvious to the observer. Space has taken an important role in the understanding of social phenomena, driven by a conceptual renewal of the role of space in social sciences and humanities[1] and a novel permeation of Geographic Information Systems (GIS) in these scientific fields, permitted by an increasingly shared reliance on computation.[2] In spite of this renewed armamentarium, socio-spatial realities, although powerful tools to understand societies, remain elusive to who intends to delineate them precisely. Embedding spatial dimensions in public policies, however, require methods to tell them apart effectively. How to provide resources to residents of disadvantaged communities if we do not know what a disadvantaged community is? How to alleviate mishaps in the housing market if the spatial structures and extent of housing

[1] Warf and Arias 2008.

[2] Goodchild and Janelle 2004.

markets are impenetrable? Beyond direct spatial targeting, policy interventions often generate externalities—positive and negative—and spillovers who can only be comprehended through their spatial dimensions.

Spatial dimensions of political institutions appear equally complicated, calling comparisons with layer or marble cake, "characterized by an inseparable mingling of differently colored ingredients, the colors appearing in vertical and diagonal strands and unexpected whirls".[3] But however complex institutional architecture reveals itself, social space as a whole offers more dimensions and changes more rapidly.

[3] Grodzins 1960.

In this research I **investigate the discrepancy between spaces of social practice and spaces of institutions**. Taking the example of two spacial realities targeted by public policies, metropolitan areas and disadvantaged communities, I evaluate the current official definition and propose alternatives to improve policy efficacy. I go beyond the policy-maker point of view to understand what type of inter-governmental collaboration, and within which spaces, do people support. The three papers composing this dissertation form a coherent path to investigate the chasm between social and institutional spaces.

The first paper, *Identifying the Space of Urban Life: Delineating American Metropolitan Areas* evaluates the definition of metropolitan areas as the functional units of urban America, traced from commuting patterns between places.

The second paper, *On Point: Designing Robust Spatial Targeting for Public Policies, The Example of Disadvantaged Communities in California* focuses on a smaller spatial reality, disadvantaged communities in California, targets of social and spatial justice policies intending to compensate for these communities relative lack of resources. By looking at these communities and how the State of California looks to profile and outline them, I reveal specifically geographic pitfalls stemming from spatial biases. Using space and spatial statistics as policy instruments opens a range of relevant policy pathways but exposes policy-makers to the vagaries of spatial aggregation, overlapping effects, scale, neighborhood effects and spatial autocorrelation... all effects that should be addressed when space if used as a policy instrument.

Lastly, the third paper, *The Place and Scale of Consent: Individual Support for Local Government Collaboration in California Metropolitan Areas* takes a bottom-up approach to understand the features swaying people's support for inter-governmental collaboration. Social spaces are complex and institutional spaces are slow to adapt. Moreover, institutions cannot capture in one delineation the intricacies of social spaces. Therefore, public policies are often designed and implemented by networks of collaborating institutions. Research has been focusing on actions of policy-makers and evaluation of the intrinsic merits of governance forms. Few, however, have examined perceptions and motives of the people themselves. We might recognize that a given area is the right space to conduct land-use policy, but what do people living in the area actually think? What do they perceive as the legitimate space of action, to do what, and how? I answer these questions with a survey experiment exploring land-use policy collaboration in California.

In this introductory chapter, I provide a higher level background to understand the stakes of each of these three investigations. In section 1 I portray attempts to resolve the discrepancy between social and institutional space. Then, in section 2 I explain why metropolitan areas and disadvantaged communities are appropriate case studies to approach spatial mismatches between spatial realities and policy endeavors. In section 3 I describe how the United States are a valid field of research to explore this question, in a federal system with a high degree of local autonomy, and important institutional and social spatial fragmentation. Lastly, in section 4 I lay out the general hypotheses for the research. These general hypotheses will be informed by the three papers looking at specific configurations.

1 Crossing the chasm

Applied and theoretical scholars alike have recognized the discrepancy between social and institutional space for a long time. They have proposed ways to bridge the gap, either by directly reforming institutions or by changing the way they act and interact with each other. However, as I describe in the following, these endeavors have largely focused on endogenous characteristics of institutions and their personnel, rather than on their interactions with society and its manifold spatial dimensions. At first, research has focused on the architecture of governance, trying to define the right institutional form (1.1). In spatial terms, this focus on architecture has materialized as a quest for the right scale of governance. In the past decades, however, *collaborative governance* has occupied the forefront. Instead of focusing on institutional reform, collaborative governance offers a fresh focus on how existing institutions and civil society actors create new ways of governance based on their interactions. With collaborative governance has come a new focus on the behaviors of policy-makers and stakeholders (1.2). These two approaches, and the multiple nuances thereof, can be described as respectively focusing on *the right institutions* and on *the right methods*. Central to institutional reform and collaborative governance alike is the idea that policies can and should be evaluated, regarding their efficacy or their legitimacy. However, there is little consensus on the way to assess and measure them (1.3).

1.1 Institutional form

THE RIGHT ARCHITECTURE. Political institutions have been the focus of policy studies for a long time, following the core tenet that better institutions lead to better policies. Before widespread urbanization grew the spatial gap between institutions and social practices, Alexis de Tocqueville described America's political virtues by its institutions.[4] Tocqueville focused at once on both the architecture of institutions and its harmony with American society. This double dimension, intrinsic virtue and adequacy to social functioning, will continue to be the yardstick of institutional evaluation. For much of their history, political sciences have taken a theoretical and normative approach, embracing an empirical turn World War II onwards.[5] Emphasizing in turn collective decision making or competition to satisfy individual preferences, political scholars have often approached these questions through an institutional prism. What are the right institutional forms to achieve these goals?

[4] De Tocqueville 1835.

[5] Dahl 1961.

THE RIGHT SCALE. In spatial terms, the focus on institutional forms translates into a pursuit of the right scale and the right extent. The affiliation of an institutional form with an univocal space dates from antiquity, where the question of the right form of government was tied to that of the right size of the polity.[6] How many men can govern themselves and what is the geographic extent that this government can reach? Expectedly, more contemporary schools of institutional form comport a comparable spatial dimension. Institutional reform schools calling for government consolidation insist that governments should grow in extent to follow the growth of urban settlements.[7] Public choice theorists posit that only small governments can satisfy the aggregated preferences of their populations.[8] Moreover, they contend that multiple small governments offer people a choice to move to one that is in line with their preferences. Debates over the right scale have not withered and contemporary debates about institutional form in urban environment grapples with questions of delineation.

[6] Ostrom 1972.

[7] Jones 1942; Briffault 1996.

[8] Tiebout 1956.

1.2 *Collaborative governance*

Collaborative governance has brought an alternative to the focus on institutional by investigating **practices of government and policy** rather than their architecture. At the core of collaborative governance is the idea that institutions, and individuals therein, have an autonomy of action going well beyond what is captured by institutional architecture. Consequently, the architecture of institutions is less important than the context they are placed in, the path they have taken, and the individuals they are composed of. In a network of distributed agency, institutional reform carries limited clout. By focusing on relations between agents through fieldwork and empirical analysis, scholars have built an understanding of political[9] and administrative personnel.[10] Starting from an understanding of the practices and relationships between formal institutions of gov-

[9] Fenno 1978.

[10] Lascoumes and Le Gales 2007.

ernments,[11] collaborative governance has progressively broadened its purview to include organized civil society actors and a variety of other agents and stakeholders. The term is now largely used to described collaboration between state and non-state agents.[12] Collaborative governance is as much descriptive as it is prescriptive. Proponents of collaboration argue that this form of governance, by increasing information and deliberation, produce higher quality outcomes, as well as appear more legitimate.

[11] Ostrom 1972; Poteete, Janssen, and Ostrom 2010.

[12] Ansell and Gash 2007.

1.3 *Efficacy and legitimacy*

Both institutional form and collaborative governance measure the relative merits of institutional arrangements in terms of efficacy, legitimacy, or both.

EFFICACY measures the ability of an institution to deliver the policy it is supposed to be delivering. Beyond efficacy, efficiency measures the institution's capacity to do so optimally, without wasting time and resources. Both efficacy and efficiency are measures of a policy's **output**. Efficacy arguments run into measurement problems however, as it is often difficult to assess of effective and efficient a specific policy is.[13] Direct cost can be measured to some extent, but only captures part of a multi-faceted and complex set of benefits and policy externalities. The direct cost of policing, for instance, can be relatively straightforward to assess, but its benefits are not. Policies have effects in different time-frames, so that a complete cost-benefit analysis, if at all possible, might only be reachable long after the policy has been conducted. An important question for this research is the possibility of optimizing for efficacy and efficiency and the extent to which these arguments bear any weight in people's preferences for a policy.

[13] Ostrom 1973; Andrews, Boyne, and Walker 2006.

LEGITIMACY measures the degree to which how a policy is designed and implemented adheres to standards of political legitimacy, often defined by democratic and social justice values, mainly looking at a policy's **input and throughput**. Several hurdles lie on the way of evaluating a policy instrument's legitimacy. The first obstacle is that individual preferences are seldom transitive.[14] Overall, a person's set of preferences towards policy might present paradoxes or be downright incompatible the ones with the others. A second obstacle is that preferences do not aggregate easily, especially with voting methods generally in use.[15] Aggregation, in turn, is a source of more intransitivity. A third obstacle is that individual preferences are not fixed. People might prefer one policy over another at one time, but change their mind and switch preferences a while later.[16] This can be due, in part, to neighborhood and social reinforcement effects whereby individual start to align their preferences with ones of their neighbors, friends and acquaintances. Then, people's preferences are not context-less. Preferences

[14] Tversky 1969.

[15] Arrow 1950; Farrell 2011; Nurmi 2012.

[16] Jennings and Niemi 1975.

declared in surveys, for instance, have limited predictive power for actual decisions. The context in which people make decisions matters considerably.[17] Even for matters as important as retirement savings, for instance, changing the context and the way the decision is presented has sizable effects on decisions. For all these reasons, empirically measuring legitimacy by comparing policy instruments and outcomes to people's preferences presents critical caveats.

[17] Kahneman and Tversky 1979.

In addition to empirical efforts to measure legitimacy, normative approaches of political theory attempts to measure legitimacy of a process by comparing it to a prototypic ideal of justice and democracy.[18] The major quandary of this approach is one of external validation of the theory of legitimacy that we should compare actual policy instruments to. Again, an important question for this research is the question of people's preferences for forms of legitimacy, and tis influence on supporting one institutional or another. Can we find external validation for theories of legitimacy?

[18] Manin 1987.

2 *Two spatial realities without institutions*

I approach the discrepancy between social and institutional spaces by focusing on two spatial realities of different scales: metropolitan areas and disadvantaged communities. These two spatial realities offer a good comparative and contrasted point of view on the challenges of delineating policies with spatial dimensions. They share four important characteristics. First, there is a wide consensus about their existence with a general *lay understanding* of what they are. Second, they do not have a coextensive local government or institution. Third, they are ambiguous to be challenging to define for policy purposes. If we agree they exist, depicting them in precise terms defies legislative and regulation attempts. In both cases there is a simple but unidimensional and binary definition. Lastly, these two spatial realities are the target of public policy programs with critical consequences for their occupants, residents and neighbors. I begin by describing metropolitan areas (2.1) and disadvantaged communities (2.2) before developing their shared characteristics (2.3).

2.1 *Metropolitan areas*

Metropolitan areas capture the urban regions forged by decades of suburbanization and extension of urban settlement beyond the limits of compact cities. They are functional units of urban life, units of urban settlement where people live and travel for most of their routine business. This routine mobility shapes regional job and housing markets. Residents of a metropolitan area are highly interdependent. residents of a metropolitan area are more linked to each other, regarding their everyday occupations, than they are to the rest of the country. They share common resources and common problems. Interdependency does not suppose homogeneity. A metropolitan area can be highly segregated, by income, by race, by household status, often by multiple dimensions at the same time.[19] Even living close but apart, however, metropolitan residents affect each other through strong externalities. Whether they come from a poor or a wealthy neighborhood, cars contribute to congestion all the same, for instance. For this reason, many economic development and housing policies, transit and transportation infrastructure programs, are directed towards metropolitan areas.

[19] Fischer et al. 2004.

Metropolitan areas are the focus of policies for functional reasons. Because metropolitan areas are the best units of urban life, urban problems pertaining to these functions are best understood by looking at metropolitan areas. Strong interdependency begets strong externalities. If this fact is little contested, the way to address externalities is contested between proponents of consolidation, competitions, or collaboration.

2.2 *Disadvantaged communities*

Disadvantaged communities are communities lacking resources compared to the rest of the population. Poor neighborhoods have been documented since science has been looking at cities. They have been, under the lens of epidemiology[20] or the study of poverty,[21] the first focal points of nascent urban sciences. To educated observers of cities, poor neighborhoods were sources of legitimate questions if not problems, long before the city as a whole or wealthier communities became so. Suburbanization and, later on, metropolitanization, have created the conditions for an amplification and transformation of segregation. Indeed, increase choice of commuting driven by rail transit followed by individual cars and freeways has given wealthier household options to surround themselves with their own kind. If racial segregation has somewhat receded since the Civil Rights movements in the 1960s, income segregation has risen.[22]

[20] Snow 1855.

[21] Embree 1900.

[22] Fischer et al. 2004.

In the United States very few policies have aimed at desegregating neighborhoods by promoting social diversity.[23] On the one hand, social homogeneity provides better chances for local support networks. On the other hand, diverse neighborhood provide more opportunities, especially for children,[24] while local social ties alleviate trust issues between individuals of diverse backgrounds.[25] Since very little is done to diversify neighborhoods, public policies have prioritized mitigating neighborhood effects of economic disadvantage by providing additional resources in compensation. Among these programs intend to treat neighborhood-scale effects of poverty are tax incentives for job location, magnets schools[26] or, like the program I examine in detail in this dissertation, assistance for grant application. If identifying disadvantaged individuals and household as policy beneficiaries is already challenging, adding an element of spatial aggregation by targeting disadvantaged neighborhoods contributes to blur the line further. Segregation does not

[23] de Souza Briggs, Popkin, and Goering 2010.

[24] Chetty, Hendren, and Katz 2016.

[25] Stolle, Soroka, and Johnston 2008.

[26] Metz 2003.

create pure homogeneity, and even disadvantaged communities are diverse. How to recognize, in aggregate, what makes disadvantage? The same aggregate statistic, for instance median household income can depict an array of vastly different realities, with households homogeneously clustering around the median value, or in contrary constituting two groups at the lower and higher end of the scale. Because of their smaller scale, disadvantaged communities are particularly prone to geographic biases.

Disadvantaged communities are the focus of policies for social reasons. It is not mainly because they offer channels for policy efficiency that they are centers of policy action, but because their existence and life conditions in these communities hurt our sense of justice and social fairness. Disadvantaged communities are contrasting complements to metropolitan areas for the investigation of the discrepancy between social and institutional space. They are, substantially, the product of the same forces that propelled metropolitan areas into being: increased mobility and commuting, and subsequent expansion of residential choice, combined with a concentration of wealth production in large urban settlements.

2.3 *Elusive realities with real consequences*

Metropolitan areas and disadvantaged communities are two sides of the same coin, an increase in routine mobility and residential choice since the end of the 19^{th} century. They stand, however, at vastly different scales. Where the measure of metropolitan areas attempts to capture entire urban regions, disadvantaged communities are smaller scale units in the urban fabric. Far from isolated, metropolitan areas take place in an increasingly important network of large urban settlements, and disadvantaged communities often fit into a pattern inside metropolitan areas. Both share four characteristics making them strong grounds to investigate the discrepancy between social and institutional spaces: 1. there is a general consensus that they exist and they have a *common sense* definition 2. they have usually no coextensive government or institutions 3. their precise delineations is elusive, and 4. they are the target of numerous public policies

Spatial realities. Metropolitan areas and disadvantaged communities are *spatial realities*. There is a general consensus that they exist and are in fact relevant units of social space. Both concepts have been subject of extensive scientific research for decades. "Metropolitan areas" appears in 491 000 occurrences in Google Scholar along with United States. "Disadvantaged communities" appears in 30 300 occurrences. For metropolitan areas, the word has risen in use in parallel with the reality. The use of the expression "Disadvantaged community", however, is a more recent way to describe what might have been named "poor neighborhood" before, in an attempt to neutralize social stigma and include a wider range of potential disadvantage. "Disadvantaged community" is also used to describe non-geographic unit, involving any community suffering from a disadvantage. For these reasons, contours of disadvantaged communities are more blurry. Both realities have graspable definitions. Metropolitan areas are urban spaces where people live their everyday life. Disadvantaged communities are local communities at a disadvantage, mostly economic.

NO COEXTENSIVE INSTITUTIONS. Metropolitan areas and disadvantaged communities have generally no coextensive government or institution, in the United States. Attempts of consolidating local government in metropolitan areas, or to create a new government layer encompassing whole metropolitan areas have largely failed. Few exceptions have not eliminated local governments but rather complemented them. Disadvantaged communities come in all shapes and form. Therefore, if they sometimes happen to coincide with municipal boundaries, it is often not the case. On the contrary, wealthy communities have been leading the way in municipal incorporation, precisely because they had access to more resources and driven toward optimizing their fiscal environment and controlling access.[27]

[27] Burns 1994.

ELUSIVE DELINEATIONS. If they have intuitive lay definitions, metropolitan areas and disadvantaged communities are difficult to precisely delineate for policy purposes. Lay perceptions of the same reality can be diverging and contradictory. For instance, every resident of the San Francisco Bay Area has a sense of what the Bay Area is, but what exactly are the contours of the Bay Area? Individuals perspectives are diverse, and someone commuting 50 miles from North to South Bay everyday might have a different understanding of someone biking to work in San Francisco. By contrast with the relative consensus on externalities, metropolitan-wide identification is generally weak.[28] Equally, there can be a general sense that a neighborhood is struggling economically, but very little consensus on how to draw the border of this neighborhood. Neighborhood identification and labeling is usually unstable.[29]

[28] Kübler 2005.

[29] Coulton et al. 2001.

Metropolitan areas, and urban ensembles in general, have multiple definitions, but the White House's Office of Management and Budget (OMB) definition, implemented by the US Census Bureau, serves as a reference.[30] Disadvantaged communities do not benefit from such a standard.

[30] Office of Management and Budget 2013.

PUBLIC POLICIES. Absent operative ambition, realities with elusive definitions have little relevance. Metropolitan areas and disadvantaged communities, however, are the intended targets of countless public policies. Because they do not have coextensive institutions, it behooves every policy to define precisely how to delimit them.

Metropolitan areas are targeted by policies from the Federal government, State governments, and local governments collaborating to solve common problems. These three layers often interlace and instruments mandated by the Federal government, such as *metropolitan planning organizations* (MPO) are also vested by state programs with other policy powers. Metropolitan policies most often deal with domains presenting strong metropolitan-wide externalities such as housing, economic development, transportation and transit. Increasingly, metropolitan areas are also designated to conduct environmental protection programs, even if ecosystems and watersheds seldom co-locate precisely with metropolitan areas. Because of this history of policy mandates, metropolitan areas present an important degree of inertia, with long-standing structures and networks of inter-governmental collaboration, appealing to policy makers.

Disadvantaged communities are the target of social and spatial justice policies, most often from federal and state governments. Rarely do local governments go to the extent of setting a definition for local disadvantaged communities. Because there is no common standard delineation nor denomination, each policy defined its own guideline. The California cap-and-trade program, for instance, generates millions of revenue earmarked for disadvantaged communities every year. Public health is also an important area of policy interventions.[31] Neighborhood-level public policies in disadvantaged communities follow two distinct goals: 1. to compensate for their relative lack of resources and allow these communities to perform at the same level of more resourceful ones, for instance by making sure they receive their fair share of grant allocations 2. to compensate for neighborhood effects on individuals and households in the community, for instance by providing better education locally

[31] Kawachi and Berkman 2003.

3 *Fragmentation and federalism in the United States*

The United States are a particularly good field to understand the discrepancy between social and institutional space because in both dimensions of urban development and institutional architecture, they present a high level of diversity while sharing common deep trends and patterns. First, I summarize how the urbanization of the United States has followed shared trends while producing variegated results (3.1). Then, I describe how the urban and institutional fragmentation of the country offers an illuminative field (3.2). Lastly, I explain how federalism principles have conducted to a large autonomy of local and state governments, producing an assortment of institutional arrangements to address the discrepancy (**??**).

3.1 *Regional variations on urban trends*

The United States have a rich urban history, from the first colonies to today's large metropolises. A seminal dimension of this context for this research is the expression of strong underlying trends in diverse settings. Two dominant, and interacting, sources of diversity are the physical geographical context of urban development and the historical progression or urbanization from East to West. These two factors explain how different cities have been struck by the same trends in a different stage of their development and in a different way.

TRENDS. America's urban history can broadly be described as following a series of phases.[32] Development of colonial towns follows the model or urban Europe, with an increased emphasis on division of land parcels, creating a dense fabric of small towns and agricultural land. From the independence in 1776 onward, opens an era of simultaneous westward, agrarian colonization and industrial development in the East. As rural communities develop in the West, cities grow and become compact industrial centers in the East.

[32] Boehm and Corey 2014.

The emergence of rail, and especially urban rail transit, opens the door to heavy exploitation of natural resources in the West—mining, forestry—and suburban development around western industrial centers. With some delays, the same trends strike western burgeoning urban centers. Western and Southern cities developing during this phase do not experience a phase of compact urban industry, but directly expand horizontally with large urban rail networks fledging early suburbs. They also tend to be farther apart, each one of them attracting a higher share of their region's growth, than in the East. Cities are also at the heart of social reform movements.

Starting in the inter-war period and accelerating after World War II, the advent of the car, facilitated by freeway construction programs and decline in public transit, fosters an intense suburbanization of demographic and economic growth. Downtowns loose their role of major employment centers in favor of suburban centers. Where big eastern cities had large, weighty downtowns that managed to retain an important share of employment, southern and western downtowns were all but economically wiped out, concentrating poverty as affluent white population left for the suburbs. This trend has pinnacled in the late 20th century with deindustrialization, concentration of employment in "edge cities" and growth in the suburban sunbelt.

A movement or re-urbanization has only recently brought demographic and economic growth back to central cities and their downtowns. This growth has not balanced yet effects of decades of intense suburban growth, but is markedly reshaping central cities' social fabric.

Since the inception of suburbanization, different trends of urbanizations have fostered different types of segregations and sociospatial fragmentation. Expansion of commutes and residential choices have obliterated necessities of co-location between groups of diverse background, race and class. Metropolitanization is also the story of the expansion of an urban environment more diverse as a whole but more homogeneous in its parts. This contrast creates new challenges to gear public policy toward them.

Cities in the United States have experiences similar waves of urban development. But these waves have struck them in a very different context and period of their development, explaining the diversity visible today.

DIVERSITY. If common trends are visible in all American cities, their history make them diverse. Portrayed elementarily, the Northeast is composed of a denser network of cities and towns, in a large urban continuum. This continuum has been describe as a megalopolis with no clear separation between each large city's zone of influence.[33] The urban hierarchy has been further befogged by growth in peripheral employment centers—edge cities[34]—often not sitting at the edge of a specific city but drawing commuters from a large area. This continuity renders delineations particularly difficult in the Northeast, because there is no clear border in a network of interrelated places. Dense interlacing of places of very different character creates challenges in evaluating a place's context, and pool of resources that its residents have access to.

[33] Gottmann 1957.

[34] Garreau 1991.

The South and, in large part, the Midwest, are composed of larger isolated cities. Municipalities in the South are significantly more populous, because they progressively annexed a large proportion of their own suburbs over time. Midwestern and Southern cities are separated from each other by large swathes of rural land. Nevertheless, the line is often blurry between urban and rural land, as large suburban developments progressively encroach rural land and interlace with it in a patchwork. Edge cities, large employment centers commonly surpassing downtowns in job counts. They are sometimes associated with expansive planned communities, such as the Woodlands, north of Houston, TX.

The West exhibits a significant contrast between inland isolated cities separated by large topographical features and expansive urban regions on the Pacific Coast. Coastal cities have comparatively retained more of their downtowns, and experiences a stronger urban renewal since the 1990s. Coastal cities are still very suburbanized, however, and the *back to the city* narrative must be counterbalanced by continuing development of *boomburgs* of suburban character and growth of peripheral networks of middle-size cities forming regional *inland empires*.

3.2 *Fragmented federalism*

Across the United States, metropolitan areas and disadvantaged communities do not look the same. Yet, everywhere they are spatial realities with no coextensive institutions. Strategies to identify and manage them vary from place to place, due to an important institutional fragmentation combined with a large degree of state and local autonomy. Fragmentation and autonomy is a source of variation in the way the discrepancy between social and political space is resolved locally.

Fragmentation. The United States are an institutionally fragmented country. This fragmentation arises differently in different regions. Firstly, as a federal country the United States are composed of 50 different states with a large degree of legislative and regulatory autonomy. States do not uniformly divide the American territory. They tend to be much smaller in the Northeast. As a result, urban regions often span over state lines, placing different parts of a same metropolitan area in different state jurisdictions. In the Midwest and in the South, larges rivers like the Mississippi, Missouri, Red River or Ste-Croix River serve as state borders. These rivers frequently host large cities on their banks. These cities' areas of influence cross the river and extend over multiple states. Memphis, TN, is for instance located along the Mississippi River, close to the border with Arkansas and Mississippi. Kansas City, on the Missouri River, spans over the two states of Kansas and Missouri. In the West, urban regions are mainly contained in a single state. With many exceptions, state borders primarily cross rural, desert or mountain land.

Local governments are, more than states, the major source of political and institutional fragmentation in the United States. According to the census of governments, there were 89 004 local governments in 2012. This include counties (3 031), municipalities (19 522), townships (county subdivisions with political power in the Northeast and Midwest, 16 364), special districts (37 203) and school districts 12 884. By contrast with many other countries, municipalities do not cover the whole American territory, but have to be specifically incorporated. Counties are the base political subdivision, and directly administrate territories that are not incorporated in a municipality. A metropolitan area will typically encompass several counties, many municipalities of various sizes, and portions of unincorporated, but sometimes populous land. The number of independent special-purpose governments is an equally distinctive trait of the United States.

Schools are controlled by local school district, whose board is directly elected. Beyond schools, special districts are motley and abundant. They provide services and resources, levy taxes, pace bonds on the ballot, fund, build and operate infrastructures... Board members are elected or appointed, but special districts have a large degree of autonomy, beyond a mere collaboration of general-purpose local governments. A metropolitan area contains many special districts. Absent a register of special districts, determining the count and delineations of existing special districts serving or enclosing a given neighborhood is an Augean task. Communities can find themselves in a myriad different institutional settings: incorporated or not, served by special districts... leaving their identification all the more uncertain.

Federalism. The high degree of local autonomy held by local governments is a major driver in the fragmentation. The United States Constitution protects state rights without saying much about local governments, governed by state law. They are, in effect, largely autonomous. Their effective independence from state government vary from state to state. The optional character of local government creation and ubiquity of elected offices reinforce this sense of autonomy.

States have extensive latitude to set local governments' legal framework. New England municipalities have different powers and typical organization than western municipalities. Western local governments enjoy more autonomy, including in how they wish to organize themselves, and more policy powers. Local diversity of organization add to state-level diversity. In high local autonomy states—*home rule* states—local governments organize freely by adopting a chapter. In states with reduced local autonomy, municipalities enjoy several possible forms of organizations pre-determined by law. Special districts experience considerable diversity of organization.

States are not federations of local governments. However, the institutional architecture of the United States prioritizes local autonomy before centralization. This generates a capacity of adaption to local conditions, but hinders our ability to gain comprehensive information about the functioning of local governments. If cities are generally monitored and controlled by state administration, information about special districts is hard to collect.

Because of this diversity of organizational form, added to the scale of institutional fragmentation, local governments do not provide a good base to identify spatial realities based on social practices, such as metropolitan areas and disadvantaged communities.

4 General research question and hypotheses

Research question

4.1 *How to design policies addressing spaces with no coextensive institution?*

Complexifying social spaces and increased institutional fragmentation have jointly created a situation where numerous spaces of relevance for public policies are at once blurry and devoid of direct institutional instrument. Metropolitan areas and disadvantaged communities are two examples of these spaces. To policy makers, this situation creates an unprecedented quandary. This research project contributes to shedding light on the tactics at use today to delineate theses spaces for policy purposes, and evaluate if a better path can be taken.

In order to do so I formulate three general hypothesis of the research. The hypotheses are of high-order and are developed in specific form in each of the three papers composing this dissertation. The work that follows informs theses hypotheses by focusing on the specific cases of metropolitan areas and disadvantaged communities.

Hypothesis 1

4.2 *Geographic context drives local institutions*

The first general hypothesis of the research can be summarized by *one size does not fit all*. Much of the work on local governance has focused on common traits between different local situations. I make the hypothesis that local specificity is more important than common traits. This hypothesis does not imply that scholars should abandon comparative work, or the quest for shared characteristics. On the contrary, shared methods need to be used to compare local contexts with each other. Commonalities can be found between different local contexts. A comparative toolbox for understanding and comparing local conditions can help bring better policies better than a tentative unifying theory of local governance.

Hypothesis 2

4.3 *Spatial realities are continuous*

Policies addressing the two spatial realities at the center of this research use a binary measure of space. A place is either in a metropolitan area, in a disadvantaged community, or it's not. In the American context of segregation and fragmentation, space has many discrete dimensions. Movements of people and social use of space, however, is more continuous than discrete. By trying to find a univocal, binary measure of social space, these policies create considerable room for bias and exploit, undermining their core objectives.

Hypothesis 3

4.4 *An experimental approach to policy is viable*

Accounting for local contexts to define policies is challenging. Moreover, in a fragmented, federal country like the United States, political paths for policy implementation can appear labyrinthian. We have methodological instruments to understand people's preferences in decision settings. Therefore, beyond observational data, useful to set the stage and inform specific policy hypotheses, experiments involving local residents, voters and policy-makers can contribute productively to shaping effective and befitting policies.

Abbreviations

GIS Geographic Information Systems

MPO Metropolitan Planning Organization

OMB (White House) Office of Management and Budget

References

Andrews, Rhys, George A. Boyne, and Richard M. Walker (2006). "Subjective and objective measures of organizational performance: an empirical exploration". In: *Public Service Performance: Perspectives on Measurement and Management*. Ed. by George A. Boyne. Cambridge University Press, pp. 14–34. ISBN: 9780521859912.

Ansell, C. and A. Gash (2007). "Collaborative Governance in Theory and Practice". In: *Journal of Public Administration Research and Theory* 18.4, pp. 543–571. ISSN: 1053-1858. DOI: 10.1093/jopart/mum032.

Arrow, Kenneth J. (1950). "A Difficulty in the Concept of Social Welfare". In: *Journal of Political Economy* 58.4, pp. 328–346. ISSN: 0022-3808. DOI: 10.1086/256963.

Boehm, Lisa Krissoff and Steven H. Corey (2014). *America's urban history*. Routledge, p. 426. ISBN: 9781317813316.

Briffault, Richard (1996). "The Local Government Boundary Problem in Metropolitan Areas". In: *Stanford Law Review* 48.5, pp. 1115–1171. ISSN: 0038-9765. DOI: 10.2307/1229382.

Burns, Nancy (1994). *The Formation of American Local Governments: Private Values in Public Institutions*. Oxford University Press, USA, p. 208. ISBN: 0195090934.

Chetty, Raj, Nathaniel Hendren, and Lawrence F. Katz (2016). "The Effects of Exposure to Better Neighborhoods on Children: New Evidence from the Moving to Opportunity Experiment". In: *American Economic Review* 106.4, pp. 855–902. ISSN: 0002-8282. DOI: 10.1257/aer.20150572.

Coulton, Claudia J. et al. (2001). "Mapping Residents' Perceptions of Neighborhood Boundaries: A Methodological Note". In: *American Journal of Community Psychology* 29.2, pp. 371–383. ISSN: 00910562. DOI: 10.1023/A:1010303419034.

Dahl, Robert A. (1961). "The Behavioral Approach in Political Science: Epitaph for a Monument to a Successful Protest". In: *American Political Science Review* 55.04, pp. 763–772. ISSN: 0003-0554. DOI: 10.1017/S0003055400125924.

de Souza Briggs, Xavier, Susan J. Popkin, and John Goering (2010). *Moving to opportunity: The story of an American experiment to fight ghetto poverty*. Oxford University Press. ISBN: 978-0195392845.

De Tocqueville, Alexis (1835). *De la Démocratie en Amérique*.

Embree, Frances Buckley (1900). "The Housing of the Poor in Chicago". In: *Journal of Political Economy* 8.3, pp. 354–377. ISSN: 0022-3808. DOI: 10.1086/250679.

Farrell, David M. (2011). *Electoral systems : a comparative introduction*. Palgrave Macmillan. ISBN: 9781137285508.

Fenno, Richard F. (1978). *Home style : House members in their districts*. Longman, p. 304. ISBN: 032112183X.

Fischer, Claude S. et al. (2004). "Distinguishing the Geographic Levels and Social Dimensions of U.S. Metropolitan Segregation, 1960-2000". In: *Demography* 41.1, pp. 37–59. ISSN: 1533-7790. DOI: 10.1353/dem.2004.0002.

Garreau, Joël (1991). *Edge city: life on the new frontier*. en. Anchor Books, p. 580. ISBN: 9780385424349.

Goodchild, Michael F. and Donald G. Janelle (2004). *Spatially integrated social science*. Oxford University Press, p. 456. ISBN: 019534846X.

Gottmann, Jean (1957). "Megalopolis or the Urbanization of the Northeastern Seaboard". In: *Economic geography*, pp. 189–200.

Grodzins, M (1960). "The federal system". In: *Goals for Americans: The Report of the President's Commission on National Goals.* Englewood Cliffs, NJ: Prentice Hall, pp. 74–78.

Jennings, M. Kent and Richard G. Niemi (1975). "Continuity and Change in Political Orientations: A Longitudinal Study of Two Generations". In: *American Political Science Review* 69.04, pp. 1316–1335. ISSN: 0003-0554. DOI: 10.2307/1955291.

Jones, Victor (1942). *Metropolitan government*. Vol. 39. Chicago: University Of Chicago Press.

Kahneman, Daniel and Amos Tversky (1979). "Prospect Theory: An Analysis of Decision under Risk". In: *Econometrica* 47.2, p. 263. ISSN: 00129682. DOI: 10.2307/1914185.

Kawachi, Ichirō. and Lisa F. Berkman (2003). *Neighborhoods and health*. Oxford University Press, p. 352. ISBN: 019974792X.

Kübler, Daniel (2005). *La métropole et le citoyen: les agglomérations urbaines en Suisse vues par leurs habitants*. fr. PPUR presses polytechniques, p. 166. ISBN: 9782880745622.

Lascoumes, Pierre and Patrick Le Gales (2007). "Introduction: Understanding Public Policy through Its Instruments?From the Nature of Instruments to the Sociology

of Public Policy Instrumentation". In: *Governance* 20.1, pp. 1–21. DOI: 10.1111/j.1468-0491.2007.00342.x.
Manin, Bernard (1987). "On Legitimacy and Political Deliberation". In: *Political Theory* 15.3, pp. 338–368. ISSN: 0090-5917. DOI: 10.1177/0090591787015003005.
Metz, Mary Haywood. (2003). *Different by design : the context and character of three magnet schools*. Teachers College Press, p. 268. ISBN: 0807743445.
Nurmi, Hannu. (2012). *Comparing Voting Systems*. Springer Science & Business Media, p. 224. ISBN: 9789400939851.
Office of Management and Budget (2013). *Revised Delineations of Metropolitan Statistical Areas, Micropolitan Statistical Areas, and Combined Statistical Areas, and Guidance on Uses of the Delineations of these Areas*. EN. Tech. rep. Washington, D.C.: Office of Management and Budget, Executive Office of the President, p. 152.
Ostrom, Elinor (1972). "Metropolitan Reform: Propositions Derived From Two Traditions." In: *Social Science Quarterly* 53.3, pp. 474–493.
— (1973). "On the meaning and measurement of output and efficiency in the provision of urban police services". In: *Journal of Criminal Justice* 1.2, pp. 93–111. ISSN: 00472352. DOI: 10.1016/0047-2352(73)90091-3.
Poteete, Amy R., Marco A. Janssen, and Elinor Ostrom (2010). *Working Together: Collective Action, the Commons, and Multiple Methods in Practice*. en. Princeton University Press, p. 370. ISBN: 9780691146041.
Snow, John (1855). *On the Mode of Communication of Cholera*. 2nd ed. John Churchill, p. 162.
Stolle, Dietlind, Stuart Soroka, and Richard Johnston (2008). "When Does Diversity Erode Trust? Neighborhood Diversity, Interpersonal Trust and the Mediating Effect of Social Interactions". In: *Political Studies* 56.1, pp. 57–75. ISSN: 0032-3217. DOI: 10.1111/j.1467-9248.2007.00717.x.
Tiebout, C.M. M (1956). "A Pure Theory of Local Expenditures". In: *The Journal of Political Economy* 64.5, pp. 416–424.
Tversky, Amos (1969). "Intransitivity of preferences". In: *Preference, Belief, and Similarity : Selected Writings*. MIT Press. Chap. 19, pp. 433–461.
Warf, Barney and Santa Arias (2008). "Introduction: the reinsertion of space into the social sciences and humanities". In: *The Spatial Turn. Interdisciplinary Perspectives.* Ed. by Barney Warf and Santa Arias. Vol. 26. Routledge. Chap. 1, pp. 1–10. ISBN: 9781135972677.

Chapter I
THE SPACE OF URBAN LIFE
DELINEATING AMERICAN METROPOLITAN AREAS

The Space of Urban Life: Delineating American Metropolitan Areas

The expansion of urban development beyond central cities during the 20th century has begotten larger integrated urban areas. These metropolitan areas are the functional units of urban life. Many policies, such as housing or transit support programs, are directed to metropolitan areas. Hence, the delineation of these areas has direct consequences on policies.

The US Census defines metropolitan areas as clusters of counties linked together by a high degree of commuting integration. When two counties are part of the same commute pool, they are in the same metro area. In this paper, I test the robustness of this definition and evaluate its fitness for policy purposes.

I use hierarchical clustering to assess how counties group together on the continuous scale of commuting integration, forming metropolitan areas, urban regions, and larger commute sheds.

I find that commuting integration between counties reveal the functional structures of urban America, but does not exhibit a clear threshold that would allow a definite identification of which county is part of which metropolitan area. Furthermore, commuting integration varies geographically inside the United States, following urban settlement patterns. Commuting patterns are different between the urban continuum of the coasts and the isolated urban centers surrounded by rural or desert environment in the Mid-West and the South.

I recommend that studies and policies based on metropolitan areas not rely on a *one size fits all* definition based on commuting integration, but on a metropolitan dashboard, taking into consideration different structural properties of urban clusters.

Policy take-aways

- Commuting ties is a good instrument to understand the structure of metropolitan areas.
- This structure cannot be captured by a single delineation.
- Metropolitan delineations from the OMB are neither internally valid nor robust.
- Metropolitan areas are forming differently in Eastern, Western & Southern United States.
- The *relevant delineation* depends on each policy, and should be a part of each grant application.

Contents

1 *Literature review*

Metropolitan areas have been of growing relevance for public policies over the last decades, because their advent and development is the product of the evolution in how our largely urban societies organize themselves spatially. Metropolitan areas reflect and expose how urban societies use space to function. Because of this interdependence, what happens in a metropolitan area has consequences on all of its residents. In this section, I first expose how the U.S. Census measures and delineates metropolitan areas today. Then, I expose how metropolitan areas have taken the shape and structure they posses today, over the courses of the past century. Finally, I show how relevant this concept is for public policy, and therefore the importance of evaluating the U.S. Census' way of delineating metropolitan areas.

1.1 *Delineating metropolitan areas as functional units*

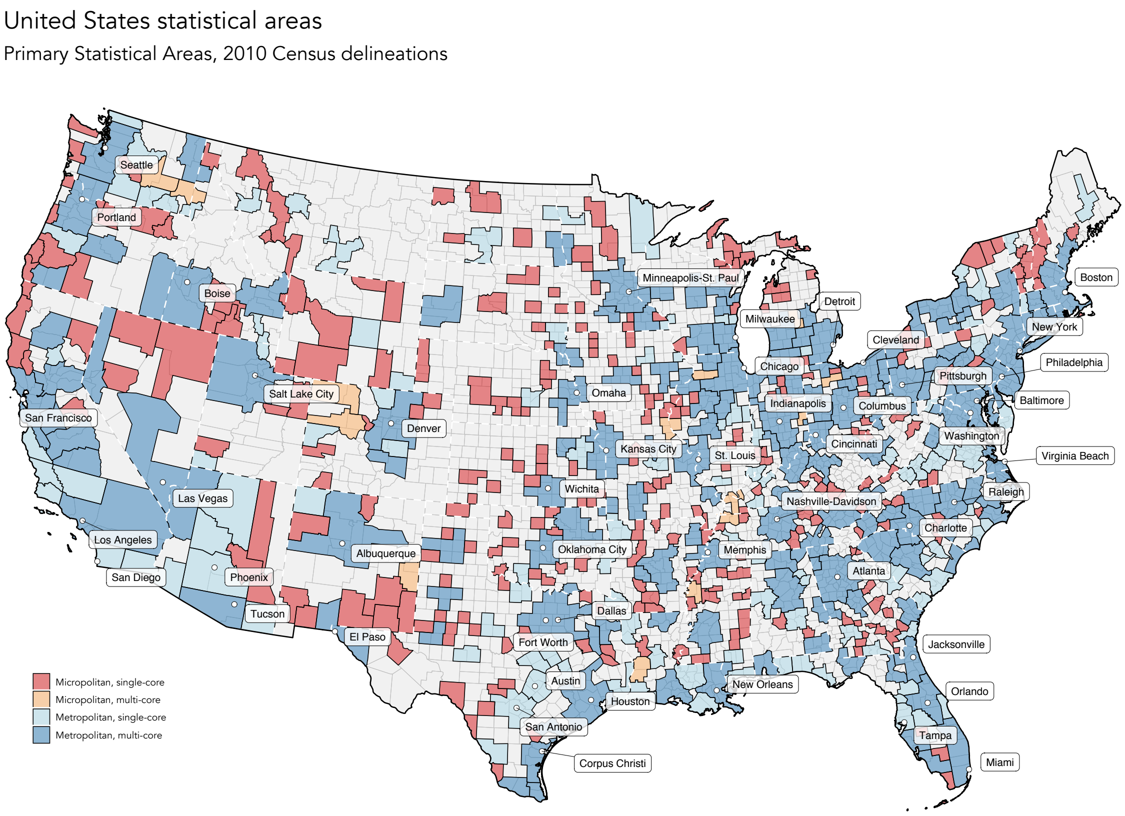

Figure 1: United States Primary Statistical Areas, by type, 2010 Census delineations.

Metropolitan areas are urban areas of strong interdependence between actors (residents, institutions, economic actors...). There are many and frequent exchanges between parts of a metropolitan areas. These exchanges make actions and policies conducted in parts of the metro area relevant to other parts, and to the area as a whole. Actions taken in the metro area have **externalities** for others in the metro area.[1]

[1] Lucas 2001.

For instance, a municipality that plans a large employment area, attracting many jobs, will put the transportation and transit system of the whole region under increased use. Likewise, municipalities that refuse to build housing to accommodate demographic growth put housing markets all over the metropolitan area under pressure, thus creating a regional housing shortage.[2] Industrial specialization creates spatial spillovers that benefit regional innovation and competitiveness, beyond local borders.[3] Roads themselves create externalities that impact congestion and pollution beyond their particular location.[4]

[2] Saks 2008.

[3] A. Marshall 1890; Panne 2004.

[4] Anas and Lindsey 2011.

Actions with strong externalities often create contentious debate in metropolitan areas, and the best course of action to address these externalities is often difficult to foresee. However, the fact that these externalities are real is of little debate. Even the *public choice* school of thought, emphasizing the efficiency of competing local governments, recognizes the importance of externalities,[5] arguing that competition is the most efficient way to address them.

[5] Ostrom, Tiebout, and Warren 1961; Frey and Eichenberger 2004.

The U.S. Census Bureau started to measure metropolitan areas in 1952, using the 1950 decennial census, as "integrated economic area[s] with a large volume of daily travel and communication between the central city or cities and the outlying parts of the area"[6]. Details of the definitions have evolved since then, but the underlying basis has stayed the same, composed of two elements:

[6] Klove 1952, p.96.

1. **An urban core**. A large central city, or a number thereof, is the core of the urban region.

2. **Exchanges between core and periphery**. Interdependence between parts of the region is measured through commuting relationships between center and periphery.

Metropolitan areas are defined at the level of the county, the only level where commuting data is exhaustively collected. Today, county-to-county commuting data is gathered on a sampled, yearly basis by the American Community Survey (ACS), and averaged over several years. Place-to-place commuting estimates are available between large places only. Because the ACS is a sampled survey, it produces uncertainty in measurement estimates. This uncertainty is reduced with the size of the geographic unit of aggregation. Regarding commuting, estimates for larger counties is more certain than for smaller, often rural counties. In fact over the 136 794 county-to-county commuting estimates in the 5-year ACS 2010, only 40 077 have an estimate larger than the margin of error.

OMB's definition of metropolitan areas follows Christaller's *Central Place Theory*,[7] whereby urban geography is understood as a hierarchy of cities and their areas of influence, nested inside each

[7] Christaller 1933.

other, with little or no overlap between centers of the same level. For instance, a large city would exert influence over a whole region, a series of peripheral centers would be centers quarters of this region, and towns and villages would command their immediate countryside. At each level, services and retail serve their respective region. In this model, the main function of cities is to be service centers for an area.[8] The U.S. Census' definition adheres to this concept by defining metropolitan areas as areas directly under the influence of large central cities, as opposed to more rural areas, under looser influence of secondary centers. In his account, and critique, of the continuity of this definition up to today, John Adams exposes how the Census has relied on the same underlying principle over the decades.[9] Indeed, latest standards for metropolitan areas delineations, defined by the White House's Office of Management and Budget (OMB), follow the same structure.[10]

[8] A. Getis and J. Getis 1966, p.220.

[9] Adams, VanDrasek, and Phillips 2013, p.695.

[10] Office of Management and Budget 2010, p.37249.

Urban settlement patterns have evolved and complexified since the first definition of 1950, as I expose hereafter in section 1.2, with metropolitan areas expanding and merging with each other. To account for these evolutions, the OMB has refined its definition, introducing a layer of possible multi-centrality for metropolitan areas. The OMB has now three possible layers of definition:[11]

[11] Office of Management and Budget 2010, p.37249.

Core Based Statistical Area (CBSA) composed of one and only one urban center of more than 10 000 inhabitants, and adjacent counties with a high degree of socio-economic integration as measured by commuting ties. CBSAs themselves are divided in two classes, depending on the population of their urban cores:

- *Micropolitan Statistical Area* with an urban core of more than 10 000 and less than 50 000 inhabitants.
- *Metropolitan Statistical Area* with an urban core of more than 50 000 inhabitants.

Combined Statistical Area (CSA) combining adjacent CBSAs with a high degree of socio-economic integration as measured by commuting ties between themselves.

Primary Statistical Area (PSA) are a composite class composed of CSAs and all CBSAs that have not been combined in CSAs. PSAs represent the highest level of metropolitan integration for each county.

1.2 *Metropolitanization since the 20th century*

The urban fabric of the United States looks very different today that it did in the 19th century. During the 20th century, the United States have evolved from a clear separation between small rural places living from agriculture and large industrial cities to a realm of poly-centric metropolitan areas.[12] As I have shown in section 1.1, however, the official definition of metropolitan areas has hardly budged to adapt to new metropolitan realities. I trace the evolution

[12] Oliver 2001, p.35.

of metropolitan areas in four periods, from 1870 to today: streetcar suburbs, the advent of the automobile, the diffusing city, and merging metropolises. Each period, roughly delimited in time, corresponds to variations in mobility and commuting practices, opening different spatial opportunity for residential location and economic development. Although less dramatic than the variations in commuting, each period corresponds to different institutional organizations and local governance patterns.

FROM 1870 TO WORLD WAR I, URBAN RAIL TRANSIT EXPANDS THE INDUSTRIAL CITY. From the beginning of the 19th century to 1870, the industrial revolution has fed the growth of American cities as large centers of employment and economic activities.[13] Lack of transportation meant that workforce and industries had to be co-located in dense, compact cities. This co-location constraint fell with the advent of urban rail transit, from 1870 onward. Streetcars and other urban railways started a "reverse exodus"[14] of suburbanization, initiating a wave of "streetcar suburbs".[15] Thanks to rail transit, it was now possible to live relatively far away from employment centers, industrial or commercial, and *commute* between places of residence and places of work. Cities stayed heavily mono-centric, but residential neighborhoods spilled further away from the center, as wealthier residents were able to afford suburban houses around rail corridors.

[13] Olson 2002.

[14] Z. L. Miller 1968.

[15] S. Warner 1962.

A series of mono-graphic works recount this process, repeated in many large American cities, such as Boston,[16] or Cincinnati.[17] Even Los Angeles, considered in the second half of the 20th as the epitome of the car-oriented city, expanded heavily around the streetcar network.[18]

[16] S. Warner 1962.

[17] Z. L. Miller 1968.

[18] Fogelson 1993; Wachs 1984.

Politically, the first wave of suburbanization corresponded to a rise in *municipal incorporation*, the formation of new local governments to manage newly developed land.[19] New municipalities were mainly formed to provide services to newly suburban residents.[20] The increased social segregation between suburbs and city centers opened the door of central city politics to urban bosses, at the head of political machines.[21]

[19] Teaford 1979.

[20] Burns 1994.

[21] Z. L. Miller 1968; Stave et al. 1988.

Entering into World War I, Americans were mostly living either in small rural places or mono-centric industrial cities.[22]

[22] Wallis 1994a.

IN THE INTER-WAR PERIOD, THE ADVENT OF THE AUTOMOBILE. The increased availability of individual automobile reinforced the movement of suburbanization around industrial cities in the inter-war period. Americans transitioned from a rail commute to a car commute but, before freeways could drastically change their mobility habits, cars essentially reinforced trends started during the streetcar suburbs expansion. The economic boom of the 1920s, preceding the great depression, fueled urban demographic growth as nascent car congestion started to trigger a decentralization of economic activities.[23] Road patterns started to adapt to individual

[23] Wachs 1984.

cars, with cul-de-sacs and other discontinuities, and be less oriented to pedestrian traffic around public transit.[24] The 1920s are a pivotal period, prolonging the suburbanization movement initiated by rail transit, while adapting the urban fabric to a more diffuse, less hierarchical organization fitting individual car mobility.

[24] Barrington-Leigh and Millard-Ball 2015.

In the post-war period, the era of the freeway and the diffusing city. It it only after the war that cities begin to change drastically in response to the automobile. Specifically, the Federal Aid Highway Act of 1956, that oversaw the construction of the 41 000 miles-long Interstate system in the United States, caused a diffusion of development further away from city centers.[25] This diffusion concerned not only residential development, but also economic activities, de-concentrating from city centers to spread along freeways in metropolitan areas.[26]

[25] Baum-Snow 2007.

[26] Gordon and Richardson 1996; Bogart and Ferry 1999; Lang and LeFurgy 2003.

Politically, this diffusion of development caused a partisan polarization, between Democratic central cities and Republican suburbs.[27] In conjunction, the incorporation movement of new municipalities did not slow down. With the adoption of the civil rights act of 1964, outlawing most obvious means of racial spatial segregation, land use, and the control over incoming population that land-use regulation provides, has become the primary motivation for new municipal incorporation, along with tax optimization.[28] Alongside continued fragmentation of general purpose local government, the post-war era has witnessed the explosion of single-purpose and multi-purpose policy special districts.[29]

[27] Nall 2015.

[28] Burns 1994.

[29] Burns 1994; Stephens et al. 1998.

From the 1990s to today, merging metropolises and urban renewal. The 1990s and, more markedly, the beginning of the 21st century have seen a renewal of interest for central cities, following a movement of *gentrification* that pushed young elites back to dense and central environments. Concurrently, however, metropolitan areas have accentuated their diffusion beyond the central city / suburb dichotomy into loosely hierarchical networks of places. The reinforcement of this metropolitan networks dimension has a double engine, both fueled by the expansion of mobility.

On the one hand, places in an ever-expanding metropolitan area cease to cede precedence to central cities to acquire a role of their own. Metropolitan areas are redundant networks where the disappearance of a node, the central city or the historical downtown thereof, would only marginally impair the capacity of the network to function.

On the other hands, expanding metropolitan areas are merging with each other. This phenomenon is visible in San Antonio and Austin, Texas, where municipalities between the two central cities are experiencing a strong growth, both in population and in economic development, linking the two areas in a single metropolitan continuum.

The structure and functioning of American metropolitan areas have changed significantly since World War II. Metropolitan areas have greatly expanded and become less hierarchic and centralized, with a diffusion of development, both demographic and economic. This diffusion has brought a decline in the relative importance of central cities. Metropolitan areas can now be understood as an urban area of local interdependence, rather than the hierarchical area of influence of a single central city. The bulk of the demographic growth has happened in small municipalities or unincorporated communities in large urban environments revolving around multiple urban cores.[30] The relative demographic importance of big cities in these areas has been continuously diminishing, while the number of municipalities was increasing. The upscaling of these areas has created a spatial institutional pattern of fragmentation. People are scattered into many different political entities—incorporated places, counties, states—and are mobile between these places. However, the OMB still bases its definition of metropolitan areas on the old *Central Place Theory* model. This discrepancy between how metropolitan have evolved and how they are still measured motivates an evaluation of the current definition's validity.

[30] Wallis 1994b; Jackson 1985.

1.3 *Policy relevance and current progress in the understanding of the metropolitan reality*

Changes in the structure of metropolitan areas have prompted policy makers to recognize the policy-relevance of the metropolitan scale, therefore triggering an endeavor to imagine ways of governing metropolitan policies. In turn, this public administration effort to define ways of governing the metropolis has conducted scholars to develop better instruments of understanding and delineating metropolitan realities.

POLICY RELEVANCE OF METROPOLITAN AREAS Because of their growing significance as the unit of everyday social life, metropolitan areas have been a flourishing focus of federal and state policies since the post-war period. In 1960, Connery & Leach counted nine main policy areas of action for the federal government targeting metropolitan areas: housing, water resources, water pollution control, airports, military installations and defense industries, civil defense, highways, air pollution control and recreation.[31] The shift in focus from cities to metropolitan areas resulted from an acceleration of suburban growth, resulting in more metropolitan externalities and rendering large central cities less relevant to address urban problems comprehensively. Housing aid and planning grants have been the first policies to explicitly target metropolitan areas.[32] Since the end of the cold war, civil defense and military installations have phased out and transportation, environmental and social justice programs have intensified, both from federal and state governments.[33] In a federal country like the United States, with a

[31] Connery and Leach 1960.

[32] Gelman 1959.

[33] Lewis and Sprague 1997; Barbour 2002.

large degree of local autonomy and little means to force collaboration or consolidation, these programs often come in grants. The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, especially, has accelerated the role of Metropolitan Planning Organizations (MPO) in the planning, funding and grant funneling in metropolitan areas.[34] Most of metropolitan planning and funding organizations, however, are policy-specific and do not constitute general-purpose governments. Adams et al. give an extensive and diverse list of federal use of metropolitan areas' delineations for federal policy purposes.[35]

[34] Goldman and Deakin 2000.

[35] Adams, VanDrasek, and Phillips 2013, p.702.

Governing metropolitan areas Existing local governments as well as state and federal governments have implemented new institutional instruments to address metropolitan policy issues, but with little exception, no general-purpose new layer of government has been created. The description of metropolitan areas as "legal non-entities", recognizing that "the people of a metropolitan region have no general instrumentality of government available to deal directly with the range of problems which they share in common", made by Ostrom, Tiebout & Warren in 1961 is as valid today as it was then.[36] This fragmentation has even intensified, with the incorporation of new municipalities,[37] largely within metropolitan areas, in order to perform fiscal optimization[38] or control who can live in one place via land-use regulations.[39] In addition to new municipalities, special purpose institutions have been created to address a single policy issue or a limited set thereof. Special districts, in particular, to fund and manage infrastructure and service provision.[40] Special districts are independent institutions of various shape, sometimes able to levy their own taxes, with a board directly elected by the population or appointed, in charge of missions as varied as airports, mosquito control, transit operation, or water supply. Local governments can also create a formal entity to exercise their powers in common in certain areas. States have different frameworks to do so. In California, Joint Powers Authorities serve this purpose.[41] Informal cooperation between local governments is also very present in the United States, especially in areas where municipalities have most of the power, like police, fire, or roads.[42] At last, states and federal governments sometimes mandate intergovernmental institutions be created to funnel and implement state programs locally, often with the goal to foster local coordination beyond state programs only. Metropolitan planning organizations, for instance, are federally mandated organizations interacting with states and federal governments in planning, often applying to and channeling grants.[43]

[36] Ostrom, Tiebout, and Warren 1961.

[37] Teaford 1979; G. J. Miller 1981.

[38] Rodriguez 2000.

[39] Burns 1994.

[40] Burns 1994; Stephens et al. 1998.

[41] Cypher and Grinnell 2007.

[42] Bel and M. Warner 2015.

[43] Lewis and Sprague 1997; Goldman and Deakin 2000.

The quest for a fitting metric The growing relevance of metropolitan areas for public policies, joined with the stability of its measurement in the past decades has conducted scholars to re-examine the standard definition. Many of these studies are conducted outside of the United States. As metropolitan areas' definition is based on common standards, their methods are equally applicable in the United States. These endeavors to better measure the metropolitan reality have taken two forms. One is to go beyond commuting data to find other measures of social use of space. The other is to go back to commuting data and propose a more robust treatment of the data.

The first approach recognizes metropolitan areas as the place of society's *daily routine* but criticizes the use of commuting data, either as being insufficient or as being unnecessarily complex. A major critique of commuting data is that it only captures journey to work, excluding all other forms of mobility or communication,[44] or workers that do not have a regular commute, such a mobile workers for instance.[45] Bode proposed to use land-prices to use the fraction of land prices attributable to agglomeration effects to measure metropolitan areas, applying it to Germany.[46] Adams et al. argue that population density alone is a good measure of metropolitan areas.[47]

44 Lofland 1975.

45 Pratt 1997.

46 Bode 2008.

47 Adams, VanDrasek, and Phillips 2013.

Karlsson & Olsson summarize the second approach as based on a "high frequency of intra-regional interaction", as measure by local labor market, commuting ties or accessibility.[48]Lastly, Dash Nelson & Rae have attempted to delineate "megaregions" by optimizing *modularity* in the network of commutes between census tracts.[49] Modularity is the property of groups of nodes in a network to have denser connections inside groups than between groups.[50]

48 Karlsson and Olsson 2006.

49 Dash Nelson and Rae 2016.

50 Newman 2006.

Using commuting data poses an external validity question. Is commuting a good indicator of social use of space in general, since we want want to capture people's daily routine? Commuting patterns are strongly linked to urban form.[51] Journey to work is a good indicator of other routine mobility—retail, everyday leisure, family and social—but not necessarily of occasional mobility, where residents of dense urban centers also tend to have longer distance occasional mobility (day trips and overnight trips).[52] It appears that commuting is indeed a good proxy for routine mobility and for social use of space in general, either as a product of a correlate of other variables of interest.

51 Stead and S. Marshall 2001; Giuliano and Narayan 2003; Ewing and Cervero 2010.

52 Munafò 2015.

2 *Research question*

In section 1 I have reported that official OMB's definitions of statistical areas dates from the 1950s and has scantly changed since. Metropolitan areas themselves, however, have evolved considerably, expanding in area and growing in complexity. This has prompted scholars to propose new methods of delineation. Nonetheless, the quest for a better metropolitan metric should start by a thorough assessment of the strength and shortcomings of the current one. Relying on robust metropolitan delineations is important to provide a solid framework to the on-going and unsettled debate about metropolitan governance, as well as for the numerous federal and state policy programs directed at metropolitan areas.

2.1 *How valid is OMB's definition of metropolitan areas?*

I first aim to **assess the validity and robustness of the current definition of metropolitan areas**, based on commuting ties between places. Since external validity of using commuting as a metric has been established, by correlation with both urban form and other forms of routine mobility (see 1.3), I will focus on **internal validity of the commuting metric**. That is, using county-to-county commuting relationships, can the OMB effectively delineate robust clusters of counties using their method? Robustness is the property of a measure to cope with errors. In this context, a robust measure is a method able to correctly portray metropolitan areas regardless of the imprecision contained in the commuting data. I use a comprehensive clustering of counties with multiple methods an compare my results with OMB's delineations.

2.2 *Can we create a better measure of metropolitan areas?*

In a second time, based on the assessment of OMB's official definition, I seek to **propose a more robust delineation method, based on the same commuting data**. Using commuting data, can we find a more robust and internally valid delineation method? Construction of a new potential metric stems from an examination of the structural properties of metropolitan areas, as revealed by commuting ties between counties. In particular, the proposed metric interrogates a series of given properties of OMB's metric: the predefinition of an urban core as a way to seed county clustering in urban ensembles, uniform nation-wide commuting threshold, type of clustering and its interpretation to understand metropolitan functional structuring, and even the relevance of a single metric, as opposed to an array of different measures to be used in conjunction.

3 *Methods*

In order to assess the robustness of the OMB's definition, I evaluate the stability of the original metric: county-to-county commuting relationships. First (3.1), I run a series of clustering algorithms on the network of commute relationships to gage how counties cluster together at different scales. Second (3.2), I calculate cumulative statistics of aggregation along the dimension of commuting strength to determine if there is a natural, obvious cutoff point that could serve as a threshold for determining which clusters form natural aggregates that would be good candidates for delineating metropolitan areas. Lastly (3.3), I evaluate if the clustering of counties along commuting ties strength behaves homogeneously over the contiguous United States, in order to assess the relevance of using a unique definition for the whole country.

3.1 *Hierarchical clustering of counties by commuting ties*

Metropolitan areas are, in the current definition used by the OMB, clusters of counties linked by strong socio-economic ties as demonstrated by commuting relationships. I scrutinize the foundation of this definition by studying how counties cluster together based on commuting statistics. The data comes from U.S. Census 2009-2013 5-Year ACS. Because the ACS is a sampled survey (see 1.1), estimates of commuting flows have large margins of errors for small counties. I address this uncertainty conservatively, by subtracting the margin of error from the estimates to calculate a strict estimate. I discard commuting relationships where the margin of error is greater than the estimate. The resulting data is a graph, where nodes are counties and edges commuting ties between them. I weigh each edge relative to the proportion of the total number of county's commuters going to work in linked county. The graph is directed. The commuting link from county A to county B is the proportion of the total number of commuters from county A (including internal commuters of the county, living and working in the same county) going to county B.

I use four different clustering methods, selected for their interpretability regarding metropolitan areas: single, complete, average and combined linkage. Single, complete and average linkage clustering are well-documented methods of hierarchical clustering.[53] These three methods follow the same principle, and vary by the computation of distances between clusters. With combined-linkage I extend these methods to the case where the measure of distance between clusters can be recalculated by pooling together base units of each cluster, in this case commuters. These four methods share two important characteristics:

[53] Everitt 2011, p.73-84.

Deterministic Running the algorithm multiple times on the same data will produce the exact same result. There is no element of random sampling or other stochastic element in the calculation of clusters.

Hierarchical The algorithm constructs a hierarchy of clusters, whereby higher order clusters are composed of multiple lower order clusters merged together. At the bottom, each individual node is a cluster and at the top, there is only one cluster. Results can be represented as a **dendrogram**, displaying the hierarchical structure of clusters. The hierarchical nature of these methods allows me to test if there is a natural threshold in commuting to delineate clusters.

Agglomerative The clustering hierarchy is constructed from the bottom-up. At the beginning, each node is its own cluster and at each step of the process, two lower order clusters are merged into one higher order cluster until there is only one cluster comprising all nodes. This is by contrast with *divisive hierarchical clustering*, where the process starts with a single cluster containing all the nodes that is at each step divided into lower order, smaller clusters.

These four methods originate in hierarchical clustering of multi-dimensional spaces. In such spaces, one can produce a *dissimilarity matrix* measuring the distance between any two objects within the space. Weighted graphs, such as the graph of county-to-county commuting relationships, are simply a specific case wherein the dissimilarity matrix is sparse. In this case, some pairs of objects have a distance, when they are linked by an edge in the graph, and others do not. Moreover, because the county-to-county commuting graph is directed, the distance matrix is not only sparse but also asymmetric. That is, the distance between county A and county B is different in the matrix from the distance from county B to county A, because the proportion of commuters they send to each other is different. The distance matrix that I use for the clustering is directly inferred from commuting relationships and composed of direct county-to-county relationships only. The distance of A to C, for instance, is only the proportion of total commuters from A commuting to C and does not include indirect relationships like A to B and B to C.

I adapt these four clustering methods to the specific case of sparse, asymmetric matrices, using a generalization of Kruskal's algorithm.[54] These four methods follow the same algorithm, illustrated by figure 2. Compared to the classic implementation of Kruskal,[55], this implementation recalculates distances between clusters at each iteration. The only difference between each method is the metric used to compute the distance between two clusters.

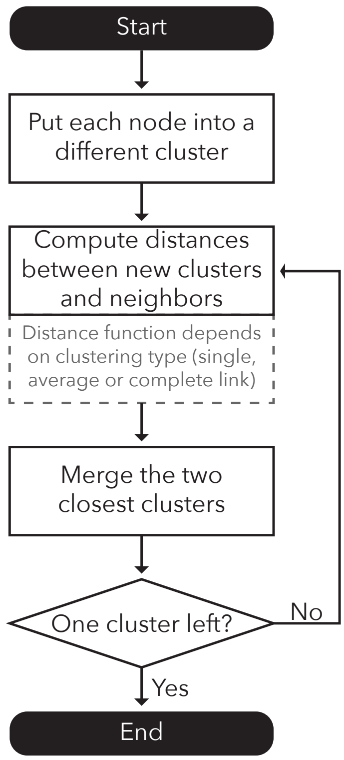

Figure 2: Clustering Algorithm

[54] Kruskal 1956.

[55] Cormen 2009, p.631.

Starting with each node—each county—being its own cluster of one element, the algorithm merges two clusters into one at each step of the process. In the end, clusters are reduced to one single cluster composed of all original nodes. At each step, the merge occurs between the **two clusters that are the closest to each other**. However, the way of measuring how close clusters are differs for each of the four methods, and induces a different interpretation in regards to metropolitan areas.

For single, average and complete linkage, the algorithm produces a minimum spanning tree,[56] because it is guaranteed that edges of later iterations are longer than edges of earlier ones. Combined-linkage, however, is not guaranteed to yield a minimum spanning tree. For single, average and complete linkage, distances between clusters are computed from distances between nodes in the clusters, such as distances in a later iteration are always higher than distances used for earlier merges. However, combined-linkage recalculates distance between clusters by pooling together all the commuters of each cluster, as if, once merged in a cluster, counties lost their identity. Because the distance between clusters is a proportion of commuters and not an absolute count value, distance between clusters at later iterations can sometimes be lower than distances at earlier ones.

[56] Gower and Ross 1969.

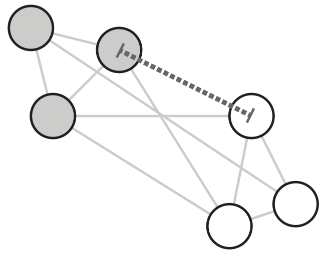

Figure 3: Single-Linkage Clustering

The distance between two counties in the space of county-to-county commuting relationships is formulated as:

$$d_{N\to M} = \frac{\sum [N \to M]}{\sum [N \to X]}$$

The distance from county N to county M is the proportion of the total number of commuters from county N—X, including commuters staying in county N—commuting to county M.

SINGLE-LINKAGE CLUSTERING This method favors **proximity between immediate neighbors in the graph**. Distance between two clusters is equal to the distance between the two closest nodes of the clusters, as shown by figure 3. Applied to commuting, single linkage emphasizes **continuity of commuting relationships** in the metropolitan area, at the expense of internal cohesion. Using single linkage, it is possible that some counties in the same cluster have little to no relationship as measured by commuting. They are clustered together because there is a chain of such tight relationships between them. County A is linked to county B, in turn linked to county C. In this case, counties A and C can be in the same cluster even if they do not send commuters to each other.

$$d_{A\to B} = \min \{d_{N\to M} | N \in A \wedge M \in B\}$$

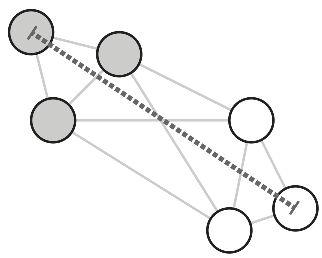

Figure 4: Complete-Linkage Clustering

COMPLETE-LINKAGE CLUSTERING This method favors **proximity of all members of a single cluster**. Distance between two clusters is measured by the distance between the two elements that are the farthest apart from each other, as illustrated by figure 4. For our purpose, complete linkage emphasizes **internal cohesion** of metropolitan areas, to the expense of continuity. For instance, it is possible that two counties having close socio-economic ties are separated in two distinct clusters because other counties in their clusters are too far apart in the measurement of commuting relationships. Furthermore, complete-linkage indicates **specificity** in the relationship between two clusters, because the overall distance between two clusters is measured as the distance between the weakest relationships of nodes of both clusters.

$$d_{A\to B} = \max \{d_{N\to M} | N \in A \wedge M \in B\}$$

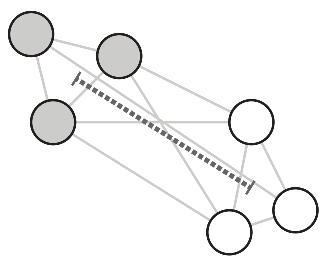

Figure 5: Average-Linkage Clustering

AVERAGE-LINKAGE CLUSTERING Distance between two clusters is measured as the mean distance between any two nodes of each cluster, as shown by figure 5. Therefore, this method is a trade-off between internal cohesion and immediate proximity. Average-linkage takes counties as the base unit of distance computation, and not directly commuters inside these counties. In the average distance, each county has the same weight, regardless of its size or number of commuters. Distance is **unweighted** in regards to the number of commuters in each county.

$$d_{A\to B} = \frac{1}{n} \times \sum^{n} \{d_{N\to M} | N \in A \wedge M \in B\}$$

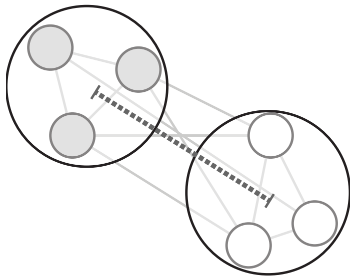

Figure 6: Combined-Linkage Clustering

COMBINED-LINKAGE CLUSTERING Distance between two clusters is recalculated every time from the aggregation of properties of each node in the clusters, as if nodes in each clusters were merged together, illustrated by figure 6. By contrast with single, complete and average linkage, combined linkage is not guaranteed to produce a clustering that is linear in regards to the measure of distance. That is, merges happening later in the process can be between clusters that, with their recalculated distance, are **closer to each other** than previously merged clusters. This cannot happen with the other three methods. Thus, this method reveals relationships between **groups of counties considered as whole**.

$$d_{A\to B} = \frac{\sum [A \to B]}{\sum [A \to X]}$$

CLUSTERING STRUCTURE These four methods produce different types of clustering structures. At each step, this structure is best summarized by the **balance** of the merge. I expand the concept of balance from weight-balanced binary trees (WBTs).[57] In WBTs, balance is calculated from the size of each sub-tree attached to a node. I replace the size of sub-trees by total weight in number of commuters of each cluster. Therefore, balance measures the difference in total number of commuters originating from each of the two merged clusters. A merge of two clusters of identical size will be perfectly balanced, like a merge of two densely populated part of a metropolitan area. A merge between clusters of very different population will have a low balance, like a single peripheral county being aggregated to a cluster of central, urban counties in a metropolitan area. The balance $B_{\{N,M\}}$ of a merge between clusters N and M of respective population P_N and P_M is measured as:

[57] Nievergelt and Reingold 1973.

$$B_{\{N,M\}} = 1 - \left(\left(\left| \frac{P_N}{P_N + P_M} \right| - 0.5 \right) \times 2 \right)$$

A perfectly well balanced merge will have a balance value of 1 and un-balanced merges tend to 0.

3.2 *Identifying ranges of stability in the clustering for threshold validation*

In a second time, I evaluate the presence of an internal natural cutoff point in county-to-county commuting relationships. Such a cutoff could serve as an internally valid threshold to identify metropolitan areas. I approach the threshold in two different ways.

GLOBAL STABILITY. A global threshold is a value of commuting strength that can be used to delineate metropolitan areas uniformly in the United States. To ensure that such a threshold is robust and internally valid, it must be an **area of stability in merges along the domain of commuting strength**. The OMB sets this threshold at 15%, without justifying this arbitrary choice. To test for the presence of areas of stability in the data, I compute the cumulative count of merges along the domain of commuting strength and identify the rate of change in the count at each point. Areas of stability that would be valid candidates for a nation-wide threshold are areas where the rate of change is close to or at zero. I perform this analysis on for all four clustering methods.

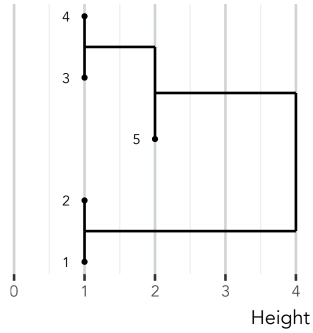

Figure 7: Individual cluster stability

Local cluster stability. The objective to find an internally valid threshold of commuting strength serves to identify a good delineation criterion for metropolitan areas. Such a threshold, however, does not need to be universal. Beyond regional variations that I examine in 3.3, each cluster has its own **stability** value. Individual cluster stability measures how long a cluster stays stable before being merged with another cluster. Therefore, cluster stability is measured by the difference between the commuting level that creates the cluster by merging two lower-order clusters, and the commuting level that will see the cluster disappear, merged in another, higher-order cluster. Figure 7 illustrates individual cluster stability. In the figure, 5 nodes hierarchically cluster into one, from a height of 1 to 4. The cluster {1, 2} formed by nodes 1 & 2 forms at a height of 1, and is merged with another cluster at a height of 4. The cluster has a stability of 3 (4 − 1). By contrast, nodes 3 & 4 also cluster together at 1. But the cluster they form is less stable, because it merges with another cluster at height 2 (merging with node 5, to form another, distinct cluster). Therefore, the stability of cluster {3, 4} is of 1.

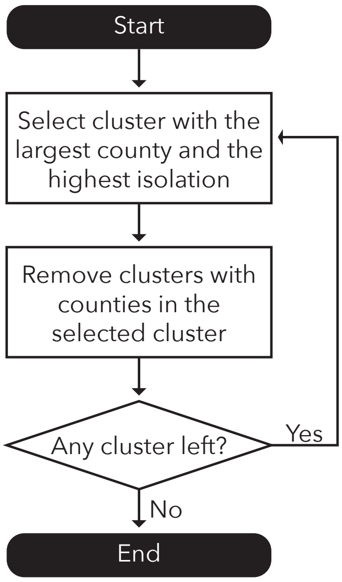

Figure 8: Identification of metropolitan areas by optimizing cluster stability

After having identified the clustering method producing clusters that are closest to what is usually understood as metropolitan areas, I select clusters based on their population and stability as **metropolitan areas**, following the algorithm described in figure 8. The process starts with all possible clusters in the hierarchical tree. For instance, the example of figure 7 has 4 different clusters: {1, 2}, {3, 4}, {3, 4, 5} & {1, 2, 3, 4, 5}. The algorithm first selects the most stable cluster containing the most populous county (for contiguous United States, Los Angeles County, CA). With this cluster selected as the metropolitan area of this county, the algorithm then removes all remaining clusters containing members of the selected cluster. The removal step is crucial to ensure that no overlapping clusters are selected as metropolitan areas. This process is repeated as long as there is still clusters that have not been either selected or eliminated in the list. In this case, it would select the most stable cluster containing the second most populous U.S. county, Cook County, IL, containing Chicago. This process leaves a number of isolated counties, that are not part of any selected stable cluster. These counties are more stable isolated than they are clustered.

3.3 Variations of clustering between regions of the United States

Third, I study how structural properties of clusters, balance and stability, vary geographically. Specifically, I search for regional differences. Are clusters more balanced in a given region of the United States than the other? Is there a more robust commuting threshold by region than at the nation-wide level?

Urban settlement patterns vary geographically in the United States, for historical, cultural, topographical and climate reasons. Variations in settlements may correspond to variations in commuting patterns as well, therefore influencing clustering structures. For instance, the urban continuum of the Northeastern United States has been described by Jean Gottman in 1957.[58] John Rennie Short describes this large ensemble of 45 M inhabitants from Boston to Washington D.C. as "liquid",[59] without clear internal borders. On the other hand, in the MidWest, Texas and part of the South, major cities are isolated from each other by large areas of rural or desert land. The non-coastal West is divided by expansive mountain ranges, oriented North-South, and deserts, impending possible continuities between urban settlements. The Pacific Coast comprises a number of large cities, from Seattle in the North, to San Diego in the South, and alternates large population centers sometimes composed of multiple urban cores with vast rural areas.

[58] Gottmann 1957.

[59] Short 2010.

In a first approach, I test if these regional ensembles can be identified by the clustering data, looking at the last steps of each clustering process. In these last steps, counties have largely clustered together in a limited number of large clusters. I assess if these clusters correspond to regional ensembles.

In a second time, I test if structural measures of clustering, balance and stability, differ significantly between clusters of different regions of the United States. For instance, it could be expected that region with isolated cities, such as Texas, have more stable metropolitan clusters. Once the limit of the urban region reached by the clustering algorithm, the cluster is stable for a longer range of commuting values before merging with another cluster. In the North-East, clusters are expected to be less stable, continually merging until encompassing the whole "Megalopolis".

4 Results

4.1 Hierarchical clustering reveals structures of urban America

To illustrate differences between clustering methods, I take the example of the San Francisco Bay Area, displayed in figures 9 to 13. The Bay Area is illustrative because it is a large, multi-polar metropolitan area, revolving around San Francisco and Oakland on the one hand, and San Jose and the Silicon Valley on the other hand, with multiple, smaller urban centers spread along 100 miles from North to South. The San Francisco Bay Area is also close, and closely linked to, the greater Sacramento in the North-East. Furthermore, as the Bay Area experiences an important economic and demographic growth, its extension beyond the Diablo mountain range deep into the central parts of the California Central Valley, around Stockton and Modesto, is often mentioned. Topographically, however, there is a stronger continuity between Sacramento and the rest of the Central Valley. Hierarchical clustering sheds light on the functional relationships between counties in the Bay Area.

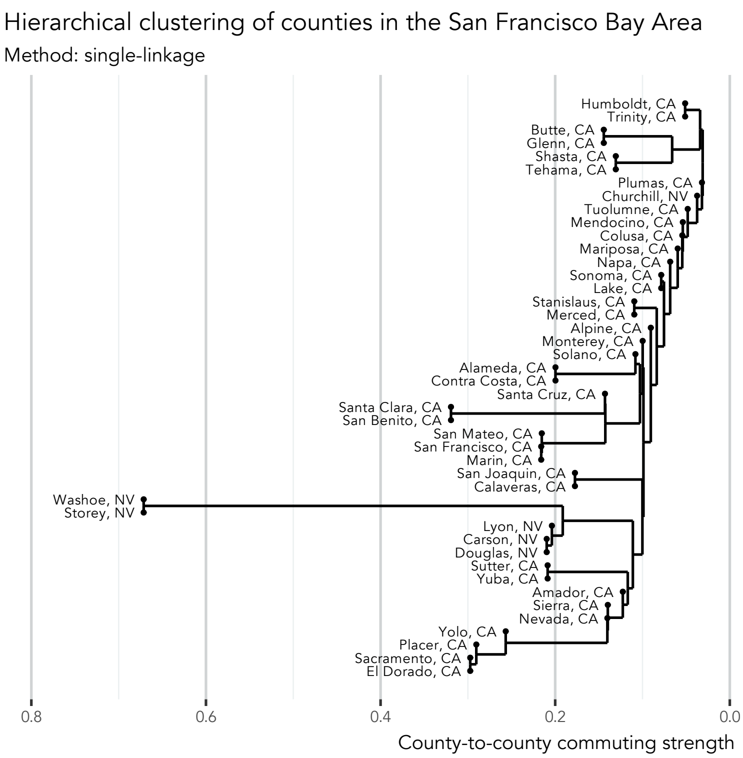

Figure 9: Hierarchical clustering of counties in the San Francisco Bay Area, single-linkage

Figure 9 shows the clustering of Bay Area counties with the single-linkage method. Single-linkage emphasizes continuity and chains of commuting relationships. As expected, figure 9 exposes three distinct phases of clustering. First, urban counties like San Francisco, San Mateo, Marin (Peninsula and West Bay cluster), or Alemeda and Contra Costa (East Bay cluster), or Santa Clara and San Benito (Silicon Valley cluster), agglomerate into urban core clusters of relatively limited size. In a second phase, these urban clusters merge together, attracting in the process a number of suburban counties, forming what we usually mean at the Bay Area. In a third phase, the Bay Area merges with the greater Sacramento, and together they progressively, linearly agglomerate a number of suburban and rural counties around them.

Complete-linkage, in figure 10, comes in stark contrast with the previous description of single-linkage clustering. Local clusters of the West Bay (San Francisco and Marin) and the Peninsula and Sil-

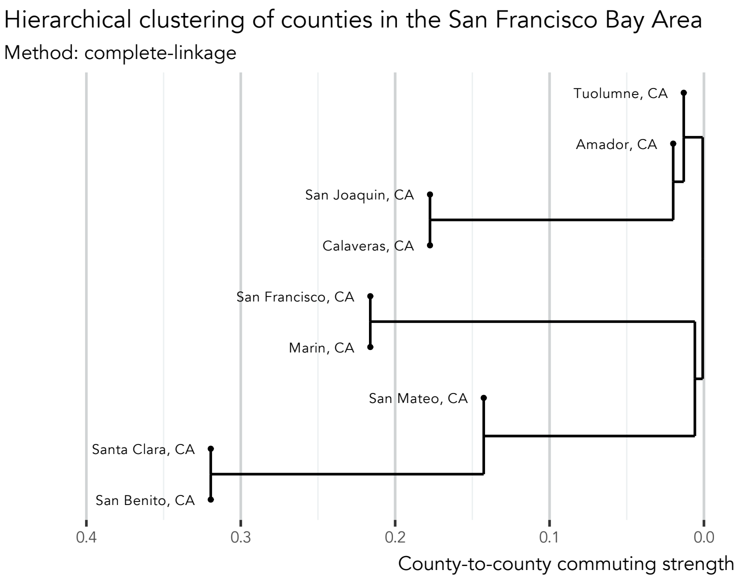

Figure 10: Hierarchical clustering of counties in the San Francisco Bay Area, complete-linkage

icon Valley (Santa Clara, San Benito & San Mateo) merge together relatively late, and cluster with part of the Central Valley around Stockton (San Joaquin, Calaveras, Amador & Tuolomne). East Bay (Alameda, Contra Costa) and North Bay (Napa, Solano) counties do not merge with other part of the Bay Area until the very last merge event. In the San Francisco Bay Area, complete-linkage demonstrate that the three ensembles of San Francisco-Marin, East Bay, and Silicon Valley function relatively independently. Revealing commuting relationship specificity, complete-linkage also reveals the connection between the Bay Area and part of the Central Valley.

The way complete-linkage highlights specificity is particularly visible when examining clustering around large cities in Texas (figure 11). Each large city—Houston, Dallas, Fort-Worth, San Antonio, Austin and Corpus Christi—is in its own cluster. Texas is a revealing case for complete linkage because the state is formed of numerous large cities with sprawling suburbs and rural, arid regions in between them. Two pairs of cities, Dallas and Fort Worth on the one hand, San Antonio and Austin on the other hand, are close to each other and often portrayed as *twin cities*, especially for Dallas and Fort Worth. Complete-linkage reveals the specific zone of influence of each member of the pair. San Antonio and Austin each command long, continuous bands of hinterland. Counties immediately in between the two cities—Hayes, Comal & Guadalupe—exhibit an attachment to the more distant Houston. By contrast with San Antonio and Austin, Dallas and Fort Worth display an intertwined, tiled influence over surrounding counties and large parts of the region around them independently cluster into a third, suburban group of counties. Moreover, complete-linkage also reveals network

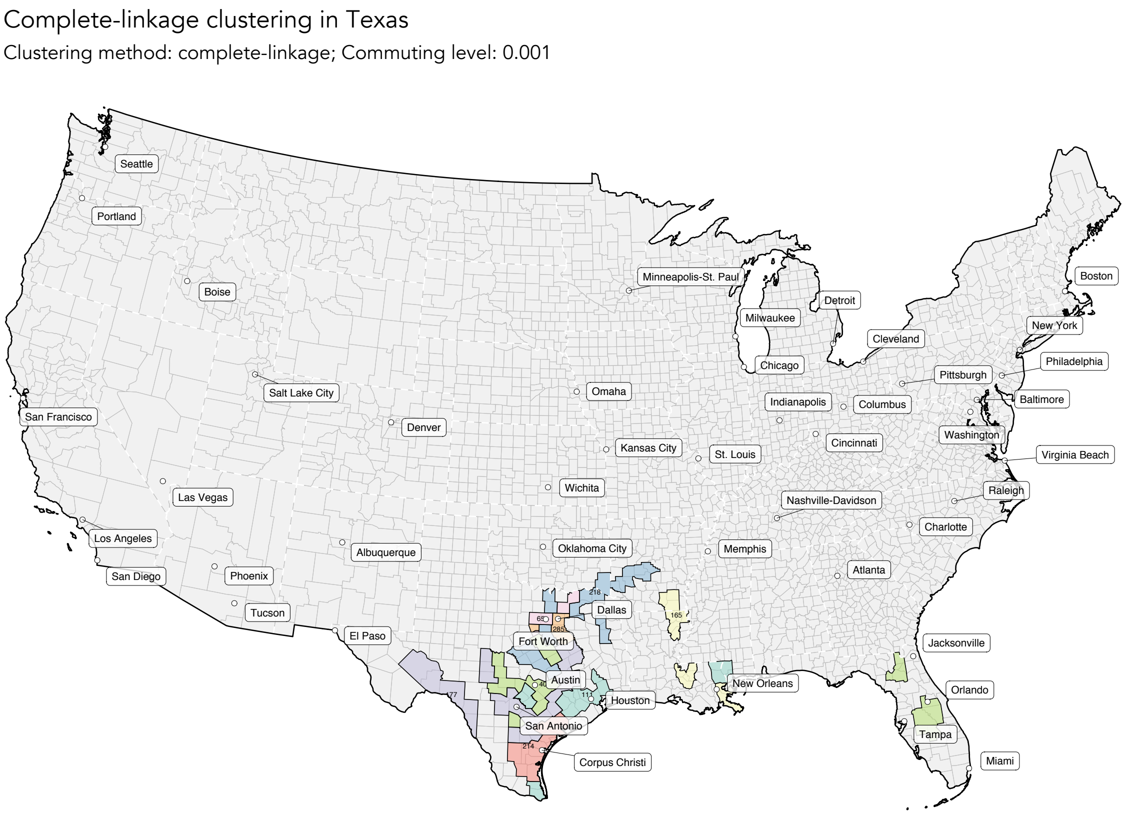

Figure 11: Complete-linkage clustering in Texas

of cities spanning large territories. Austin, for instance, is in the same cluster as Orlando, FL, and part of Northern Florida around Lake City.

This combination of urban networks and specific hinterland is particularly visible in Louisiana, also shown on figure 11. New Orleans clusters with Baton Rouge and a rural part of North-East Louisiana, but not with other large cities on the coast of Louisiana—Lafayette, Lake Charles—although they are much closer, while the Northern shore of Lake Pontchartrain, close to New Orleans, clusters with Houston.

Average-linkage, in figure 12, shows a multiplicity of smaller, local groups of counties: West Bay, Silicon Valley, East Bay, Central Valley, Greater Sacramento and Sierra Nevada. These smaller groups all cluster together relatively late in a continuum of commuting relationships from the Pacific to the Sierra. Inside these clusters, merges are progressive along the scale of commuting strength, and it is therefore challenging to identify the proper level of identification.

Combined-linkage, shown in figure 13 distinguishes clearly between a greater Bay Area on the one hand, and the Greater Sacramento on the other hand. It is notable that counties of the Central

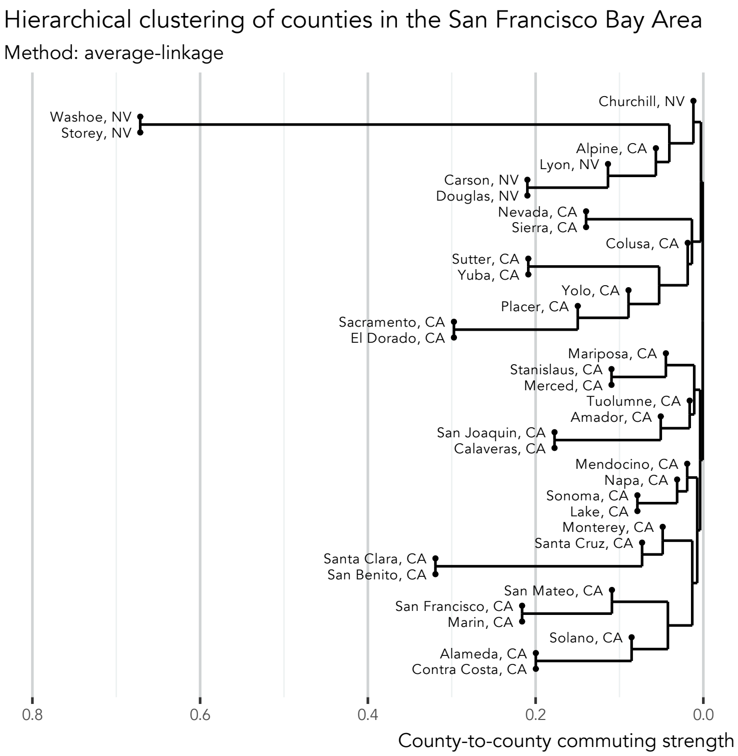

Figure 12: Hierarchical clustering of counties in the San Francisco Bay Area, average-linkage

Valley like Stanislaus and Merced agglomerate relatively quickly with the Bay Area, before the South Bay and the Silicon Valley are merged with the rest of the Bay Area. Combined-linkage clustering also exhibits a type of progressive agglomeration, like single-linkage, inside large clusters.

These four methods are **complementary** in revealing different structural aspects of urban ensembles. We can learn about a specific region by looking at the four of them in parallel. In the specific case of the San Francisco Bay Area, we confirm that the Bay Area has close ties with the Greater Sacramento, and the two of them function as a continuous urban region on a higher level. We get a precise sense of the direct rural *hinterland* of the region, incorporating part of the Sierra Nevada. We understand that different urban cores as parts of the region: San Francisco and Marin, East Bay, Silicon Valley, Sacramento, North Bay, Central Valley. The U.S. Census' definition of the Bay Area as a Core-Based Statistical Area (CBSA) merges San Francisco and Oakland (Alameda County) as a single urban core. Hierarchical clustering shows that the East Bay (Alameda & Contra Costa) keeps an important specificity. We also learn of the definite attachment of part of the Central Valley to the Bay Area. Overall, hierarchical clustering brushes a much richer portrait of the Bay Area, its internal structure, and its ties with surrounding areas.

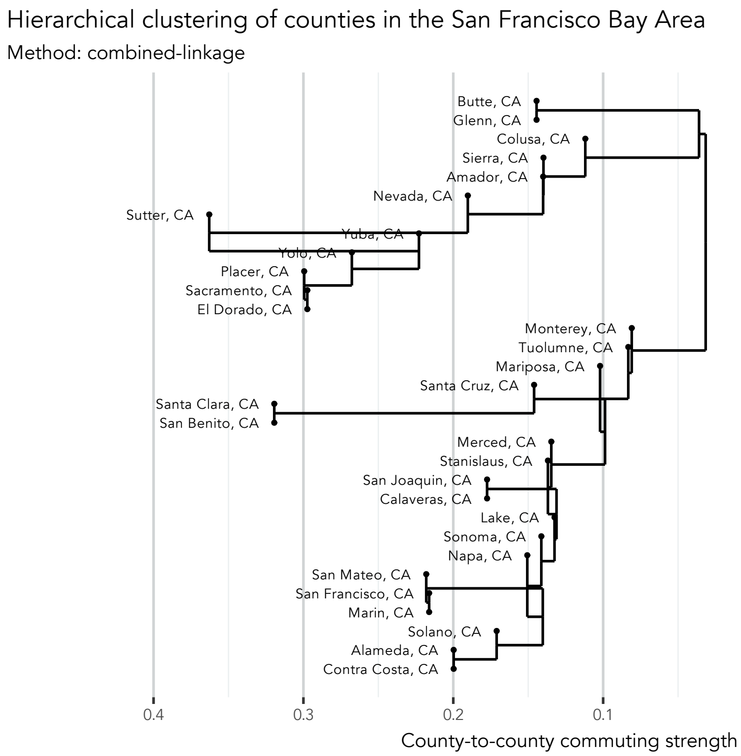

Figure 13: Hierarchical clustering of counties in the San Francisco Bay Area, combined-linkage

Regarding clustering methods, **combined-linkage is the closest to what is usually understood as a metropolitan area**, a region with one or several urban cores, and a large following of suburban or peripheral settlements. Combined-linkage also shows relations of proximity between a metropolitan area and its neighbors. Average-linkage reveals smaller urban ensembles. Single-linkage shows urban cores and progressive agglomeration around them, exposing progressive degrees of metropolitan integration. Complete-linkage unveils specificity in commuting ties between counties.

These methods differ in regards to the structural property of clusters they produce, as evidenced by merges' balance (see 3.1). Table 1 shows that combined and single-linkage produce merges that are generally less balanced than average and complete-linkage. Combined and single-linkage tend to progressively aggregate smaller clusters or individual counties to already large ones, where average and complete-linkage merges together clusters that are comparable in size. This is consistent with the examination of merges in the San Francisco Bay Area. Average-linkage tends to identify local clusters and then merges them together, where the high specificity of complete-linkage tends to keep urban counties separate for a long time until merging them later when the commuting threshold is close to zero.

These structural differences are visible in more details on fig-

Clustering method	Median balance
average	0.403
combined	0.209
complete	0.401
single	0.214

Table 1: Balance statistics by hierarchical clustering method

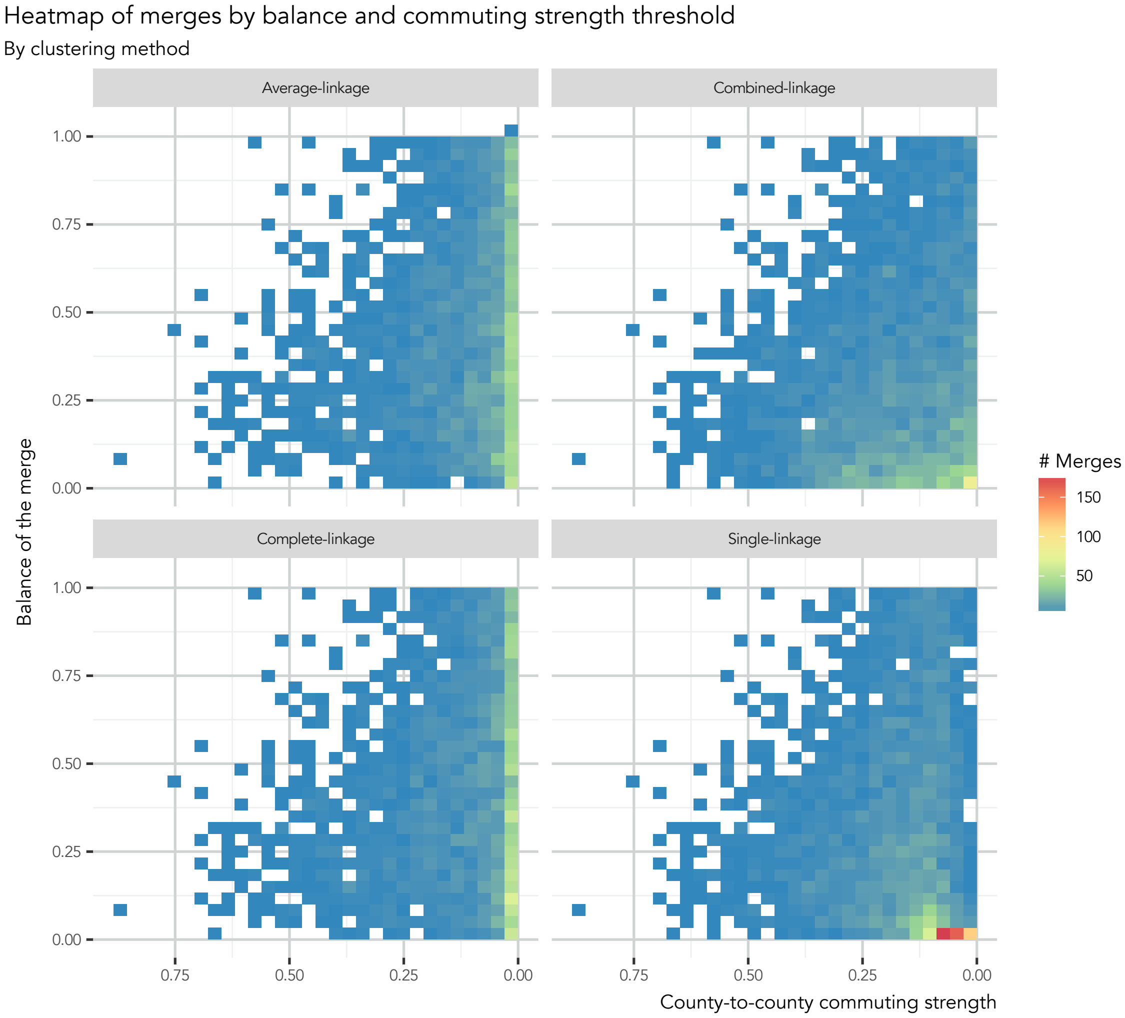

Figure 14: Heatmap of merges by balance and commuting strength threshold, by clustering method

ure 14, a series of heatmaps of merges by balance and commuting strength threshold broken down by clustering method. Figure 14 shows that for all clustering methods, the range of merge balances tends to widen as the commuting threshold is lowered, with early merges being largely unbalanced, clustering together populous counties with smaller ones. As the commuting threshold is lowered, average and complete-linkage produce more merges all over the balance scale, while combined and single linkage do produce balanced merges, but in smaller quantities.

4.2 *Metropolitan clusters can be locally optimized for stability, but not nation-wide*

In section 4.1 I have shown that different clustering algorithms produce different agglomeration patterns offering a diversity of interpretations on how counties group together to form metropolitan areas and urban regions. The OMB uses a similar process to delineate specific metropolitan areas. For this criterion to be suitable, it should display an evident, internally valid threshold. All counties linked together by commuting ties stronger than the threshold form a metropolitan area together. In this section I examine if the data exhibits an obvious candidate value for such a threshold.

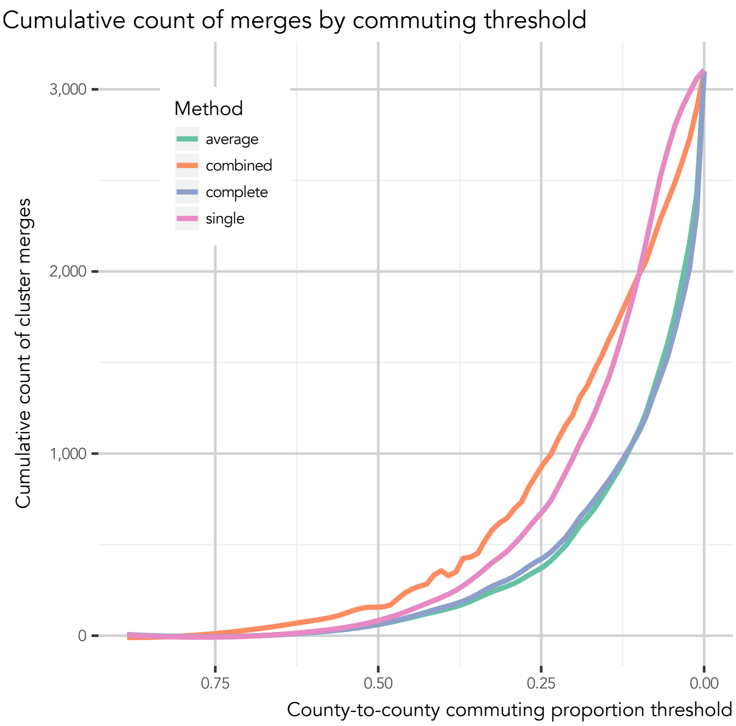

Figure 15: Cumulative count of merges by commuting threshold

Global stability. Figure 15 displays the cumulative count of merge events between clusters along the scale of commuting strength between counties. That is, when the threshold of commuting strength is lowered, more clusters merge. The cumulative count measures how many such merges have been performed by the algorithm from the highest possible commuting strength down to the current commuting strength threshold.

In regards to this cumulative count, figure 15 shows that the four clustering methods are behaving differently. Complete and average-linkage methods display a similar exponential growth. However, as I have explained in section 4.1, this similarity conceals a different interpretation. Single-linkage exhibits a growth curve more akin to a logarithmic one, with merge events accelerating and then slowing down towards the end. Combined-linkage displays a polynomial growth of merge events, more steadily accelerating the rate of merge events as the commuting strength threshold is lowered. If a nation-wide natural threshold existed in the data, we should see the curve flatten around one or more commuting strength values, indicating that no merge is being performed around this value. None of the clustering method exhibit this pattern in figure 15.

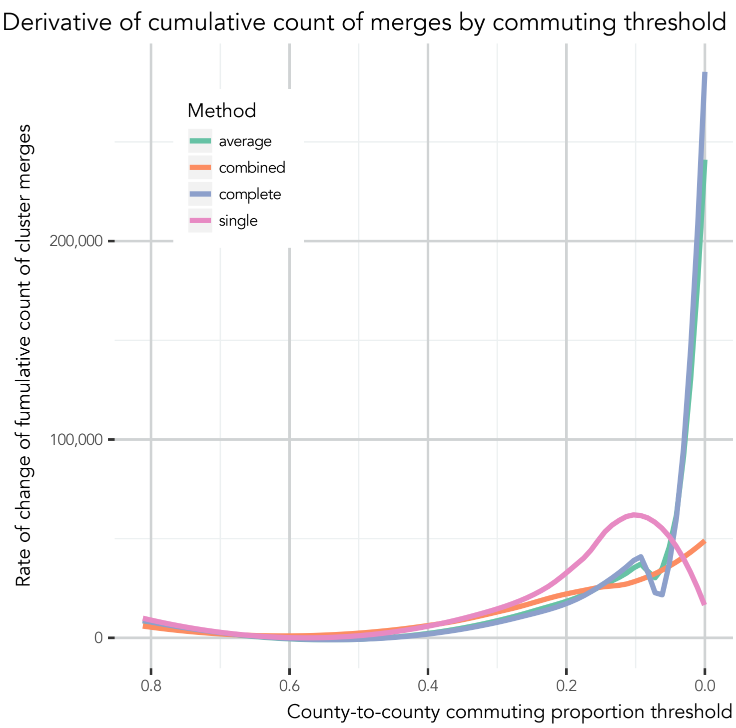

Figure 16: Derivative of cumulative count of merges by commuting threshold

This is confirmed in figure 16, displaying the derivatives of cumulative merge counts. Derivatives express the rate of change of the cumulative count, and a natural threshold would correspond to a point where the rate of change is close to zero, preferentially staying around zero for a range of values around the threshold. If figure 16 reveals differences in the distributions of merge events produced by the four clustering methods, none of them is exhibiting a rate of change close to zero. Therefore, **there is no internal, nation-wide threshold in the data**.

Local cluster stability. There is by definition a point of optimal local clustering stability for each county. That is, each county is part of multiple clusters, and one of them is the most stable. I have determined in section 4.1 that combined-linkage is the clustering method producing clusters that are the closest to what is usually understood as metropolitan areas. I process hierarchical clustering

United States Metropolitan Areas

Using combined-linkage hierarchical clustering and optimized cluster stability, clusters of > 50,000 inhabitants

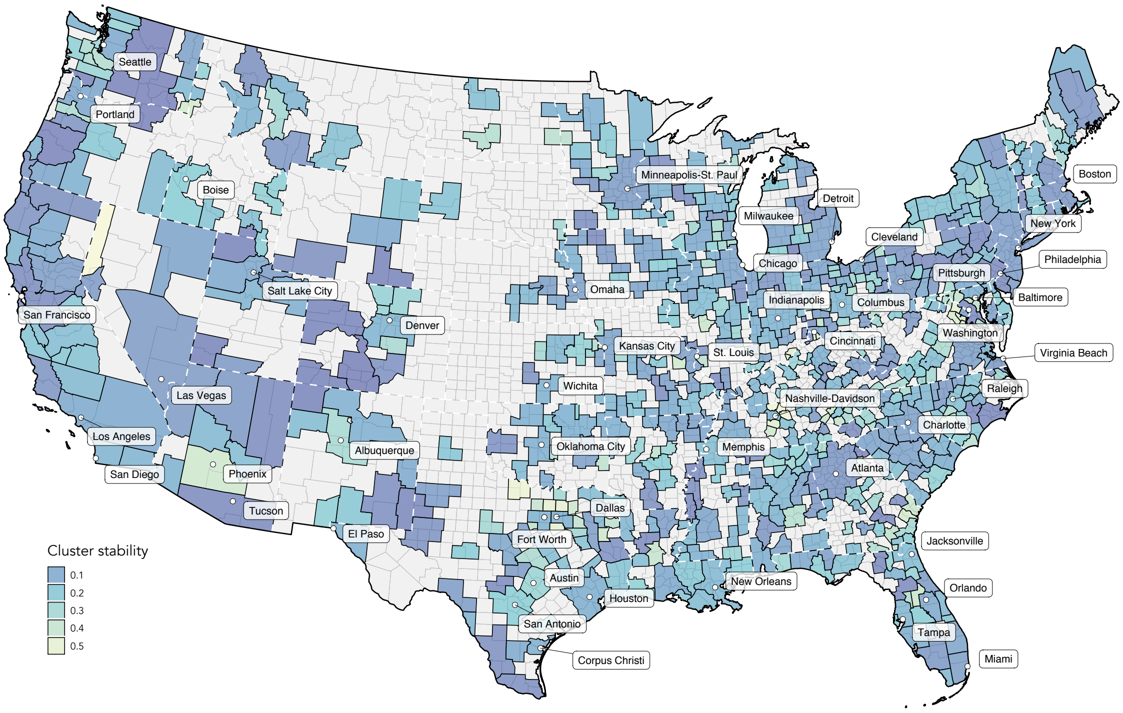

Figure 17: United States Metropolitan Areas, using combined-linkage hierarchical clustering and optimized cluster stability, clusters of > 50,000 inhabitants

produced by each clustering method—single, complete, average & combined—with the local stability optimizing algorithm described in section 3.2 and illustrated by figure 8. This algorithm optimizes the stability of clusters in descending order of their population. Table 2 shows summary statistics for metropolitan clusters identified with each of these methods. When all clusters are considered, there is little difference between these methods, all of them having a median cluster stability of 0,14. Combined and complete-linkage tend to select more populous clusters. More salient differences appear by selecting clusters with a population above 50 000 inhabitants, the population threshold used by the OMB to delineate metropolitan areas. With clusters above 50 000 inhabitants, combined-linkage selects metropolitan clusters markedly more populous than other methods, with a median population of 252 068. Median stability of metropolitan clusters is, however, slightly lower than with average and complete, but above single-linkage. The fact that combined-linkage selects larger clusters without sacrificing stability reinforces the conclusion of section 4.1 that this methods reflects metropolitan reality more effectively. An examination of map 17, displaying metropolitan clusters with combined-linkage, confirms it.

At first glance, clusters selected for their local stability validate

type	average	combined	complete	single
Mdn stability	0.146	0.141	0.137	0.141
Mdn population	55365	77314	74801	64019
# 50000+	1691	1886	1951	1757
Mdn stability 50000+	0.141	0.122	0.137	0.100
Mdn population 50000+	133544	252068	162806	189093

Table 2: Summary statistics of metropolitan clusters by clustering method

this approach because they are indeed close to what is understood as metropolitan areas. Some specific delineations can appear unexpected, such as in the San Francisco Bay Area, for instance. San Francisco's metropolitan cluster comprises counties of the Central Valley that are usually not counted as part the Bay Area, while part of the Silicon Valley—Santa Clara & San Benito counties—are separated from the rest of the Bay. However, the close examination of county-to-county relationships in section 4.1 provided context for this result, and it shouldn't be surprising. In the same way, I have shown how Dallas and Fort Worth are more independent, as measured by their commuting ties, than usually accounted for, and their placement in two separate areas should therefore be expected as well. Compared to maps of locally stable clusters under other methods (figures 25 to 27 in appendix), combined-linkage is clearly closer to the expected delineation of metropolitan areas. Combined-linkage is the clustering method that encapsulates and conveys more information. Especially, other methods exhibit substantially more fragmentation around large cities. See, for instance, the areas around San Francisco or New York in figures 25 to 27.

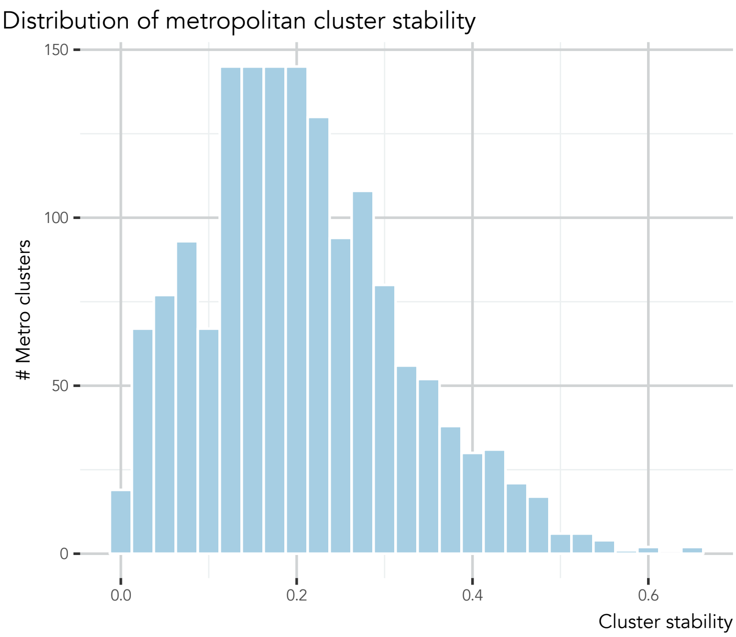

Figure 18: Distribution is metropolitan clusters' stability

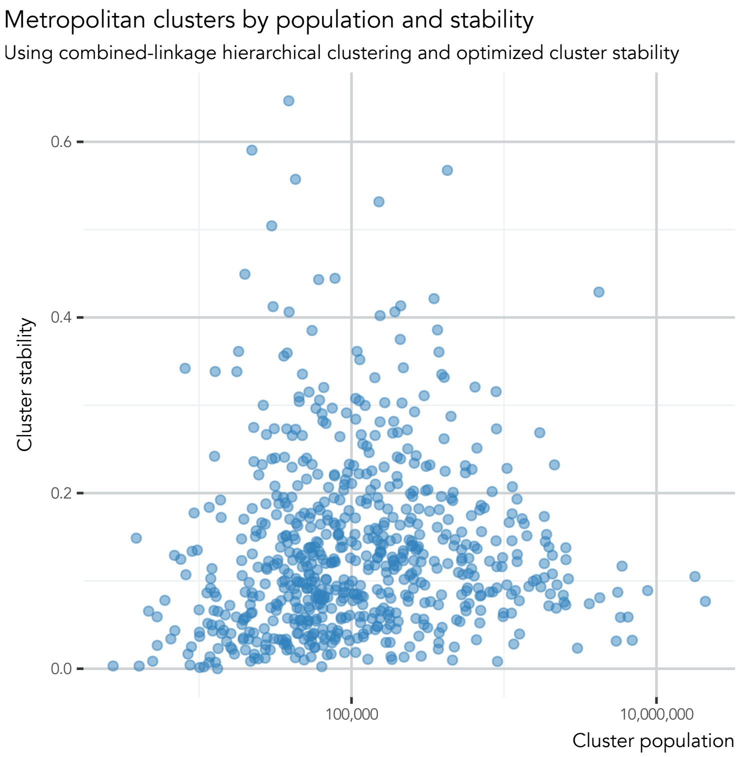

Figure 19: Metropolitan areas by population and cluster stability.

The stability optimizing identifies 1 585 clusters, of which 917 are isolated counties. Isolated counties tend to be rural, but some of them are rather populous. As in the OMB's official metropolitan delineation, San Diego is, by far, the most heavily populated isolated county, with 3 095 313 inhabitants in 2010. The median population of isolated counties is 19 286.

Optimizing local cluster stability captures much of the information on commuting relationships between counties. In figure 20, I illustrate it with a map of metropolitan clusters in Northern California, around the San Francisco Bay Area. This map should be compared with figures 9 to 13, section 4.1, displaying dendrograms of clustering counties in Northern California for each method. Figure 20's map shows topography, because topography often shapes perception of social space, without necessarily shaping social space itself. The nine counties usually understood as part of the Bay Area—Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma—are all touching the Bay. The Bay itself occupies a large valley nestled in the California Coast Ranges, separated from the Pacific by the Santa Cruz Mountains in the South and the Marin Hills in the North, and bordered on its eastern side by a series of successive mountain ranges including the Diablo Mountain Range. East of the Coast Ranges lies the California Central Valley, north of which Sacramento is located.

OMB's Primary Statistical Area of San Jose-San Francisco-Oakland include three more counties not bordering the Bay—San Joaquin, Santa Cruz & San Benito. San Joaquin is in the Central Valley, with Stockton and Tracy as notable cities. Figure 21 shows OMB's delineation of primary statistical areas in Northern California. The map makes apparent how, with the exception of San Joaquin county being attached to the Bay Area, delineations usually follow topographical features. Counties in the same valley are usually grouped together in a PSA, and moutain ranges separate PSAs. This can be explained, in part, by how statistical areas are constructed by the OMB. The *raw data* of commuting ties is adjusted with input from local authorities. It is therefore expected, given this manual input, that statistical areas would correspond closely to perceptions of urban and metropolita areas.

Metropolitan clusters in Northern California

Method: complete-linkage, optimized local cluster stability

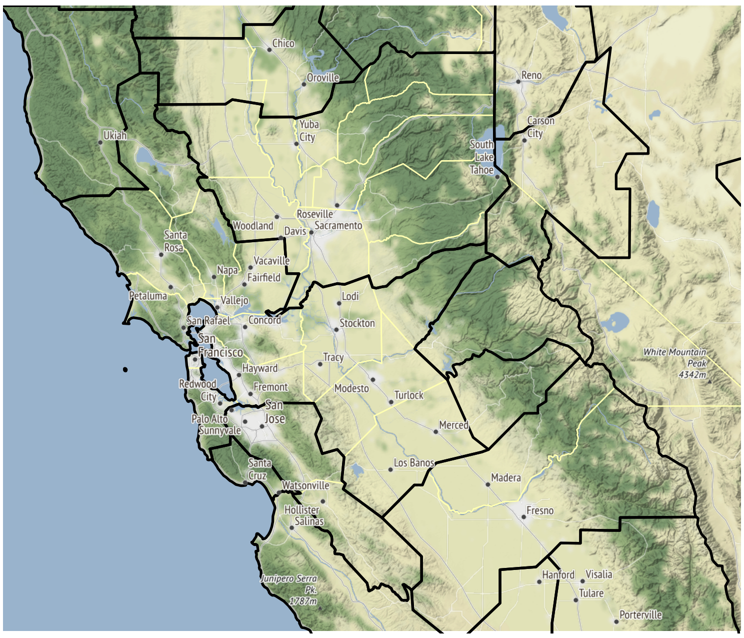

Figure 20: Metropolitan clusters in Northern California, complete-linkage clustering, optimized local cluster stability.

Optimized local cluster stability offers a different picture, as illustrated in figure 20, with two main differences compared to OMB's definition. The first is that part of Silicon Valley—Santa Clara & San Benito counties—is not included in the same metropolitan cluster, even though there is a topographic and urban continuity between the two. Santa Clara demonstrates enough specificity to be counted apart. The second important difference is that the northern part of the San Joaquin Valley, occupying the central parts of the Central Valley, is firmly attached to the Bay Area. Beyond the sole

San Joaquin county included in OMB's delineation, the Bay Area extends to Stanislaus, Calaveras & Merced counties, including fairly large cities like Modesto, Turlock & Merced.

These differences are consequential concerning how metropolitan problems are framed. The San Francisco Bay Area is facing a housing shortage fed by a strong economic and demographic growth, and a slowdown in construction after the Great Recession of 2008.[60] This shortage generates controversies regarding if and where new housing should be built to accommodate the area's growth, pitting South Bay municipalities accused of building too much office space for too few housing units, against San Francisco. The metropolitan map I present here, however, shows that the South Bay is relatively functionally independent from the rest of the Bay, and that the regional housing shortage is likely spurring growth and commuting to the Bay Area from beyond the Coastal Ranges in the Central Valley.

[60] Paciorek 2013.

Similarly, the State of California and local governments are making important investments to develop rail transit along the Bay, building an extension to regional rail system BART, [61] linking East and South Bay, and electrifying commuter rail Caltrain between San Francisco and San Jose. [62] Transit links between the Central Valley and the Bay are seldom the focus of public debate, even though a large part of the valley is linked to the Bay. The only rail commuter service linking the Central Valley to the Bay is a commuter service to San Jose. [63]

[61] See *VTA's BART Silicon Valley Extension*, http://www.vta.org/bart/

[62] See *Peninsula Corridor Electrification Project*, http://www.caltrain.com/projectsplans/CaltrainModernization/Modernization/PeninsulaCorridorElectrificationProject.html

[63] See *Altamont Corridor Express*, https://www.acerail.com/

Figure 20 exposes a potential bias of using counties as units of aggregation for commuting statistics. Counties are large and diverse, and commuting links could reflect small but populous part of counties. This is especially salient north of the Bay and east of Sacramento. A small part of these counties is urbanized, and accounts for much of the county's commuting, while other parts of the county are more rural. Such aggregation bias could be alleviated by using smaller-scale statistics.

Each metropolitan cluster is optimized for its stability, but it does not mean that each metropolitan cluster is equally stable. The median stability for non-isolated metropolitan clusters is relatively low at 0,11. Figure 18 shows a wide distribution of the stability of metropolitan clusters, with few being very stable. However, figure 19, presenting stability in regards to cluster population, shows that there is little correlation between a cluster's stability and its population. Even though the algorithm is designed to optimize stability for populous counties, some dense areas integrated in large urban continuums are not part of any stable cluster. It is notably the case in the northwestern "megalopolis". For instance, Washington D.C.'s metropolitan cluster, comprising 8 counties and 3 032 133 inhabitants, has stability of only 0,023. Similarly, nearby Philadelphia's metropolitan cluster, with 10 counties and 5 445 362 has a stability of 0,031. For both of these metropolitan clusters, it takes very little change in the commuting ties threshold to change their

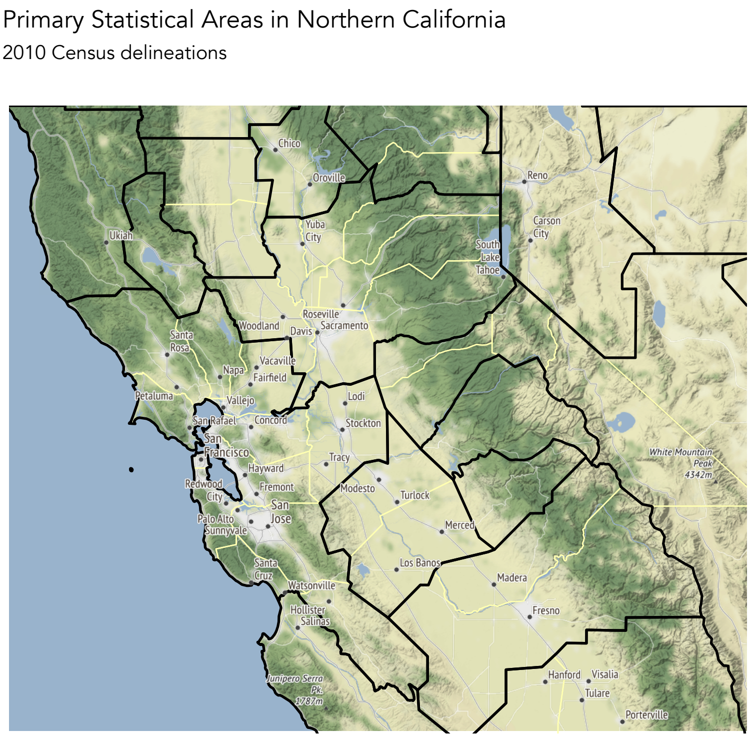

Figure 21: Primary Statistical Areas in Northern California, 2010 Census delineations.

delineation, undermining their robustness. It appears on map 17 that stable metropolitan clusters tend to be concentrated in the South. I examine geographic variations in section 4.3.

4.3 *Regional ranges of clustering stability*

I have shown in section 4.2 that there is no *internal, natural threshold* in the data to distinguish which counties would be inside or outside metropolitan areas. It is possible, however, that this is part due to geographic heterogeneity in the United States. A first glimpse at single-linkage clustering at a commuting level of 2,6 %, in figure 22 makes readily apparent a stark contrast between the Eastern and Western halves of the country. Single-linkage, as explained in section 3.1, reveals local continuity at the expense of overall internal homogeneity in the cluster. Figure 22 exposes that the continuity of commuting relationships between places breaks more rapidly in the West than in the East. With the exception of Highland County, VA, and Aroostook County, ME, the East is a continuum of commuting when the West is already broken into many different commutesheds and isolated counties, from the 100$^{\text{th}}$ meridian westward. Figure 22's map also shows clustering of urban counties along the Pacific West Coast, with Portland and Seattle in the North, and California in the South.

To understand if commuting relationships between counties

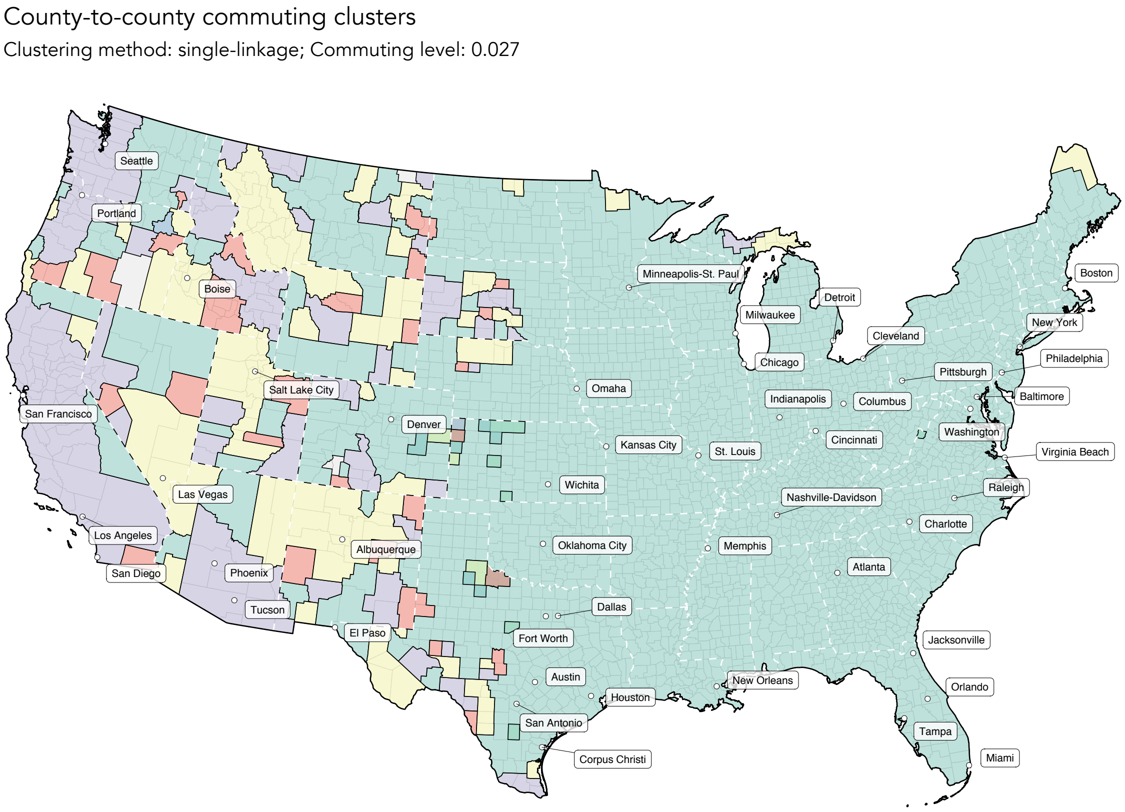

Figure 22: Map

are significantly different in different parts of the country, I use combined-linkage clustering to divide the contiguous United States in three major regions. The East comprises all of the East Coast from Maine to Florida and a large part of the Midwest. The South is mainly composed of Texas, Louisiana and the southern parts of New Mexico, Mississippi and Alabama. The West spans from the Rocky Mountains to the Pacific. Figure 28 in appendix presents a map of the three regions. A number of isolated counties and smaller clusters are excluded from the three regions.

Figure 23 shows the cumulative count of merges in each of these three regions, in a similar fashion that figure 15 is doing for each clustering method. Because these three regions have a different number of counties, therefore a different number of merge events, the count is normalized by the total of merge events. For instance, a value of 0,2 corresponds to 20% of cumulated merges up to this point. Combined-linkage clustering is not a linear process in regards to commuting strength, because distance between clusters is recalculated at the level of the whole luster, not member counties. Therefore, it is theoretically possible that, along the scale of commuting strength, the count of cumulative merges goes up and down. In practice however, the count seldom goes down. Figure 23

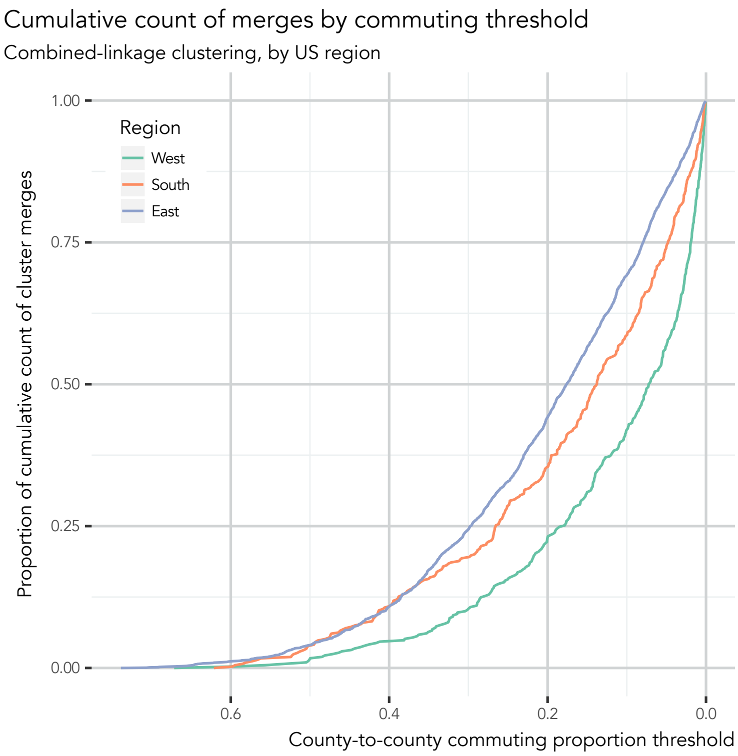

Figure 23: Cumulative count of merges by commuting threshold, combined-linkage clustering, by US region.

exposes a difference in the rhythm of clustering merges between regions. In the East, clustering is more steady for higher values of commuting strength, reflecting more continuity in commuting relationships between counties. In the West, clustering is slower for high values of commuting ties, and accelerates towards the end of the process as the threshold approaches zero. The South is on par with the East for commuting ties above 35%, denoting strong ties linking a suburban county with a central city. Clustering then slows down and exhibits a series of plateaus, that could reflect the isolation between large urban areas, before accelerating again as the commuting threshold comes close to zero.

To clarify these differences, figure 24 displays the derivative of cumulative count of merges by region. The derivative is simply the rate of change of the count for any given value of commuting strength between counties. Areas of stability have a rate of change close to zero. Since the cumulative count is coarse, the rate of change at each value of commuting strength—the commuting strength value of each merge between two clusters—varies widely locally, a evidenced by figure 29 in appendix. In order to make the information contained in the rate of change more apparent, I use locally weighted smoothing (LOESS).[64]

[64] Cleveland, Grosse, and Shyu 1992.

Figure 24 reveals that clustering shares a similar structure between regions, but that the specific commuting values differ, ob-

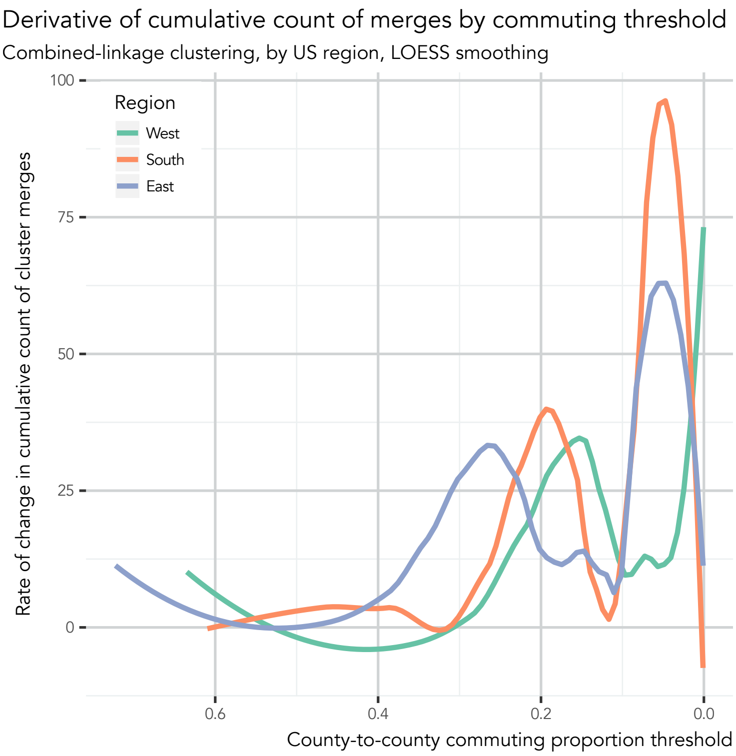

Figure 24: Derivative of cumulative count of merges by commuting threshold, combined-linkage clustering, by US region, LOESS smoothing.

fuscating this structure at a national level. Starting from higher commuting values, the more stringent threshold for clustering, all three regions exhibit an area of stability in the higher values, followed by an area of rapid clustering, followed by another area of relative stability, before clustering rapidly again. Table 3 summarizes areas of stability for each region. Where East and West show ranges of stability both in high and low commuting, the South displays sharper thresholds. While these areas of stability are readily apparent in figure 24, the use of locally weighted smoothing beclouds the noisy nature of clustering revealed by figure 29. These areas are, consequently, not areas of complete stability defining perfect internal threshold but rather areas of relative stability revealing a regional tendency.

Table 3: Areas of clustering stability by region

Region	Higher area	Lower area
East	0.6 - 0.5	0.18 - 0.11
South	0.31	0.11
West	0.3 - 0.5	0.1 - 0.05

This particular structure can be used to define a double regional commuting threshold. The higher one defines **urban cores**, while the lower delineates **metropolitan areas**. Figure 30's map in appendix shows the former while figure 31 shows the latter. Compared to figure 20, showing locally stable metropolitan clusters in Northern California, metropolitan clusters of figure 31 capture less information. They expose how part of the Central Valley attached to the Bay Area, but not the specificity of the South Bay.

If these areas of stability reveal regional differences, they do not, however, account for specific local conditions as precisely and as robustly as optimizing local stability and are still a relatively blunt tool to understand how a particular place functions for policy purposes. Nevertheless, they reveal broad differences in settlement patterns in the United States, by focusing on the actual use of space beyond physical characteristics.

5 Conclusion

5.1 Commuting data reveals many facets of urban America

As I have shown in the account of the four clustering methods (section 4.1), county-to-county commuting relationships reveal important dimensions of the functioning of urban America. Commuting is one of the only metric of socio-spatial relations available nation-wide. As I summarize in table 4, each hierarchical clustering method reveals a different structural aspect. Single-linkage emphasizes continuity, making apparent chains of counties linked by their commuters. In this sense, single-linkage starts to show that if we can create separate clusters of counties, there is a continuum of commuting exchanges between counties in the United States. Complete-linkage exposes the opposite, the specificity in these exchanges. This specificity reveals networks of relations that are not territorially continuous, but jumping over large swathes of land to link together both local hinterlands and nation-wide urban networks. Average-linkage, a middle-ground between single and complete-linkage still operating with counties as the base unit of distance calculation between clusters, exposes local affinities. Combined-linkage, by blending together all commuters of a cluster, reveals larger ensembles, akin to metropolitan areas.

Table 4: Hierarchical clustering methods

Clustering method	Reveals
Single	Socio-spatial continuity
Complete	Relational specificity
Average	Local ensembles
Combined	Urban regions

All of these measurements are based on county commuting and population only. There is no information added by identifying "urban cores" to seed the clustering process, as OMB's definition currently does.

Which of these measures is the *right measure*, however, is hard to determine without looking at specific policy contexts. All four of these characteristics are important to understand how a particular area of the country functions. As I have demonstrated with the example of the San Francisco Bay Area in section 4.1, the relevant urban unit around San Francisco could be as small as the 2 or 3 counties immediately surrounding the city on the oceanside of the Bay, to a large ensemble of more than 40 counties spanning from the Pacific to the Sierra. The relevant delineation of the San Francisco Bay Area depends on the policy to be conducted in this space. Furthermore, these different spaces are not necessarily mutually exclusive. For instance, the continuity revealed by single-linkage is important for transportation policy, where a given place is not part of an exclusive ensemble but linked to multiple other places. Local, specific relationships exposed by complete-linkage are highly relevant to housing development policies. Because commuting is a relation between places of residence and of work, commuting relationships are important to understand how economic development can affect housing demand in other places. However, commuting relationships are not necessarily relevant to conduct policies where the social use of space if of secondary importance. For instance, environmental policies depend on many other factors. Topographical features are of importance for commuting only insofar as they influence the type of transportation infrastructure that can be laid out over a territory, but they are the prime factor in watershed definition. There is no direct causal link between the two.

5.2 No single measure of metropolitan areas

Reinforcing this conclusion that metropolitan America should be approached in its structural diversity is the fact that none of these measures based on commuting relationships provide an obvious threshold to delineate metropolitan areas and tell them apart. At each stage, clustering methods provide a different portrait of urban ensembles, but none of them can be characterized as the right one. Indeed, as I have demonstrated in section 4.2, commuting data itself does not exhibit zones of stability where this threshold could be placed. The overall structure of commuting becomes clearer when examined regionnally, by contrast with a nation-wide approach. Regions—East, West, South—show two distinct ranges of relatively higer stability, and these ranges vary between regions. However, these more stable ranges are by definition less stable than locally optimized.

Cluster stability can be locally optimized to offer a picture of metropolitan America, shown in map 17. Metropolitan areas defined this way, however, are not uniformly stable. In parts of the country, metropolitan areas are very unstable. Counties are enmeshed in a dense web of commuting relationships. The density of this network does not allow for easily carving groups of counties out of it. The portrait presented by map 17 is recognizable and the best that can be achieved with commuting data only. Nonetheless, this portrait is brittle, and many of its parts are lacking the robustness needed to constitute solid foundations for public policies.

5.3 *A pluralist approach to metropolitan areas*

OMB's definition of metropolitan areas is neither robust not internally valid. However, commuting data provides important information about the structure of metropolitan America. Issues with the current definition stem from the fact that metropolitan America is more complex than can be captured with a single measure. Commuting data, however, could be the main element of a **metropolitan dashboard** revealing how counties and places function together to form urban ensembles.

I suggest that policies that are directed towards metropolitan areas today include a **relevant delineation** element, whereby applicants to these programs would justify the relevant local space for the policy. For the sake of simplicity, combined-linkage local stability optimization, in map 17 can form the base-case scenario. Local cluster stability sets a different bar for justifying a particular policy delineation. Metropolitan Phoenix or Austin, being locally more stable, would have less to justify to rely on the base-case than Washington D.C. or Philadelphia, being highly unstable metropolitan clusters.

Moreover, policy programs can issue **delineation guidelines** based, in part, on the four clustering methods applied in this research, in addition to domain-specific data pertaining to the policy. The data, as well as accessible supporting material and tools, should be made available to local applicants, so that they can understand it easily and make their case efficiently.

The burden of proof to show what is the relevant space for a specific policy would be local under this scenario. Grant applicants would have to show that the delineation they propose is indeed the relevant one for the policy. However, with a proper dashboard and set of indicators stemming from different clustering methods, applicants would be helped in this task by the US Census.

The relevant space of collaboration for a specific policy is often obfuscated by the lack of relevant and graspable data. A metropolitan dashboard can contribute to create a common table where local actors can discuss and negotiate better collaboration around policies spanning across county lines, like transportations, housing, and economic development.

References

Adams, John S., Barbara J. VanDrasek, and Eric G. Phillips (2013). "Metropolitan Area Definition in the United States". en. In: *Urban Geography* 20.8, pp. 695–726. ISSN: 0272-3638. DOI: 10.2747/0272-3638.20.8.695.
Anas, A. and R. Lindsey (2011). "Reducing Urban Road Transportation Externalities: Road Pricing in Theory and in Practice". In: *Review of Environmental Economics and Policy* 5.1, pp. 66–88. ISSN: 1750-6816. DOI: 10.1093/reep/req019.
Barbour, Elisa (2002). *Metropolitan Growth Planning in California, 1900-2000*. Tech. rep. San Francisco, CA: Public Policy Institute of California.
Barrington-Leigh, Christopher and Adam Millard-Ball (2015). "A century of sprawl in the United States." In: *Proceedings of the National Academy of Sciences of the United States of America* 112.27, pp. 8244–9. ISSN: 1091-6490. DOI: 10.1073/pnas.1504033112.
Baum-Snow, Nathaniel (2007). "Did highways cause suburbanization?" In: *The Quarterly Journal of Economics* 122.2, pp. 775–805.
Bel, G and ME Warner (2015). "Inter-Municipal Cooperation and Costs: Expectations and Evidence". In: *Public Administration*.
Bode, Eckhardt (2008). "Delineating Metropolitan Areas Using Land Prices". In: *Journal of Regional Science* 48.1, pp. 131–163. ISSN: 00224146. DOI: 10.1111/j.1467-9787.2008.00544.x.
Bogart, William and William Ferry (1999). "Employment Centres in Greater Cleveland: Evidence of Evolution in a Formerly Monocentric City". In: *Urban Studies* 36.12, pp. 2099–2110. ISSN: 0042-0980. DOI: 10.1080/0042098992566.
Burns, Nancy (1994). *The Formation of American Local Governments: Private Values in Public Institutions*. Oxford University Press, USA, p. 208. ISBN: 0195090934.
Christaller, Walter (1933). *Die zentralen Orte in Süddeutschland: eine ökonomisch-geographische Untersuchung über die Gesetzmässigkeit der Verbreitung und Entwicklung der Siedlungen mit städtischen Funktionen*. ISBN: 9783534044665.
Cleveland, William S, Eric Grosse, and William M. Shyu (1992). "Local regression models". In: *Statistical models in S*, pp. 309–376.
Connery, Robert Hough and Richard H. Leach (1960). *The Federal Government and metropolitan areas*. Cambridge: Harvard University Press, p. 275. ISBN: 9780674187818.
Cormen, Thomas H. (2009). *Introduction to algorithms*. MIT Press, p. 1292. ISBN: 0262033844.
Cypher, Trish and Colin Grinnell (2007). *Governments Working Together. A Citizen's Guide to Joint Powers Agreements*. EN. Tech. rep. Sacramento, CA: California State Legislature Senate Local Government Committee.
Dash Nelson, Garrett and Alasdair Rae (2016). "An Economic Geography of the United States: From Commutes to Megaregions". In: *PLOS ONE* 11.11. Ed. by Joshua L Rosenbloom, e0166083. ISSN: 1932-6203. DOI: 10.1371/journal.pone.0166083.
Everitt, Brian. (2011). *Cluster analysis*. Wiley, p. 330. ISBN: 0470978449.
Ewing, Reid and Robert Cervero (2010). "Travel and the Built Environment". In: *Journal of the American Planning Association* 76.3, pp. 265–294. ISSN: 0194-4363. DOI: 10.1080/01944361003766766.
Fogelson, Robert M. (1993). *The fragmented metropolis : Los Angeles, 1850-1930*. University of California Press, p. 362. ISBN: 0520913612.
Frey, Bruno S. and Reiner Eichenberger (2004). *The New Democratic Federalism for Europe: Functional, Overlapping and Competing Jurisdictions*. en. Edward Elgar Publishing, p. 132. ISBN: 9781843769019.
Gelman, N. I. (1959). "Metropolitan areas and the federal government". In: *Editorial research reports* 1.
Getis, Arthur and Judith Getis (1966). "Christaller's Central Place Theory". In: *Journal of Geography* 65.5, pp. 220–226. ISSN: 0022-1341. DOI: 10.1080/00221346608982415.
Giuliano, Genevieve and Dhiraj Narayan (2003). "Another Look at Travel Patterns and Urban Form: The US and Great Britain". In: *Urban Studies* 40.11, pp. 2295–2312. ISSN: 0042-0980. DOI: 10.1080/0042098032000123303.
Goldman, Todd and Elizabeth Deakin (2000). "Regionalism Through Partnerships? Metropolitan Planning Since ISTEA". In: *Berkeley Planning Journal* 14.1.
Gordon, Peter and Harry W. Richardson (1996). "Beyond Polycentricity: The Dispersed Metropolis, Los Angeles, 1970-1990". In: *Journal of the American Planning Association* 62.3, pp. 289–295. ISSN: 0194-4363. DOI: 10.1080/01944369608975695.

Abbreviations

ACS American Community Survey

CBSA Core Based Statistical Area

CSA Combined Statistical Area

ISTEA Intermodal Surface Transportation Efficiency Act

JPA Joint Powers Authority

MPO Metropolitan Planning Organization

OMB The White House's Office of Management and Budget

PSA Primary Statistical Area

WBT Weight-Balanced Binary Tree

Gottmann, Jean (1957). "Megalopolis or the Urbanization of the Northeastern Seaboard". In: *Economic geography*, pp. 189–200.
Gower, J. C. and G. J. S. Ross (1969). "Minimum Spanning Trees and Single Linkage Cluster Analysis". In: *Applied Statistics* 18.1, p. 54. ISSN: 00359254. DOI: 10.2307/2346439.
Jackson, Kenneth T. (1985). *Crabgrass frontier: The suburbanization of the United States*. Oxford University Press.
Karlsson, Charlie and Michael Olsson (2006). "The identification of functional regions: theory, methods, and applications". In: *The Annals of Regional Science* 40.1, pp. 1–18. ISSN: 0570-1864. DOI: 10.1007/s00168-005-0019-5.
Klove, Robert C. (1952). "The Definition of Standard Metropolitan Areas". In: *Economic Geography* 28.2, pp. 95–104. ISSN: 0013-0095. DOI: 10.2307/141019.
Kruskal, Joseph B. (1956). "On the shortest spanning subtree of a graph and the traveling salesman problem". In: *Proceedings of the American Mathematical Society* 7.1, pp. 48–48. ISSN: 0002-9939. DOI: 10.1090/S0002-9939-1956-0078686-7.
Lang, Robert E. and Jennifer LeFurgy (2003). "Edgeless cities: Examining the Non-centered metropolis". In: *Housing Policy Debate* 14.3, pp. 427–460. ISSN: 1051-1482. DOI: 10.1080/10511482.2003.9521482.
Lewis, Paul G and Mary Sprague (1997). *Federal Transportation Policy and the Role of Metropolitan Planning Organizations in California*. Tech. rep. April. San Francisco, CA: Public Policy Institute of California, p. 180.
Lofland, Lyn H. (1975). "The "Thereness" of Women: A Selective Review of Urban Sociology". In: *Sociological Inquiry* 45.2-3, pp. 144–170. ISSN: 0038-0245. DOI: 10.1111/j.1475-682X.1975.tb00334.x.
Lucas, Robert E. (2001). "Externalities and Cities". In: *Review of Economic Dynamics* 4.2, pp. 245–274. ISSN: 10942025. DOI: 10.1006/redy.2000.0108.
Marshall, A (1890). *Principles of economics*. London: Macmillan.
Miller, Gary J. (1981). *Cities by Contract: The Politics of Municipal Incorporation*. MIT Press. ISBN: 0262131641.
Miller, Zane L. (1968). *Boss Cox's Cincinnati: Urban Politics in the Progressive Era*. en. Oxford University Press. ISBN: 9780814208618.
Munafò, Sebastien (2015). "Cadres de vie, modes de vie et mobilités de loisirs: les vertus de la ville compacte remises en cause?" PhD thesis. École polytechnique fédérale de Lausanne. DOI: 10.5075/epfl-thesis-6687.
Nall, Clayton (2015). "The Political Consequences of Spatial Policies: How Interstate Highways Facilitated Geographic Polarization". In: *The Journal of Politics* 77.2, pp. 394–406. ISSN: 0022-3816. DOI: 10.1086/679597.
Newman, M. E. J. (2006). "Modularity and community structure in networks". In: *Proceedings of the National Academy of Sciences* 103.23, pp. 8577–8582. ISSN: 0027-8424. DOI: 10.1073/pnas.0601602103. arXiv: 0602124 [physics].
Nievergelt, J. and E. M. Reingold (1973). "Binary Search Trees of Bounded Balance". In: *SIAM Journal on Computing* 2.1, pp. 33–43. ISSN: 0097-5397. DOI: 10.1137/0202005.
Office of Management and Budget (2010). "2010 Standards for Delineating Metropolitan and Micropolitan Statistical Areas". In: *Federal Register* 75.123, pp. 37246–37254.
Oliver, J. Eric (2001). *Democracy in suburbia*. English. Princeton, N.J.: Princeton University Press. ISBN: 0691088799 9780691088792 0691088802 9780691088808.
Olson, James Stuart (2002). *Encyclopedia of the industrial revolution in America*. Greenwood Press, p. 313. ISBN: 0313308306.
Ostrom, Vincent, Charles M. Tiebout, and Robert Warren (1961). "The Organization of Government in Metropolitan Areas: A Theoretical Inquiry". In: *American Political Science Review* 55.04, pp. 831–842. ISSN: 0003-0554. DOI: 10.1017/S0003055400125973.
Paciorek, Andrew (2013). "Supply constraints and housing market dynamics". In: *Journal of Urban Economics* 77, pp. 11–26. ISSN: 00941190. DOI: 10.1016/j.jue.2013.04.001.
Panne, Gerben van der (2004). "Agglomeration externalities: Marshall versus Jacobs". In: *Journal of Evolutionary Economics* 14.5, pp. 593–604. ISSN: 0936-9937. DOI: 10.1007/s00191-004-0232-x.
Pratt, J. H. (1997). *Counting the New Mobile Workforce*. Tech. rep. Washington, D.C.: Bureau of Transportation Statistics, U.S. Department of Transportation.
Rodriguez, Daniel B. (2000). "Municipal Home Rule and the Processes of Intrastate Fiscal Competition". In: *U of San Diego Public Law Research Paper* 19. DOI: 10.2139/ssrn.270188.
Saks, Raven E. (2008). "Job creation and housing construction: Constraints on metropolitan area employment growth". In: *Journal of Urban Economics* 64.1, pp. 178–195. ISSN: 00941190. DOI: 10.1016/j.jue.2007.12.003.

Short, John Rennie (2010). *Liquid City: Megalopolis and the Contemporary Northeast*. Routledge, p. 200. ISBN: 9781136527463.
Stave, Bruce M. et al. (1988). "A Reassessment of the Urban Political Boss: An Exchange of Views". In: *The History Teacher* 21.3, p. 293. ISSN: 00182745. DOI: 10.2307/492997.
Stead, Dominic and Stephen Marshall (2001). "The relationships between urban form and travel patterns. An international review and evaluation". In: *European Journal of Transport and Infrastructure Research* 1.2, pp. 113–141.
Stephens, G. Ross et al. (1998). "Trends in Special Districts". In: *State & Local Government Review* 30.2, pp. 129–138.
Teaford, Jon C. (1979). *City and suburb : the political fragmentation of metropolitan America, 1850-1970*. Johns Hopkins University Press, p. 231. ISBN: 0801822025.
Wachs, Martin (1984). "Autos, Transit, and the Sprawl of Los Angeles: The 1920s". In: *Journal of the American Planning Association* 50.3, pp. 297–310. ISSN: 0194-4363. DOI: 10.1080/01944368408976597.
Wallis, Allan D. (1994a). "Inventing regionalism: the first two waves". In: *National Civic Review* 83.2, pp. 159–175.
— (1994b). "The third wave: Current trends in regional governance". In: *National Civic Review* 83.3, pp. 290–310.
Warner, Samuel (1962). *Streetcar Suburbs: The Process of Growth in Boston, 1870-1900*. en. Mass., p. 208.

Appendix: metropolitan clusters by clustering method

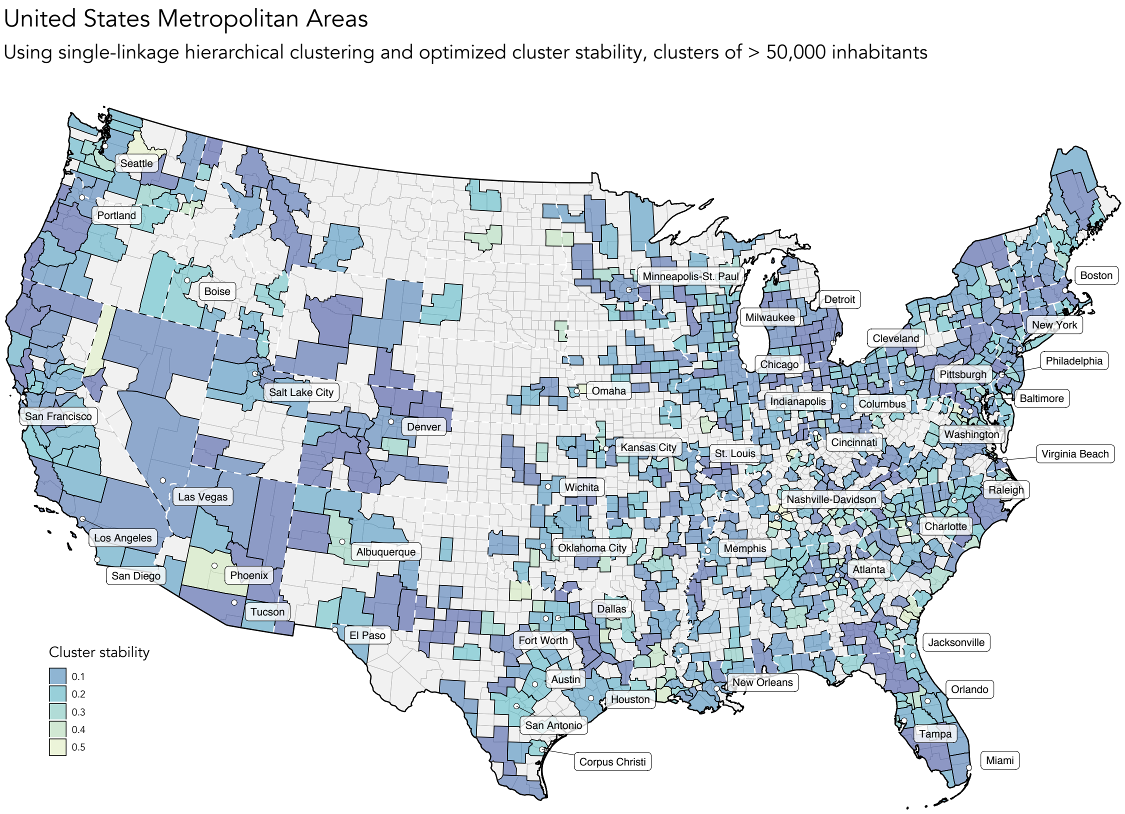

Figure 25: United States Metropolitan Areas, using single-linkage hierarchical clustering and optimized cluster stability, clusters of > 50,000 inhabitants

United States Metropolitan Areas

Using complete-linkage hierarchical clustering and optimized cluster stability, clusters of > 50,000 inhabitants

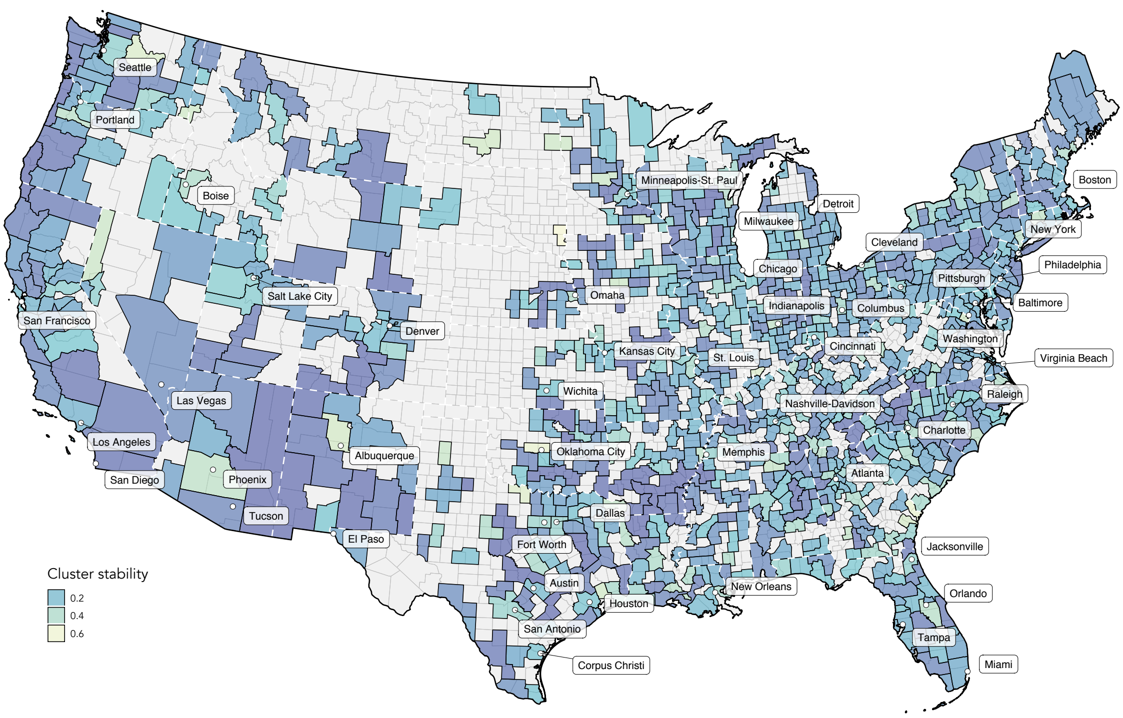

Figure 26: United States Metropolitan Areas, using complete-linkage hierarchical clustering and optimized cluster stability, clusters of > 50,000 inhabitants

United States Metropolitan Areas

Using average-linkage hierarchical clustering and optimized cluster stability, clusters of > 50,000 inhabitants

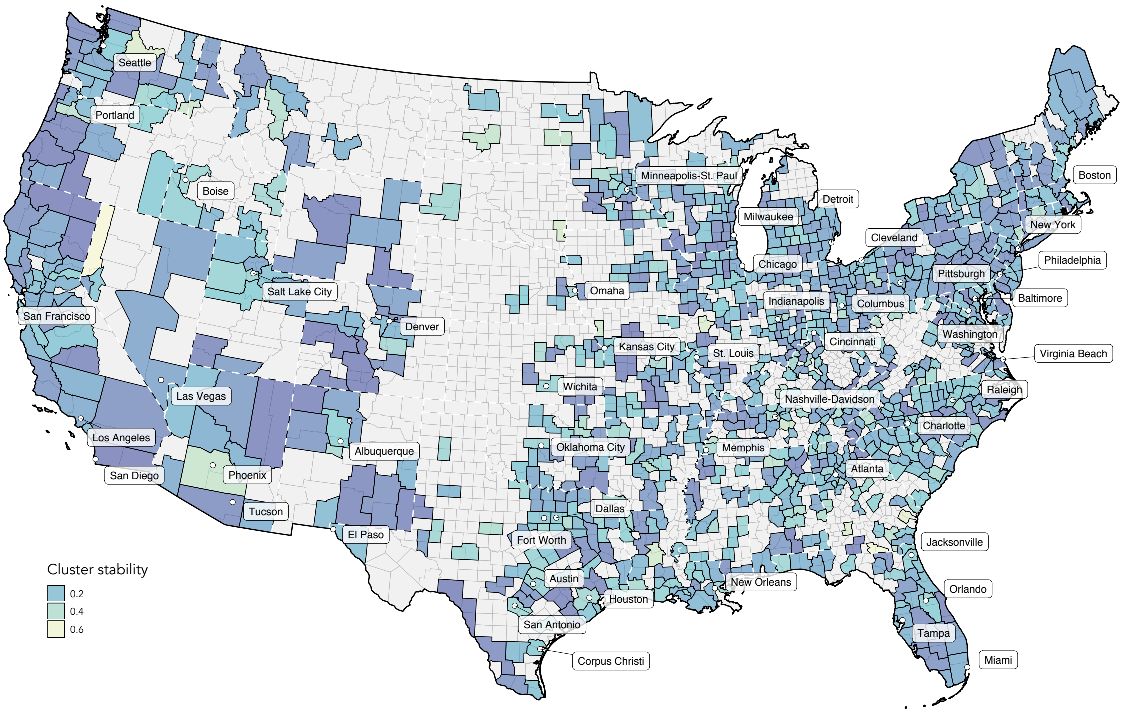

Figure 27: United States Metropolitan Areas, using average-linkage hierarchical clustering and optimized cluster stability, clusters of > 50,000 inhabitants

Appendix: regional variations

United States Regions

Defined by combined-linkage clustering

Figure 28: United States regions, defined by combined-linkage

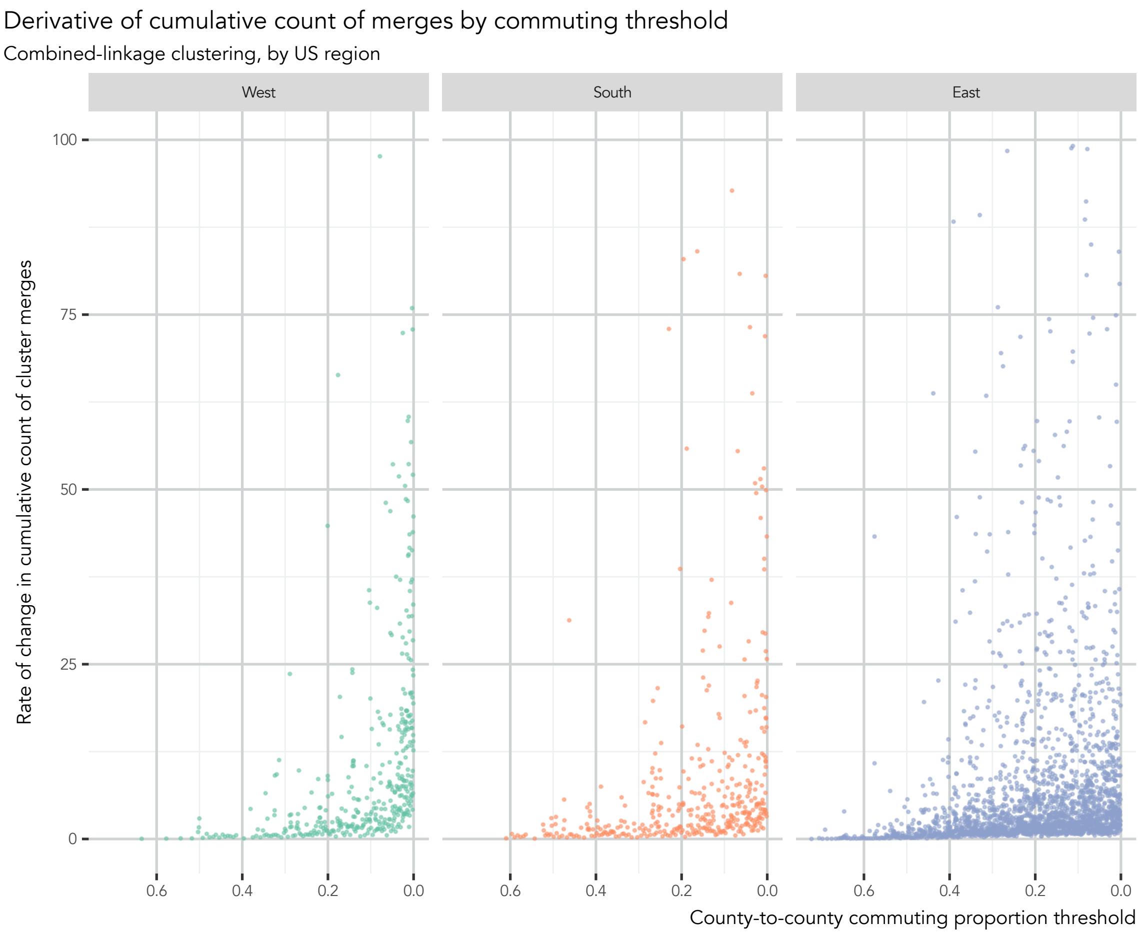

Figure 29: Derivative of cumulative count of merges by commuting threshold, combined-linkage clustering, by US region

Metropolitan Clusters by Region, Higher Stability Threshold

Combined-linkage clustering, optimizing regional stability (W=0.40, S=0.55, E=0.31), population >= 50,000

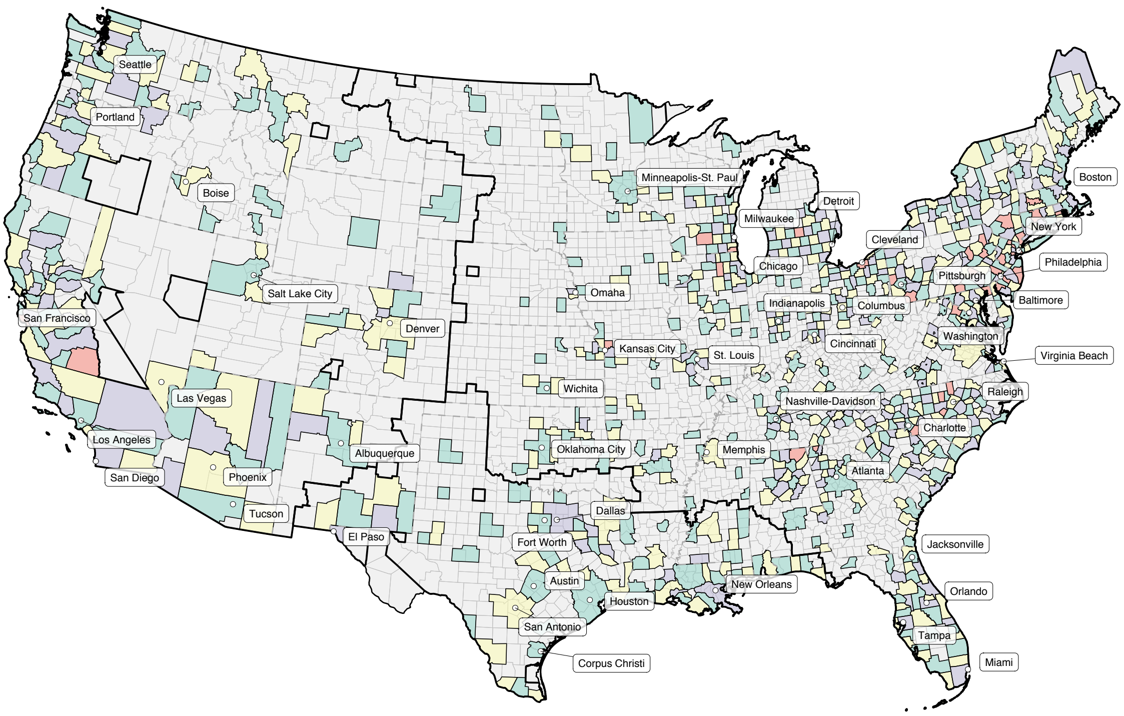

Figure 30: Metropolitan Clusters by Region, Higher Stability Threshold. Combined-linkage clustering, optimizing regional stability (W=0.40, S=0.55, E=0.31), population >= 50,000.

Metropolitan Clusters by Region, Lower Stability Threshold

Combined-linkage clustering, optimizing regional stability (W=0.75, S=0.11, E=0.11), population >= 50,000

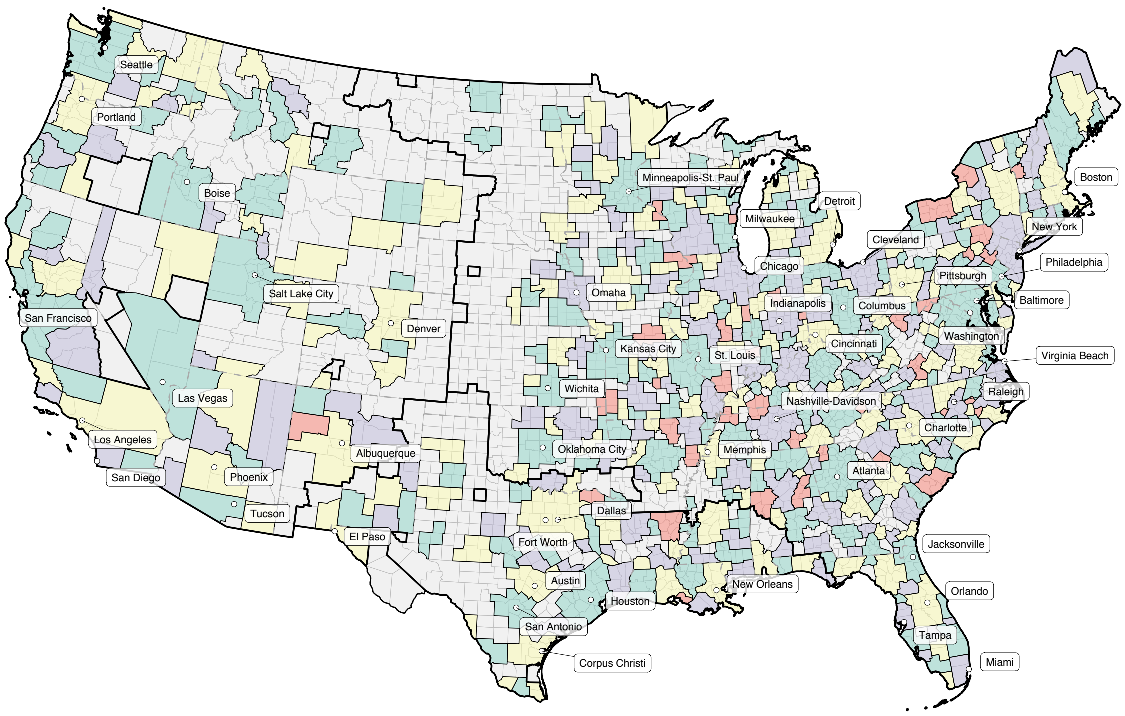

Figure 31: Metropolitan Clusters by Region, Lower Stability Threshold. Combined-linkage clustering, optimizing regional stability (W=0.75, S=0.11, E=0.11), population >= 50,000.

Chapter II

ON POINT: DESIGNING ROBUST SPATIAL TARGETING FOR PUBLIC POLICIES

THE EXAMPLE OF DISADVANTAGED COMMUNITIES IN CALIFORNIA

On Point: Designing Robust Spatial Targeting for Public Policies
The Example of Disadvantaged Communities in California.

In the American context of spatial segregation, communities can have vastly different levels of access to resources. To mitigate this effect, institutions design spatially targeted policies to provide resources to the most disadvantaged communities, compensating for their lack thereof. Delineating these communities is the principal challenge of this process.

We look at a program designed by the State of California targeting disadvantaged communities (DACs) to provide better access to water related projects. These communities are defined by being under 80% of the state median household income and they can be defined at different scales (census blocks, places...). In this paper we test the robustness of this definition and evaluate its fitness for water policy purposes.

We assess how stable the definition of DACs is across scales and how this definition correlates with water reliability stress conditions addressed by the policy.

We find that because they can be measured at different scales following a unidimensional metric of median household income, the current definition of DACs suffers from the modifiable areal unit problem: communities can be identified as disadvantaged or not depending on the scale considered. Because the metric is binary, context-less and subject to geographic bias, it fails to isolate disadvantaged communities from comparatively resourceful communities.

We recommend that institutions designing spatially targeted policies use a single scale of reference to eschew modifiable areal unit problems, that they incorporate in the delineation metrics contextual variables, such as relative cost of living, and variables relevant to the dimension addressed by the policy, and that they use a continuous metric rather than a binary one.

Policy take-aways

- Policy targeting on multiple, overlapping scales, creates sources of bias due the Modifiable Areal Units Problem (MAUP).
- Spatial policy targeting should take geographic context into account. The same measurement does not mean the same thing in two different contexts.
- Geographic biases are reinforced by trying to measure a continuous reality, such as economic disadvantage, with a discrete metric.

Contents

1 Literature review

Public policies are often directed to specific actors or categories of actors, either to balance an undesired effects, in the case of welfare policies, or to incentivize different behaviors. In this literature review, I first draw a general picture of the different types of targeting mechanisms available to policy makers. Second, I explain more precisely how these targeting tactics are used in a spatial context, when they are directed at spaces and not directly at people. Third, I describe the specific policy examined in this paper, targeting disadvantaged communities in California, helping them conducting water-related projects. Last, I expose the theoretical argument for potential biases and mis-matches created by the targeting mechanism chosen by the State of California for this policy.

1.1 Public policy targeting.

Policies are often directed at specific individuals or communities, applying selectively to some and not to others. Welfare policies, for instance, aim at alleviating inequalities and at helping the less resourceful members of society. Policies looking to foster job creation are directed at businesses that are believed to be the most likely to create new jobs. Such policies are **targeted**. Policy-makers design targeted policies to benefit only some individuals or communities, to the exclusion of others, based on set criteria. This targeting can take two forms, depending on if the selection of beneficiaries is unilateral or bilateral. If the policy applies to every eligible person whether they actively seek to benefit from it or not, the targeting is **passive and unmatched**. However, if eligible beneficiaries must apply and be selected by a provider to benefit from the policy, the targeting is **active and matched**.

PASSIVE TARGETING The simplest form of targeting is applying the policy automatically to all qualifying entities, without requesting any action on the part of the beneficiary. A sales tax exemption on necessity goods like food products to alleviate tax burden on lower income individuals, for instance, applies to all people buying necessity goods, regardless of any action on their part to benefit from the policy.[1] In fact, the policy applies regardless of their degree of awareness. The exemption even applies to individuals who have no idea they are benefiting from an exemption.

[1] California State Board of Equalization 2014.

A **spatial passive targeting** applies to all individuals and communities using the space where the policy applies, regardless of their actions or their awareness. For instance, the effort of a municipality to rebuild roads in struggling neighborhoods benefits all people living in and traveling through these spaces. No one needs to opt-in to use rebuilt roads, anyone using the road will benefit.

Passive targeting can induce two types of effects arising from the lack of selection of beneficiaries. First, passive targeting can

induce supply and/or demand through feedback effects for goods and services if they change their relative cost for consumers. This type of behavior change for consumer and/or providers of a good is sometimes a goal of the policy, but can also be an unintended or a negative side-effect. Lowering the price of a good with a tax exemption, for instance, can drive consumers to buy more of this good. Rebuilding roads in struggling neighborhoods can be part of an effort to drive in traffic and patrons to revitalize retail. Lowering the price of public transit, or offering a better service, drives people towards it. Induced demand is also a potential unintended negative consequence of a policy. The induced demand created by new road infrastructure is a well documented phenomenon.[2] Typically, new road capacity will only temporarily alleviate traffic and, in the long term, create more overall congestion through induced demand.

[2] Cervero 2002; Cervero and Hansen 2002.

Second, the absence of beneficiary selection has potential to create **dead-weight loss** for the policy provider. This effect is especially present in policies aiming at changing behaviors. Some beneficiaries would have adopted the behavior regardless of the policy. Therefore, policy resources are spent on them in vain. For these actors already behaving as intended, the policy is a **windfall gain**, an unexpected gain without anything to do in return. Because resources are spent without effect, policy resources are inefficiently allocated in regards to the policy goal: a change in behaviors. Beneficiaries consume the policy good at a discount relative to their benefit. In regards to general economic theory, a deadweight loss occurs when the equilibrium between supply and demand cannot be met, for diverse reasons such as artificial scarcity or externalities. In this case, excess resources are spent while economic value is unrealized.[3] For the specific purpose of evaluating public policies, the United Kingdom's Treasury broadly defines policy deadweight as "that part of a public expenditure program which is taken up by recipients other than those to whom the expenditure should, if possible, be directed".[4] Policy deadweight is a factor of policy inefficiency.[5] More precisely, Anu Tolika describes deadweight as "outcomes which would have occurred anyway without intervention".[6] The realized outcome is the desired outcome, but the policy intervention is superfluous because it would have been realized anyway, hence wasting resources.

[3] Hines 1999, p.168.

[4] Her Majesty's Treasury 1988, p.28.

[5] Mceldowney 1997.

[6] Tokila, Haapanen, and Ritsilä 2008, p.587.

MATCHED TARGETING A second type of policy targeting relies on action on both part of the policymaker and the beneficiary. In a *matched targeting* policy, beneficiaries need not only be eligible but must also actively apply to benefit from the policy. In turn, the policy provider can in some cases make a choice amongst applicants. These policies are a form of two-sided matching.[7] One side of the matching is the policy maker or provider, and the other side is the set of eligible beneficiaries. In general economic theory, two-sided matching is most often studies as a many-to-many mechanism, where each individual actor has a choice between many

[7] A. Roth and Sotomayor 1992.

other actors. In consumer banking, for instance, each individual has a choice between many different banks, and banks can in turn choose to accept an individual as client or not, and which products to offer to a given prospective consumer. Applied to public policy, however, two-sided matching is often heavily asymmetrical, with one provider selecting many individual applicants.

The provider side of the match can comprise a plurality of providers, mandated by the policymaker to implement the policy. Affordable and public housing in the United States often relies on a plurality of for-profit and non-profit developers. For instance, San Francisco's Below Market Rate ("BMR") Inclusionary Housing Program requires developers to set aside 12% of a project's units for low and middle income housing.[8] Public housing in the United States is generally provided by non-profit developers to an eligible population on income conditions. Eligible households must apply to benefit from an affordable housing unit. The number of eligible beneficiaries typically exceeds the supply of affordable housing available and providers must then make a selection amongst eligible applicants.

[8] *Housing Requirements for Residential and Live/Work Development Projects* n.d.

Alvin Roth has pioneered work on two-sided matching mechanisms. He describes two-sided matching mechanisms as markets where money plays little or no role.[9] Alvin Roth advocates for a more conscious embrace of the design of such two-sided markets, lest unplanned detrimental effects of these markets stay unchecked. Roth was involved in the redesign of Boston's[10] and New York City's[11] public school systems matching systems, whereby students–or their parents–express a ranked choice for schools and get registered to a specific school.[12] Roth and his colleagues take a *mechanism design* approach to policy. They anticipate and account for people's actions over time in the design of the policy itself. In doing so, they acknowledge that policies are not one way streets, but that their effects, and their efficiency, depends on the actions of potential beneficiaries. Taking into account participants' beliefs, strategies and actions, what is the best procedure to achieve the policy goal? Building on *game theory*,[13] *mechanism design* is about "the optimal choice of the rules of the game".[14]

[9] A. E. Roth 2015.

[10] Abdulkadiroğlu, Pathak, and A. Roth 2005a.

[11] Abdulkadiroğlu, Pathak, and A. Roth 2005b.

[12] Abdulkadiroglu and Sönmez 2003.

[13] Fudenberg and Tirole 1991.

[14] Borgers, Krahmer, and Strausz 2015.

1.2 *Does the target really exist? Construct validation in policy targeting.*

Both unmatched and matched targeting posit that the target they define exists as a reality. Two types of targets can be set by policies. If the definition creates the target, then *by definition*, the target is correct. However, if the policy targets an underlying social reality or group, then the policy applies *by delineation* of these targets. The specifics of the delineation mechanism, telling apart who is eligible from who is not, creates room for bias and mismatch that need to be controlled when deciding of a target definition.

Target by definition. In the simplest form of targeting, targets are correct by definition. Their criterion of selection is what makes them a target of the policy. For instance, providing recipients of welfare aid with assistance to employment, as the California "Welfare to Work" program does, targets recipients of state welfare support.[15] The measurement is **direct**.

[15] Hotz, Imbens, and Klerman 2006.

Target by delineation. When the policy applies to a social reality or a group that is posited to exist outside of the realm of the policy, policy makers create a definition in an attempt to delineate as effectively as possible the underlying reality or group. It is the case of the policy I examine in this paper, targeting disadvantaged communities in California. The policy postulates that disadvantaged communities really exist, that they are different from not disadvantaged communities, and that it is possible to delineate them in order to target them. The problem presented by targeting by delineation is to make sure the definition matches the intended reality. Are we sure that the definition of disadvantaged communities used by the State of California actually matches what proponents had in mind? This problem is akin to *construct validation* in psychology[16]— making sure that a measure actually measures what it claims to measure— because the measurement is **indirect**. A construct is an explanatory variable that is not directly observable.[17] A personality trait, for instance, cannot be measured directly and must be approached by indirect measurements. For that reason, psychology surveys and experiments attempt to measure the same trait using multiple metrics. The reality they endeavor to measure is the construct. In the same way, DACs are a construct because they cannot be directly observed but are posited to exist independently of their measurement.

[16] Cronbach and Meehl 1955; Fowler 2013.

[17] MacCorquodale and Meehl 1948, p.95.

If all metrics measure, albeit imperfectly, the same underlying construct, the marginal gain of information achieved by adding another measure decreases rapidly. If we imagine the underlying construct as an object, for instance a sculpture, having a picture of the rear of the sculpture adds a lot of information compared to having a picture of the sole front. The next picture, maybe from the left side of the sculpture, will give us more information but not as much. Each new picture has a lesser influence on the overall precision of the mental image of the sculpture. At the same time, having multiple pictures of the same sculpture help us assess that the sculpture really exists. This is the role of construct validation in psychology. In a policy context, the construct is the social reality that the policy addresses. In this paper, they are disadvantaged communities in California.

1.3 *Spatial policy targeting*

Spatial policy targeting can take two forms. On the one hand, a policy can aim to change individual or communities' spatial behavior—behaviors of people in space—,changing the social fabric of space without directly intervening on the physical characteristics of this space. On the other hand, a policy can also be directed at changing the physical space, for environmental purposes or in the hope of lifting the users of this space. Space is an important component of social inequalities. Disinvestment in neighborhoods and active spatial segregation, for instance, have fueled racial and social inequalities after the civil rights movement.[18] Today, spatially targeted policies often aim at reversing these effects.

[18] Sharkey 2013.

Changing spatial behaviors. An important part of the research on spatial matching concerns *associational redistribution*,[19] whereby the policy aims at altering "the composition of social groups",[20] by directly of indirectly changing the spatial behavior of individuals or communities. Spatial behavior is the way individuals or communities use space in their activities. For instance, which route they choose for their commute, or which sschool they choose for their children. School desegregation is an example of associational redistribution. By mixing two groups of students previously separated, desegregation levels available resources for students of the two groups. Furthermore, desegregation changes the *neighborhood effects* at play within a group. By alleviating stark contrasts of available financial resources, pupils of less affluent background gain access to an expanded set of role models.[21] To the extreme, *associational redistribution* can seek to rewire the entire spatial environment of an individual. This is what the HUD program *Moving to Opportunity for Fair Housing* (MTO) endeavored to achieve. The program offered 4 000 low-income families in several metropolitan areas housing vouchers to move to more affluent neighborhoods.[22] MTO has yielded mixed results, being beneficial for participants health but failing to raise their economic prospects.[23]

[19] Durlauf 1996.

[20] Graham 2011, p.967.

[21] Durlauf 2004.

[22] Sanbonmatsu et al. 2011; de Souza Briggs, Popkin, and Goering 2010.

[23] Ludwig et al. 2008.

This type of spatial policy seeks to influence specific *spatial behaviors* in a space otherwise left untouched.

Changing spatial characteristics. The second way of approaching spatial policy targeting is to design policies changing the physical characteristics of the space, most often for the benefits of its users, but also for larger goals. These policies often materialize in infrastructural, capital intensive projects. These policies can be the main or only source of resource allocation, when the government body drafting this policy is the main or sole responsible for the policy. Most often, however, spatially targeted policies are designed to mitigate the effects of an imbalance of resources between communities primarily responsible for the policy. In this paper, I examine water management policy. Many of the projects submitted in the grant applications are primarily within the competence of local governments and local water management agencies. Because these local institutions have various levels of resources to manage these project, the State of California allocate grants to help communities with fewer resources.

1.4 Disadvantaged communities in California

In this paper, I examine the definition of *Disadvantaged Communities* (DACs) used by the State of California to allocate grants for projects related to water supply and quality. This grant program is included in two **ballot measures** from 2006 (Proposition 84) and 2014 (Proposition 1). Direct democracy instruments are used extensively in California, where popular initiatives, referendums and recalls are implemented at state and local levels.[24] Proposition 84, the *Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act* was a multi-purpose state bond measure approved by 53.8% of California voters in 2006. Among $5.388B of approved spendings, Proposition 84 initiated a grant program specifically directed at *Disadvantaged Communities*. The DAC grant program has been continued by the *Water Quality, Supply, and Infrastructure Improvement Act*, supported by a bond measure (Proposition 1), approved by 67.1% of California voters in 2014, with a renewed focus on community involvement. From the $838M awarded in planning and implementation grants in Proposition 84, 14% have been awarded through DACs targeting.[25] Proposition 1 dedicates 10% of its $510M grant funding to DACs, amounting to $51M. California Department of Water Resources has put out a Request For Proposal (RFP) to allocate these grants in July 2016.[26] Proposition 84 inserts a definition of DACs in the California Public Resources Code.

[24] Von Arx 2002; Favre-Bulle 2009; Favre-Bulle 2015.

[25] California Department of Water Resources 2016c.

[26] California Department of Water Resources 2016b.

California Public Resources Code, Section 75005(g):
"Disadvantaged community" means a community with a median household income less than 80% of the statewide average. "Severely disadvantaged community" means a community with a median household income less than 60% of the statewide average.

The DACs targeting program stems from the concern that "many [DACs] lack the staff or financial resources to develop water projects and process grant applications and contracts".[27] In other words, because DACs are economically struggling, they lack organizational resources to navigate and successfully access the state's grant system for projects. DAC targeting, by providing organizational resources to these communities, provides an opportunity to "prioritize failing infrastructure in economically disadvantaged communities".[28]

[27] Pitzer 2013, p.8.

[28] Pitzer 2013, p.8.

In practice, grants are submitted by Integrated Regional Water Management (IRWM) agencies, established by the Regional Water Management Planning Act of 2002. California counts 48 IRWMs. The IRWM role is most often taken by a pre-existing agency. In the San Francisco Bay Area, for instance, IRWM is conducted by the Association of Bay Area Governments (ABAG), a regional association of local governments around the Bay. They can also be cities, counties, water districts. . . California DWR provides a mapping tool identifying California DACs following this definition. [29] This mapping tool is only indicative and not legally binding. The onus is on each applying IRWM group to provide a rationale for which of their communities are disadvantaged.[30]

[29] See http://www.water.ca.gov/irwm/grants/resources_dac.cfm

[30] California Department of Water Resources 2012, p.85.

California Public Resources Code's DAC definition is terse and accessible. The definition is based on a single metric: the median household income (MHI). California DWR uses the U.S. Census' measure of MHI from the American Community Survey (ACS). The law does not mandate a source for income measurement. The ACS, contrary to the decennial census, is a more complete but sampled survey of the American population. Only a fraction of residents is surveyed every year, and statistic for given geographic units are estimated from their answers. Because statistics are estimated, they exhibit a degree of uncertainty. For very small communities, statistics can sometimes simply not be estimated at all due to the low number of ACS respondents. It is for instance the case for small, rural places. For that reason, California DWR "will consider use of other data that show the community is a DAC",[31] like "a third party survey data that supports the population served by the project has an MHI of less than $48 706"[32] (80% of California median MHI according the 2006-2010 ACS). In any case, DWR only accepts measures of MHI as sole criteria for identifying a DAC as eligible for targeted grants.

[31] California Department of Water Resources 2012, p.85.

[32] California Department of Water Resources 2012, p.85.

Prop. 84 grant program has ended in 2015 with a request for proposal for implementation grants. Therefore, we have information about grants submitted by local IRWMs, their reasoning for DAC inclusion and the decision California DWR made to allocate grants. When relevant, an IRWM application for planning and, later, implementation grants, includes an attachment identifying DACs. [33]

[33] For an archive of all implementation grant applications, see: http://www.water.ca.gov/irwm/grants/docs/Archives/Prop84/Submitted_Applications/P84_2015_Implementation/

Proposition 1 extends the definition of DACs in its *Disadvantaged Community Involvement Program*, distinguishing between *Disadvantaged Communities* (DACs), *Economically Distressed Areas* (EDAs) and *Underrepresented Communities*.[34] EDAs are areas with MHI between 80% and 85% of the state MHI, and includes in addition to household income criteria of financial hardship, unemployment and population density. Beside, California DWR provides a *needs assessment template* including measures of water safety and quality [35].

[34] California Department of Water Resources 2016a.

[35] See: http://www.water.ca.gov/irwm/grants/docs/p1DACinvolvement/Attachment%201%20-%20DACI%20Needs%20Assessment%20Template_FINAL_07152016.XLSX

However, because the grant application process has just begun in 2016, while all grants have been awarded in the Proposition 84, I focus on Proposition 84 in this paper.

1.5 *Spatial policy mismatches*

Such a definition of a spatial targets is subject to different types of spatial bias or mismatches. These specifically spatial source of bias come in addition to the potential **construct validation** problem described in 1.2. First, spatial targeting can run into **spatial**

autocorrelation, a common property of geographic objects whereby proximate realities are more similar to each other than distant realities. Second, the way of aggregating discrete units of interest, such as struggling individuals or households, into an geographic area to delineate *disadvantaged community* can fall for an aggregation bias termed **modifiable areal unit problem**.

Distance bias: the Spatial Autocorrelation Problem. Spatial autocorrelation[36] is "the correlation among values of a single variable strictly attributable to the proximity of those values in geographic space, introducing a deviation from the independent observations assumption of classical statistics".[37] Waldo Tobler states that the first law of geography is that "everything is related to everything else, but near things are more related than distant things".[38] The metric chosen to measure this distance is pivotal to understand proximity between social uses of space. Two places can be close by euclidean measure, but hardly connected, therefore distant, for social purpose.

[36] Cliff and Ord 1973.

[37] Griffith 2003, p.3.

[38] **Tobler1970**.

The implications of spatial autocorrelation for spatial policy targeting are twofold. First, given a single metric of targeting, **targets are likely to be geographically clustered**. Indeed, low-income communities and high-income communities are relatively segregated from each other.[39] Second, the **context in which targets are placed differs with geography**. Two communities distant from each other are likely to experience a different context. Consequently, two communities with the same Median Household Income (MHI) might experience very different levels of hardship depending on this context. Having a low income in a place where the cost of living is low is a different experience than having the same income in a place where the cost of living is high.

[39] S. J. Rey and Montouri 1999; Taylor and Fry 2012.

This is the reasoning between the calculation of a *Purchasing Power Parity* (PPP) between different countries, stating that "when measured in the same unit, the monies of different countries should have the same purchasing power and command the same basket of goods".[40] The same reasoning stands at more local scales, especially for policy targeting goals, replacing *monies* by another relevant metric of measurement, in this case economic disadvantage. In other words, the same measurement should measure the same economic disadvantage, controlling for the difference in local context.

[40] Cassel 1918; Cheung 2009.

Aggregation bias: the Modifiable Areal Unit Problem. A second source of spatial bias stems from the necessary aggregation of the measured objects. The policy calls for a delineation of disadvantaged communities. These communities are themselves an aggregation of individuals and households. The prescribed metric, the *Median Household Income* is an aggregate statistics of the income of each individual household. Therefore, the chosen area of aggregation for this metric has a decisive influence on its actual measure.

This is a case of *modifiable areal unit problem* (MAUP). This problem occurs when spatial point data, such as census respondents, are aggregated in areas, such as census tracts.[41] In this case, "the definition of these geographical objects is arbitrary and (in theory) modifiable at choice".[42] Changing the definition of the area changes the statistics of the area. Gerrymandering offers a salient illustration of MAUP. By changing district boundaries, one can change the results of elections by creating a different distribution of votes.[43]

[41] Gehlke and Biehl 1934; Openshaw 1984.

[42] Openshaw 1984, p.3.

[43] Erikson 1972; Cain 1985.

As the California Public Resources Code defines a DAC as a "community with a median household income less than 80% of the statewide average", changing the boundaries of a community changes this aggregate statistic and can push it below or above this threshold. Let us imagine an area of low-income residents immediately abutting another area with high-income households. The selected area of reference to estimate the median household income has a critical influence on the value this statistics will take. If both types of household are taken together, the MHI might be neither high nor low, giving the impression of a middle-income community, and leaving the low-income households out of a delineated DAC, non eligible for a grant. By contrast, if both are considered in separate areas, one of them will have a high MHI, and the other will have a low MHI, and be thus eligible to DAC outreach programs.

Proposition 84's measure of DACs attempts to control for these effects by multiplying possible scales of measurements: Census Block Groups, Census Tracts, and Census Places. Block groups and tracts are statistical units redrawn by the US Census Bureau after each decennial census. Each block group and tract is drawn to have a comparable population size. They allow the collect and tabulation of significant aggregated statistics while preserving the anonymity of census's respondents. Block groups are composed of a number of Census Blocks, and are themselves subdivisions of Census Tracts,[44]. Both Block Groups and Tracts usually cover a contiguous area. Census Tracts are mainly delineated by local participants (state and local governments, tribes...) through the Census Bureau's Participant Statistical Areas Program and as such aim at reflecting community boundaries.[45]

[44] U.S. Census Bureau 1994, Ch.11.

[45] U.S. Census Bureau 1994, Ch.10.

Census Places are concentrations of populations that "have a name, are locally recognized, and are not part of any other place".[46] Places come in two types. A place can be *incorporated*, usually in the form of a local municipal government, following incorporation laws of each state. But in the United States, counties, and not municipalities, are the default level of local government. Municipal governments do not cover the whole territory. Sometimes large urban settlements are under direct administration of counties. Therefore, the U.S. Census Bureau recognizes unincorporated places as census designated places (CDP). East Los Angeles, for instance, is such an unincorporated place. Although East L.A. lies in the heart of the Greater Los Angeles and has a population of more than 120 000 inhabitants, it is under direct government of Los Angeles County

[46] U.S. Census Bureau 1994, Ch.9.

and is recognized as a CDP. For the purpose of this research, an important character of places is their diversity. Large cities covering an important territory, as well as small rural communities can be places. Contrary to tracts and block groups, places are not comparable in size or population.

2 *Research question*

The goal of this research is to evaluate the definition of *Disadvantaged Communities* (DACs) by the California Department of Water Resources (DWR). Specialists and laymen alike have a sense of what a disadvantaged community is, but charting a consistent definition based on observable metrics is challenging. DACs are currently identified using a mono-dimensional metric, the median household income, applied to entities at various scale.

For a definition of disadvantaged communities to be both effective and efficient in the context of this policy, I argue that it should fulfill 4 criteria:

Truthfulness **The definition should delineate the intended spatial reality.** Here, the definition should effectively tell disadvantaged communities apart from not disadvantaged communities. It should not make wealthy, resourceful communities eligible for grants, for this would be a blatant case of *policy deadweight*, inefficiently spending resources on communities that are not in need and, at times, subsidizing projects that would have been undertaken without the grant. The definition should also not leave out truly disadvantaged communities, preventing them from participating in a program explicitly intended for them.

Robustness **Small changes in the definition criteria should result in small, predictable changes in the delineated spaces.** Given a set of measures of disadvantage, the effect of adding or removing a specific measure should have a limited and predictable effect. Robustness of the definition relies on a valid underlying reality (i.e. disadvantaged communities are actually a thing that exist, see 1.2) and effective metrics (i.e. metrics used to delineate disadvantaged communities actually identify disadvantaged communities in some way).

Legibility **The definition should be easy to understand by policy providers as well as by individuals and communities targeted by the policy.** This is the main advantage of the California's Public Resources Code's definition of disadvantaged communities. Because the code uses a simple, mono-dimensional metric of Median Household Income, the definition is easy to understand. If half of the households of a given place have an income below the threshold, this is a disadvantaged community. In the same way that "justice must not only be done, but must be [. . .] seen to be done",[47] a welfare policy must be demonstrably and verifiably

[47] *R v Sussex Justices, ex p McCarthy* 1924.

fair. An alternative definition to the current one should preserve simplicity and legibility.

Fitness **The definition should capture the relevant spatial reality for the policy.** Even if the definition perfectly captures disadvantaged communities in a legible and robust way, the efficacy of the policy would be undermined if disadvantaged communities are bad fit for water policy purposes. The stated goal of the policy is to compensate for these communities' lack of resources to address water related issues. [TALK ABOUT DIFFERENCE BETWEEN PROP 84 AND PROP 1]

A good definition should achieve a balance between these 4 criteria, without sacrificing one to optimize the others.

California's Public Resources Code's DAC definition is simple and legible. But is it truthful, robust and fit to the policy? If not, can we create a better definition maintaining a high degree of legibility?

3 Methods

I evaluate California's Public Resources Code's DAC definition's truthfulness, robustness and fitness to the policy. I evaluate **truthfulness** and **robustness** jointly, by controlling for sources of potential spatial aggregation and distance biases, as well as for construct validity. First (3.1), I examine how the multiple scales of measurements create a potential for modifiable areal unit problem. Second (3.2), I evaluate how the lack of geographic context in the definition produces a DAC delineation bias. Third(3.3), I analyze the effects of the mono-dimensionality of the definition, attempting to capture disadvantage with the sole median household income. These three stages generate a gradually complexifying alternative DAC definition.

3.1 Multiple scale of definition and neighboring effects

First, I address potential sources of biases resulting from aggregation effects. Aggregation is susceptible to the **Modifiable Areal Unit Problem** (MAUP, see 1.5), whereby the area chosen to perform the aggregation of the variable of interest (household income) has an irrefutable impact on the aggregated statistics (median household income). Proposition 84 addresses this problem by multiplying the scales of measurements. But this superimposition creates in turn a new possible source of bias. Each IRWM group presents an argument for why each community counts as a DAC, and uses overlapping measurement units to do so. For instance, a place can be counted as a DAC if it comprises one or more tracts below the median household income threshold. A source of bias exists when affluent communities abut low income communities. In this case, the affluent neighbor can take advantage of its low-income neighbor to be recognized, together, as a DAC, and benefit from the grant program.

The classic case of MAUP, operating on a single, uniform scale of measurement, is more likely to occur in medium scales of measurements, where there is extensive leeway to change delineation areas. Census Tracts, for instance, encompass between 2 500 and 8 000 people, enough room to include multiple communities of varying income. Block Groups, in turn, are the smallest scale of measurement and relatively small areas. They are likely to leave out communities that would meet the criterion, alleviating the risk of classic MAUP to occur. In the context of Census measurements, MAUP occurrences have been overwhelmingly recognized in tracts rather than block groups. The bigger the scale of the modifiable area, the higher the risk for classic, mono-scalar, MAUP to occur. This risk is further diminished by the high degree of spatial autocorrelation in household income.[48] Because of their wide variations in size, places offer the highest potential for classic MAUP. A large place—incorporated municipality or Census Designated Place—can comprise households that are very diverse in income. The relatively arbitrary nature of place delineations significantly influences its summary statistics such as median household income and whether the place qualifies as a DAC.

[48] S. Rey 2004; Garrett, Wagner, and Wheelock 2007.

MAUP risk is further aggravated by multiple scales of measurement for DACs: census block groups, census tracts, and census places. A community can be deemed a DAC if, on one of these scales, its MHI falls below the threshold. Affluent tracts or block groups can be erroneously marked as DAC simply because they are in the same municipality as economically struggling communities, therefore becoming eligible to DAC grants. This effect is at its maximum potential when places are large, offering more opportunities to group together communities of contrasting economic situation.

MAUP creates potential for *false positives*, by identifying as DAC communities that are too affluent to benefit from earmarked grant, in line with the policy goal. I evaluate the extent of these false positives using a multi-scalar DAC definition. Census Block Groups, because of their small size, have little potential for MAUP to occur at their scale. Therefore, I use CBGs as the unit of reference to evaluate MAUP occurrences. The DAC status of a CBG measured at CBG scale is always truthful, because its size is so small. They are too small, however, to fully capture what are generally understood as communities. By definition, all CBGs having an MHI under the threshold are DACs. However, CBGs with a MHI over the threshold can be DACs if they are located inside a DAC tract or place.

I summarize, for every CBG in California, their DAC status on the three scales of Census Block Group, Census Tract, and Census Place. I uncover DAC false positives by highlighting Census Block Groups that are only DAC because they are located in a DAC Census Tract of Place. Census Block Groups are hierarchically nested into Census Tracts. Their geographic relationship is simple. However, Census Places have no rigorous relation to Tracts or Block Groups. Therefore, I compute spatial overlay between Census Places and Census Block Groups, ascribing a Census Block Group to the Census Place that it overlaps the most. [49]

[49] Using R package sp (https://cran.r-project.org/web/packages/sp/)

More than the simple count of false positive, their distribution along MHI reveals the dimension of MAUP biases introduced. If false positives are close to the threshold, their identification as DAC does not markedly deviate from policy goals. However, if really wealthy neighborhoods are included as DACs and rendered eligible to DAC grants, it introduces biases directly against policy goals of compensating disadvantaged communities for their lack of resources.

3.2 *Using rent prices to account for local purchasing power*

A second geographic source of bias in the current DAC definition is the absence of context factored in. The median household income threshold is defined for the whole state of California, fixed as 49 191,2 $ following the 2010 census, regardless of the situation of the community in the state. However, the same household income offers more purchasing power in places where the cost of living is low than in places where it is higher.

In order to assess if the DAC definition accounts for the geographically contextual nature of being disadvantaged as a community, I compute a relative purchasing power index (PPI) for every block group. I compare their DAC status with the PPI, to gage if the DAC definition correctly captures the level of economic hardship that communities experience given their geographic context.

The Bureau of Labor Statistics (BLS) releases local measures of the Consumer Price Index (CPI). CPI is a measure of everyday items prices, measuring a “representative basket of goods and services”, such as gasoline, food and clothing. Overtime, CPI measurements have been adapted to reflect cost-of-living more closely, but still fails to account entirely for substitution effects. Local CPI measures are limited to metropolitan areas, and do not cover the whole state of California.[50] Even more importantly for this study, CPI measures cannot be compared from one area to another, because the composition of each basket is determined locally. CPI measures can only be compared in the same area over time. Because of this limitations, CPI is not a good measure of local purchasing power to compare communities across the state of California.

[50] Bureau of Labor Statistics 2016.

To achieve this comparison, I build an relative purchasing power index based on rent prices, assuming that high rents signal a high cost of living in the area. I use the Zillow Rent Index (ZRI), provided by the real estate data company Zillow, tracking “monthly median rent” over multiple areas.[51] Among several measures of real estate prices provided by Zillow, I focus on rental prices because lower income population are more likely to rent than other

[51] Bun 2012.

segments of the US population.[52] Therefore, rental prices are more likely to reflect the economic conditions of disadvantaged communities than home prices. The ZRI overcomes the three major drawbacks of CPI's measurement: the ZRI is available with a large geographic coverage, at a grain as fine as the neighborhood and ZIP code, and is designed to be comparable between multiple geographic areas. However, the ZRI only incorporates real estate data, to the exclusion of every other relevant aspect of the cost of living in an area, such as food, healthcare, energy or water.

[52] Schwartz 2014.

I take ZRI measures at the zip-code level and map them to individual census tracts, through US Census ZIP Code Tabulation Areas (ZCTAs). Zip-codes do not map to Census Tracts perfectly, but ZCTAs are provided by the Census Bureau as the optimal mapping between the two. All tracts in the same ZIP code are thus attributed the same ZRI measure. For each tract, I compute a PPI simply by diving the MHI by the ZRI.[53] This HPPI gives a measure of how far a dollar goes in a certain geographic context. In places where prices are low, the same income allows a household to live more comfortably than in paces where prices are high.

[53] For each census tract, and given the Median Household Income MHI and Zillow Rent Index ZRI, the Household Purchase Power Index $HPPI$ is:

$$HPPI = \frac{MHI}{ZRI}$$

3.3 *Controlling for household structure to understand individual purchasing power*

The third geographic source of bias in the current DAC definition lies in its lack of dimensionality. The definition uses a single measure, the median household income, to assess the economic struggles of a community. The income dimension of this measurement is relatively straightforward. However, the structure of a household varies considerably between places. The US Census' definition of a household is large and includes "all the persons who occupy a housing unit as their usual place of residence", regardless of the relations they have with each other.

Household size tend to be larger in suburban homes than in city apartments, for the formers tend to roof larger families. Additionally, the "continuing separation of family and household"[54] has undermined the relevance of the household as the social unit for reference in contemporary America. The rise of cohabitation over lifelong stable, nuclear families complexifies relations between household income and the economic situation of individuals. In the traditional nuclear family with a single or primary *breadwinner*, the household income could be considered as a single account used fluidly for all household members' expenses. By contrast, in a cohabiting household with several adults in the workforce, it is more likely that each adult will dispose of their own income. In this case, the *household income* is an abstraction with limited relevance to how much each cohabiting adult can enjoy.

[54] Cherlin 2010.

To account for differences in household structure, I control for the average household size in the census block group, to create an Individual Purchasing Power Index (IPPI).[55]

[55] For each census block group, and given the Median Household Income MHI, Zillow Rent Index ZRI and Average Household Size AHS, the Individual Purchase Power Index $IPPI$ is:

$$IPPI = \frac{MHI}{ZRI \times AHS}$$

Finally, I measure how much the simple official DAC definition based on MHI alone captures the variability of the more complex measure of relative, contextual disadvantage recorded by the IPPI. Ideally, a simple measure would capture as much of the variability contained in the more complex measurement as possible, while providing a more approachable and legible account. To measure the official DAC definition efficiency at capturing IPPI variability, I first run a simple linear regression and measure how much of the variability in IPPI can be explained by the DAC categorization (R-squared). The more variability in IPPI explained by DAC categories, the better this definition performs.

Second, I compare the distribution of the two populations of census block groups, DACs and non-DACs, along the IPPI. The more apart are these two distributions, the better the official DAC definition performs. I compare their summary statistics (minimum, maximum, mean, median, standard deviation). I then compute their Kolmogorov-Smirnov distance, a measure of how apart these two distributions are. Ideally, the two distributions of DACs and non-DACs along a measure of IPPI should be as far apart as possible for the official definition to capture the information conveyed by the IPPI.

4 Results

4.1 Measurement on multiple scales identifies resourceful communities as disadvantged

Figure 1 shows the distribution of Census Block Group (CBGs), the smallest scale of DAC measurement, by DAC scale and overlap. Over the 23 212 block groups in California, 12 934 (55.7%) are not in a DAC at any scale. Their Median Household Income (MHI) is over the DAC threshold. They are located in census tracts whose MHI is over the DAC threshold, and they do not overlap with a place whose MHI is below the DAC threshold. This leaves **10 278 block groups, 44.3% of the total, that can be counted as DAC** on at least one scale of measurement. Since CBGs are designed to be of comparable population, the population of California population in DAC CBGs is approximatively the same, 43.4% (16 524 981 people over 38 066 920 total population). This high proportion of DAC block groups is a first indication that the current definition does not offer significant sorting power to identify struggling communities in the state.

Figure 2 reveals the distribution of DAC CBGs by overlap level. A block group that is not a DAC has a level of 0, where a CBG that is a DAC at all levels (block group, tract and place) has a level of 3. Over the 10 278 DAC CBGs, 2 464 are counted DAC on all 3 levels, while 4 520 CBGs see one overlap between 2 DAC scales, and 3 294 can be counted as DACs on only 1 scale. DAC levels 1 & 2 have potential to exhibit Modifiable Areal Unit Problem (MAUP).

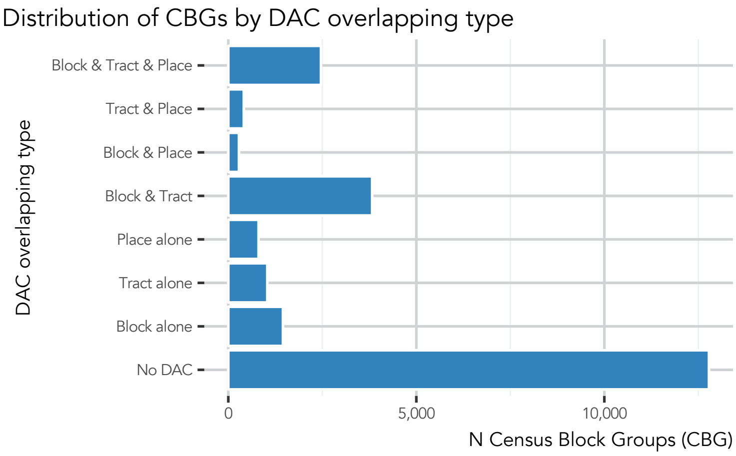

Figure 1: Distribution of CBGs by DAC overlapping type.

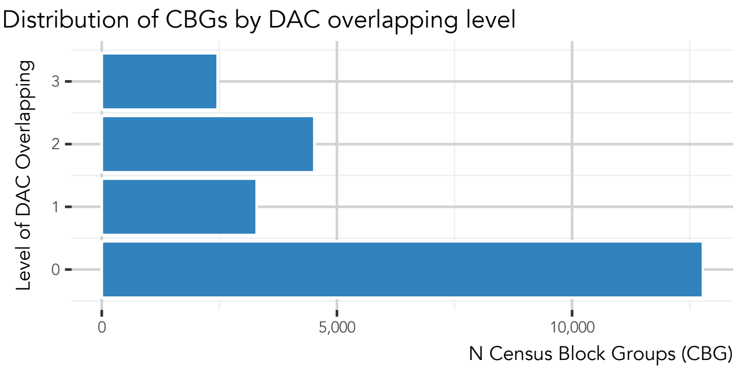

Figure 2: Distribution of CBGs by DAC overlapping level.

Indeed, level 0 CBGs are not identified as DAC at all, and level 3 CBGs are, by definition, under the DAC threshold at the CBG level too. However, level 1 & 2 CBGs can be DAC at the Census Tract (CTr) and/or Census Place (CPl) while having themselves a relatively high MHI. Indeed, figure 1 shows that 2 292 CBGs are in this situation.

Figure 3 shows that block groups that can be counted as DAC on a higher number of scales tend to have a lower MHI. They are lower income block groups situated in lower income tracts and places. Not only are they low-income, their vicinity also tends to be low-income. However, this observation also indicates that DAC CBGs with only one DAC scale tend to have a higher MHI than DAC CBGs on all three scales of measurement, including a number of high-income CBGs, categorized as DACs nonetheless. Figure 4 goes more into details and shows the distribution of MHI divided by specific DAC overlapping type (as in figure 2). The three categories where non-DACs CBGs are identified as DAC because of other scales are when they are in a DAC Census Tract (CTr), a DAC

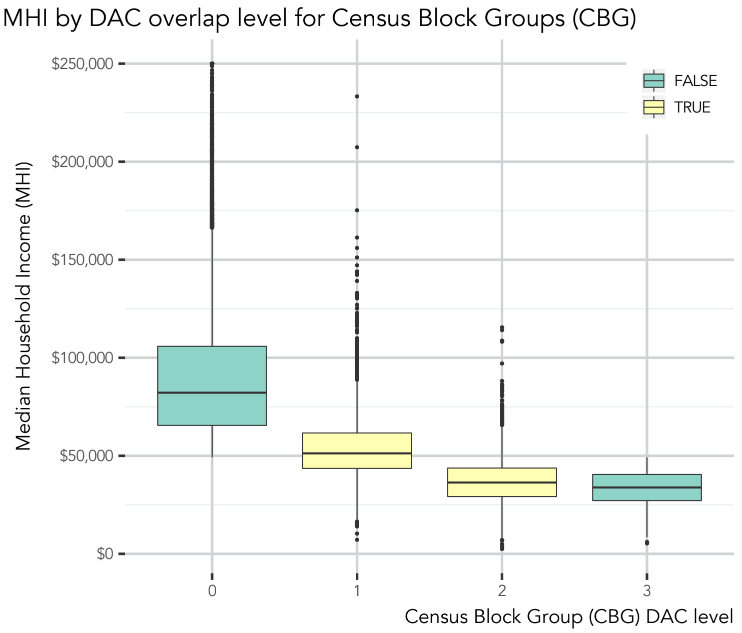

Figure 3: MHI by DAC overlap level for Census Block Groups (CBG)

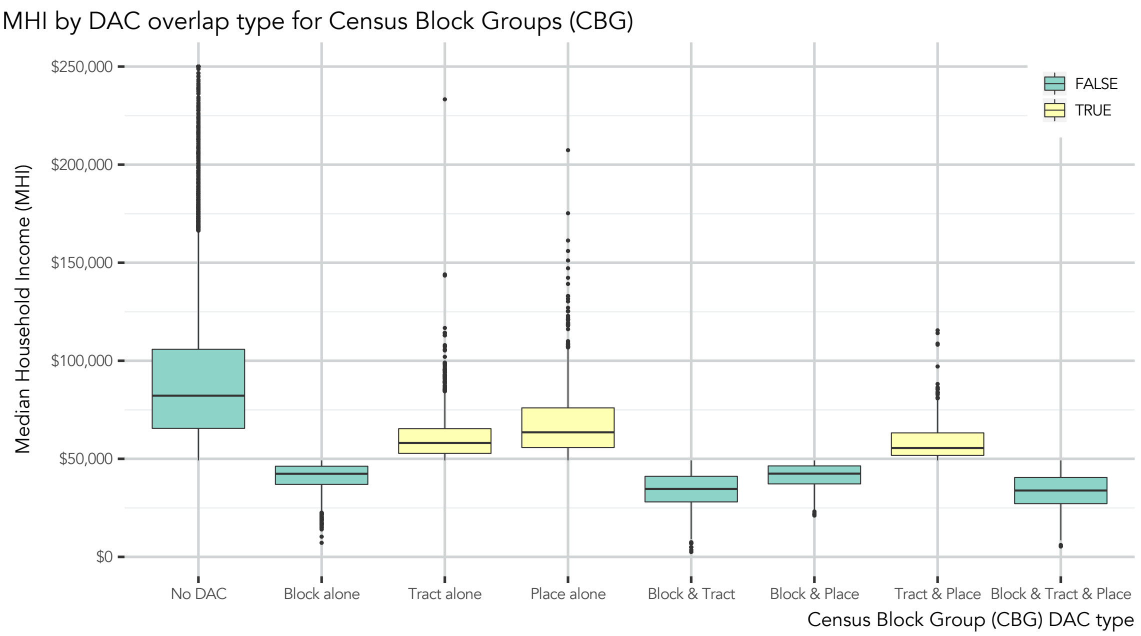

Figure 4: MHI by DAC overlap type for Census Block Groups (CBG)

Census Place (CPl), or both. Of these three possible cases, CBGs in DAC CPls have the highest MHI. This is expected considering that Modifiable Areal Units Problems (MAUP) tend to occur in larger entities, as I explained in 1.5. Places are, on average, larger geographic units, containing sometimes a large number of CBGs, thus offering more opportunities to lump high-income areas with lower-income communities creating geographic entities appearing as lower-income on aggregate statistics.

By contrast, CBGs in DAC Census Tracts (with or without a DAC Census Place) tend to have a MHI very close to the DAC threshold of $49 191. Figure 5 confirms this by showing that the MHI distribution for these CBGs is concentrated on the lower bound, closer to the DAC threshold. Thus, by extending the DAC definition beyond CBGs only to Tracts and Places, Prop. 84 provides a mechanism to include low-income communities that are not meeting the threshold. However, Prop. 84 does so by exploiting the Modifiable Areal Unit Problem in a way that was unpredictable to policy proponents.

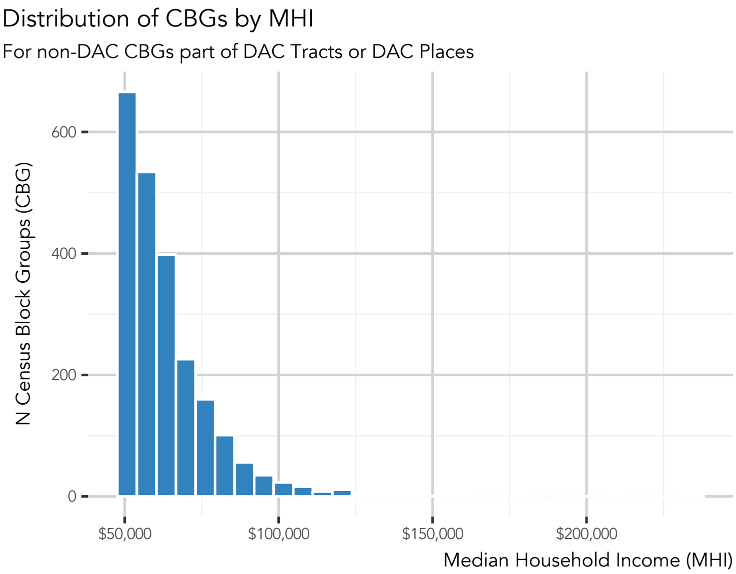

Figure 5: Distribution of CBGs by MHI.

I will now explain several examples of situations where MAUP becomes apparent and creates a potential bias for DAC identification following Prop.84 definition. They can occur either because of direct neighboring conditions (in Windsor Square) or because of large scales of measurements provides opportunity for grouping together a large diversity of communities, in regards to their MHI (in Arden-Arcade).

WINDSOR SQUARE: DIRECT NEIGHBORING CONDITIONS. Census tract 2 115 in Los Angeles epitomizes this measurement effect. Block group 3 on the West of this tract is part of the wealthy neighborhood of Windsor Square, comprising multi-million dollar homes, and the official residence of the Mayor of Los Angeles. This Block Group had in 2010 a MHI of 233 281 $. Immediately to the east of Windsor Square, making block groups 1 and 2 of the tract, is the north-west corner of Koreatown, a highly diverse and lower income neighborhood. The 2 block groups had a MHI of 41 953 $ and 41 538 $, respectively. The satellite view of this tract on figure 6 exposes the sharp contrast between home types on the eastern and western sides of the tract. Nonetheless, they are immediately abutting each other.

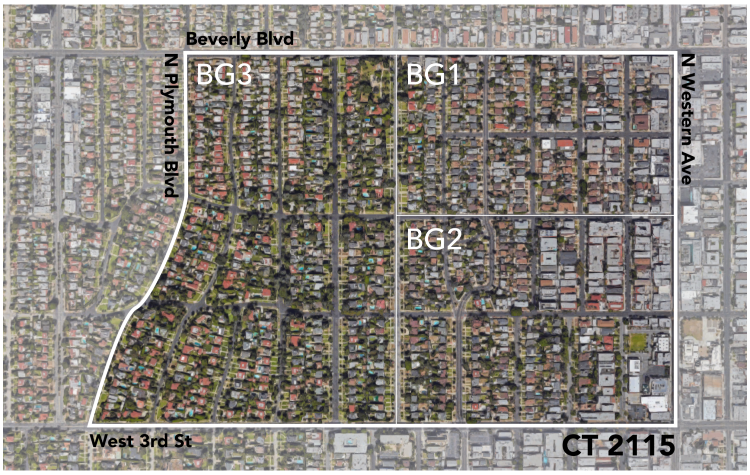

Figure 6: Census tract 2115 in Los Angeles.

Windsor Square exemplifies the importance of **direct neighboring conditions** in Prop. 84's DAC definition, applied to the segregated and contrasted human geography of California cities. Windsor Square, a wealthy community, is directly adjacent to low-income neighborhoods, and lumped in the same census tract. Although census tracts should be delineated to reflect community boundaries,[56] it is dubious that Windsor Square and the north-west corner of Koreatown would be perceived as the same community by their inhabitants. Nonetheless, it allows Windsor Square to be eligible to a grant program directed at struggling communities.

[56] U.S. Census Bureau 1994, Ch.10.

A good measure of this neighboring condition is the **standard deviation of the MHI of CBGs in the tract**, whose distribution is displayed by figure 7. A high standard deviation indicates an important contrast between CBGs relative wealth in the tract, creating potential for a DAC Tract to include high-income areas. This is a by-product of the necessary trade-off operated by the US Census between delineating tracts as close as possible to communities to be meaningful, and balancing population between tracts to permit statistical comparison between them. In the case of Windsor Square, the community delineating dimension of tracts has clearly been a second-order consideration.

Figure 7 demonstrates that Windsor Square is far from an exception and that diversity of income inside a single census tract is widespread. The distribution stays concentrated on the lower end, with more tracts being homogeneous, thus exhibiting an expected pattern of spatial autocorrelation for household income. There is however a long tail of heterogeneous tracts, as illustrated by the

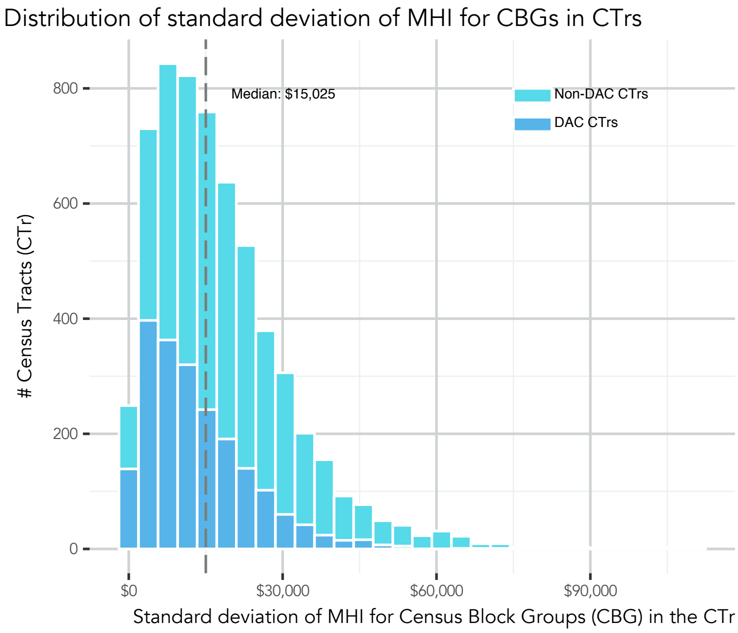

Figure 7: Distribution of standard deviation of MHI for CBGs in CTrs

median standard deviation of CBG MHI of 15 025 $. DAC tracts themselves exhibit the same distribution of income diversity. This income heterogeneity undermines the relevance of tracts as a measure of community for targeting economic disadvantage.

Arden-Arcade: Large scale of measurement. Arden-Arcade, immediately east of the city of Sacramento, offers another example of MAUP, this time due the large number of CBGs that a place can comprise. Arden-Arcade is a Census Designated Place (CDP), devoid of an incorporated municipal government and under direct administration of Sacramento county. The CDP had a MHI of 45 750 $ in 2010, and can be therefore counted as a disadvantaged community. However, the place is also home to some of the most affluent neighborhoods of the county, particularly along the American River on the south. Block group 1 of census tract 56.06, a wealthy enclave of mansions built on big lots along sinuous drives, had a MHI of 207 361 $ in 2010. Block group 3 of census tract 58.03, overlooking the American River on the south-est of Arden-Arcade, had a MHI of 175 216 $ in 2010.

Arden-Arcade illustrates the *scale problems* of the current definition. A DAC can be defined at multiple scales. If census block groups and tracts are designed to be comparable in population, places offer a wide diversity of population and size. Arden-Arcade is a large place, counting 92 186 inhabitants in 2010. Because of its sheer size, a modest median household income can obfuscate important income differences.

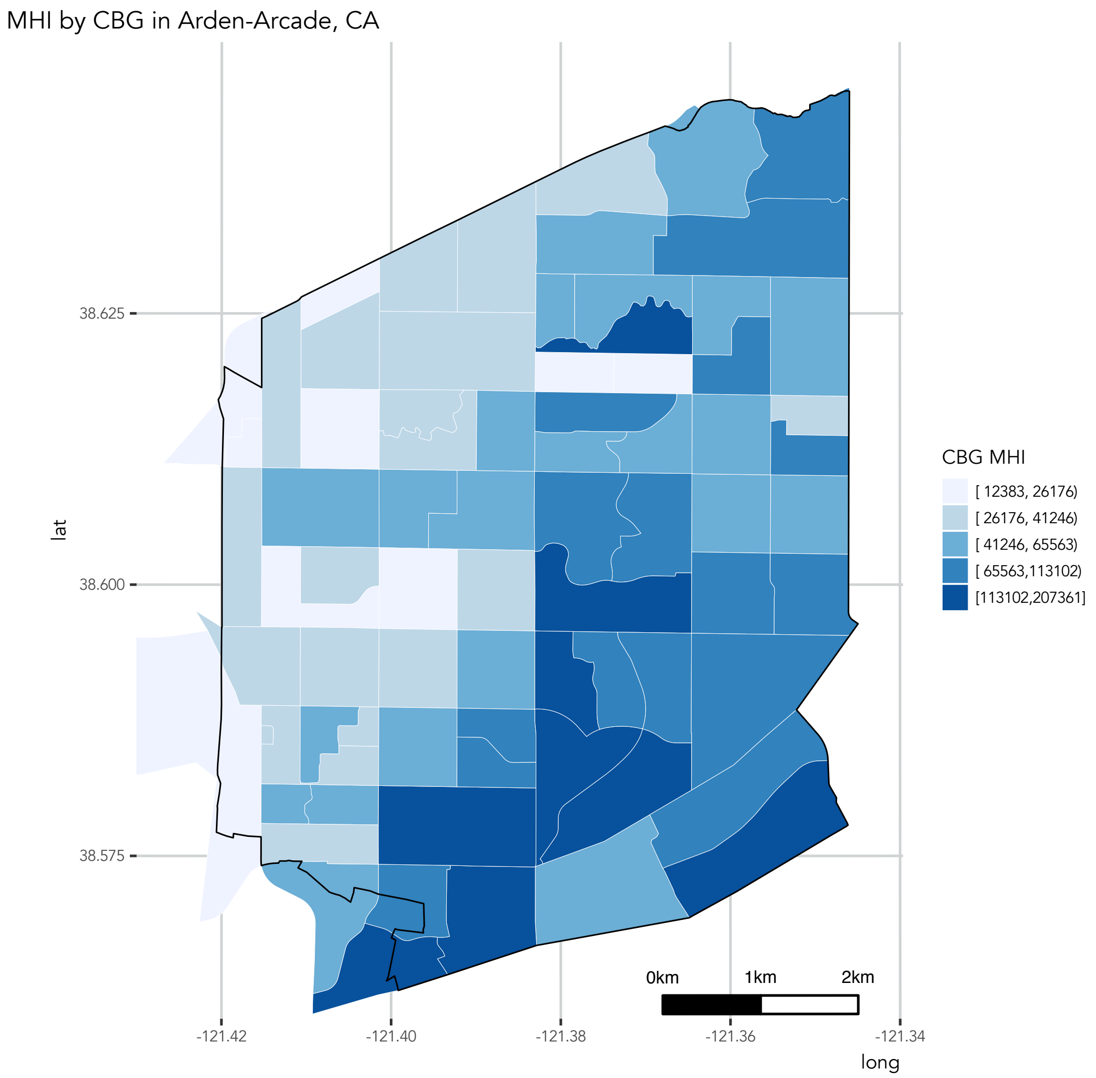

Figure 8: MHI by CBG in Arden-Arcade, California.

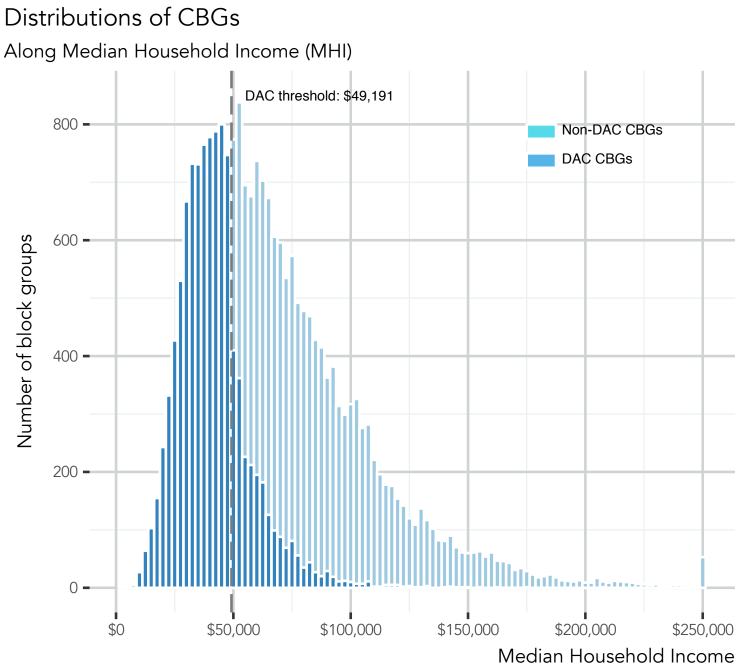

Figure 9: Distributions of CBGs, along Median Household Income (MHI)

4.2 *Household income is relative to relative local purchasing power*

Proposition 84 uses a uniform threshold of Median Household Income to define DACs all over the State of California. California is a large and diverse state, and prices of some types of goods vary widely in the state. Housing is one of them, and influences significantly local purchasing power of individuals. The same income leads to a higher purchasing power where rents are low than where rents are high.

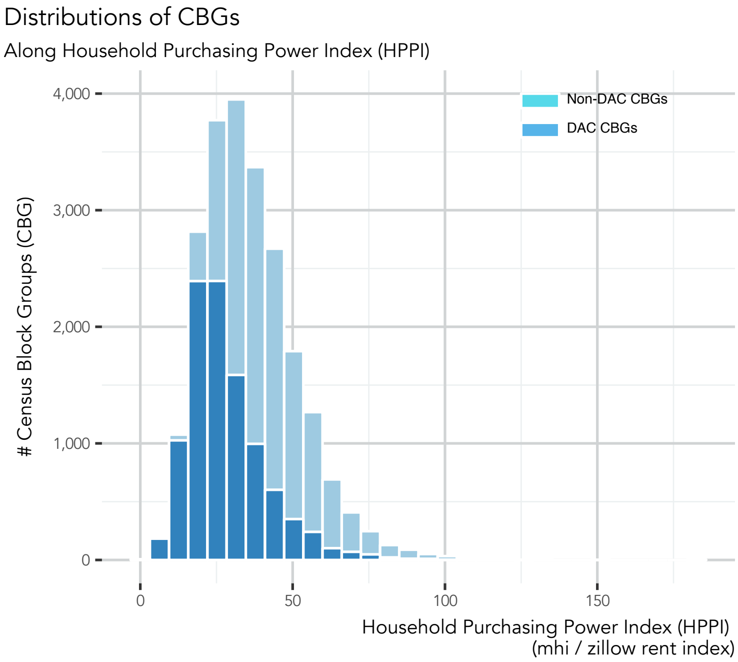

Figure 10: Distribution of CBGs, along Household Purchasing Power Index (HPPI)

Figure 10 shows the distribution of Census Block Groups by Household Purchasing Power Index (HPPI), between DAC and non-DAC block groups. Taking local purchasing power into account accentuates the number of false positives detected: block groups that are relatively wealthy in context, but still identified as DACs by the official measure. False positives are in the right tail of the distrivution of DAC block groups in figure 10. The majority of DACs have a low HPPI, in line with policy goals. But a number of DACs have a very high HPPI, indicating a high puchasing power in context. False negatives are non-DACs that really are struggling in context. They are block groups with a MHI over the threshold but situated in an area where cost of living, as measure by ZRI, is high. In figure 10, false negatives are situated on the left side of the non-DACs distribution, having a low HPPI. They are relatively rare compared to potential false positives.

Norma Triangle: above the threshold but struggling

Figure 11: Map of Norma Triangle, Census Tract 7005.01, Los Angeles County, California

IN CONTEXT. Norma Triangle, in West Hollywood, exemplifies this bias. The southern part of the triangle, along Santa Monica Boulevard, block group 3 of the census tract 7005.01, had a MHI of just 52 467 $ in 2010. The Triangle, however, is nestled in an exceptionally wealthy area of Los Angeles county, as its 90210 ZIP code testifies. The area has a ZRI of 11 671, resulting in a PPI of 4,5. Norma Triangle forms the western border of West Hollywood, adjacent to Beverly Hills. The area is therefore just shy of qualifying as a DAC following the official definition, but situated in one of the most expensive areas of the state, where houses are regularly listed for more than a million dollars. Figure 11's map shows Norma Triangle, largely composed of small houses and apartment buildings, nestled between Beverly Hills on the West, the luxury houses with stunning views of the Bird Streets on the North, urban upper-class West Hollywood on the East, and design retail around the Pacific Design Center on the South.

TOWER DISTRICT: LOWER INCOME IN AN AFFORDABLE ENVIRONMENT. Tower District in Fresno, just right north-west of Downtown Fresno, illustrates the bias in the inverse direction. Block group 4 of census tract 22 had a MHI of just 44 679 $ in 2010. Yet, it's ZRI was just 747, resulting on a PPI of 59,8. The district is urban, historic and young, lying between an active Olive Avenue on the South, counting bars, restaurants and theaters, and Fresno's City College on the North.

Residents of Fresno's Tower District earn significantly less than their WeHo's South Norma Triangle counter-parts, 7 788 $ a year less per household, but every dollar they earn goes more than 10 times as far on housing.

4.3 *Household structure provides a more detailed picture of purchasing power*

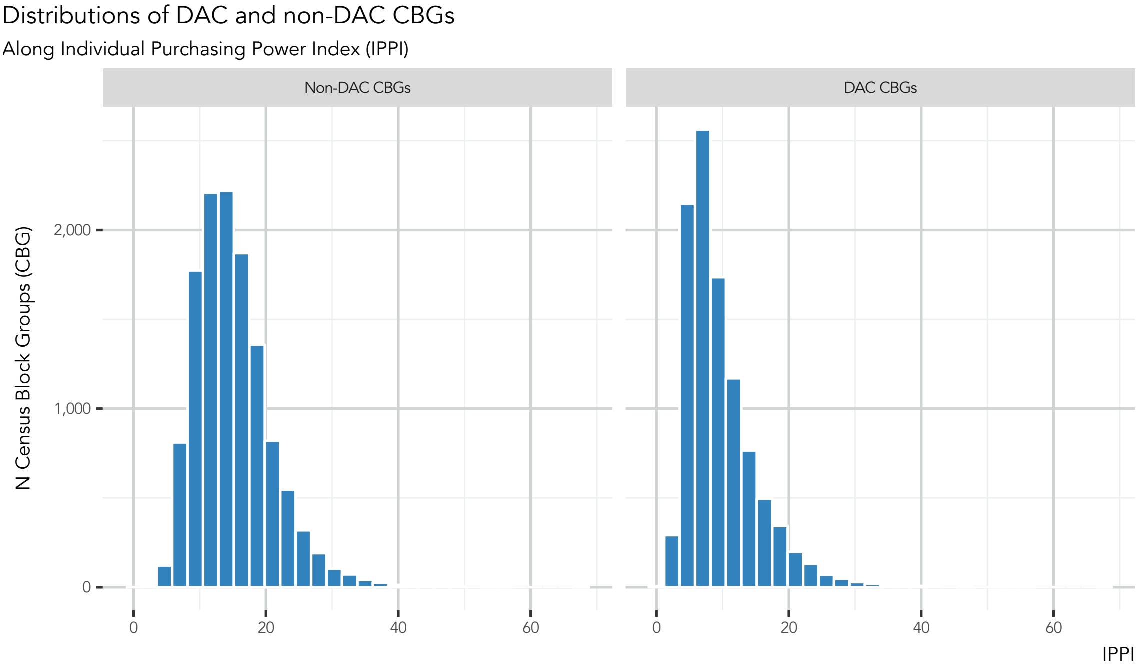

Figure 12: Distributions of DAC and non-DAC CBGs, along Individual Purchasing Power Index (IPPI)

Figure 12 shows side by side the two distributions of DAC and non-DAC census block groups along the IPPI index. The figure hints at two very similar distributions, that would indicate a poor performance of the official DAC definition at capturing disadvantaged communities.

Figure 13 compares the two distributions of DAC and non-DAC census block group along the IPPI with a quantile-quantile plot. A quantile-quantile plot compares two distributions quantile by quantile, each on one axis of the plot. If the two distributions are identical, the plot will show a straight 45 degrees line. Figure 13 shows that the distribution of DAC and non-DAC census block groups along the IPPI are very similar, with an expected right skew for non-DAC block groups. This skew is expected because a right skew along the IPPI index is a skew towards more purchasing power, but the two distributions are still very close.

The similarity of the two distributions confirms that the DAC definition set California's Public Resources Code is ineffective at delineating disadvantaged communities using a simple, but contextless and mono-dimensional metric.

DACs with relatively high purchasing power. Midtown

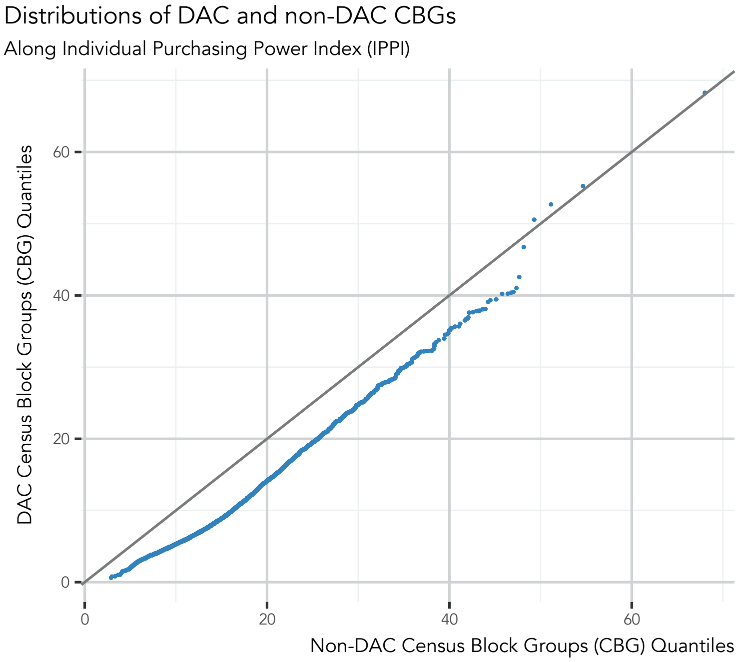

Figure 13: Quantile-Quantile plot of the 2 distributions of DAC and non-DAC blocks along Individual Purchasing Power Index (IPPI)

Sacramento illustrates how the household structure and contextual conditions nuances the picture offered by a simple MHI measure. The area around J street in the vicinity of Marshall Park (Block Group 1 of Census Tract 14) had a MHI of just 49 107 $ in 2010, below the DAC threshold. However, the area has a relatively low ZRI of 1 187 and one of the lowest average household size in the state at 1,12. Figure 16'map shows median household sizes for Census block groups in Sacramento, and exposes the relatively unique situation of this neighborhood in the region for its small households. Marshall Park is a relatively young, affordable and urban neighborhood. The MHI of 49 107 $ reflects the individual income of adults, not an income supporting a large family, explaining the high IPPI of 36,9.

Wofford Heights, Kern County, a census designated place of 2 200 inhabitants on the shores of Lake Isabella in the High Sierra (figure 17), offers another, more nuanced example of relatively high IPPI for a low income. The northern part of Wofford Heights (Block Group 4 of Census Tract 52.01), north of Route 155, had a very low MHI of 28 667 $ in 2010. The southern part of Wofford Heights (Block Group 3 of Census Tract 52.01) had a MHI of 43 500 $ in 2010, well below the DAC threshold. Because Wofford Height is rural and rental prices low, and households in south Wofford Heights are relatively small (1,52 median), its IPPI is high at 27,6.

Context and age nuance these two examples, similar if one looks at IPPI alone. Wofford Heights is a rural, aging community. Southern Wofford Heights residents have a median age of 60. There is

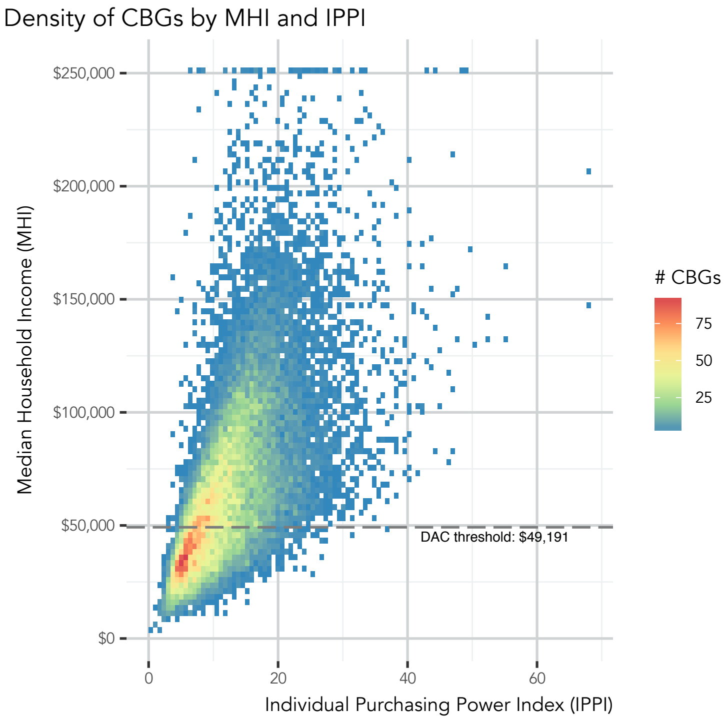

Figure 14: Density of CBGs by MHI and IPPI

very little economic opportunity in the vicinity, with the small ski resort and cabin rentals of Alta Sierra. By contrast, Midtown Sacramento residents are younger with a median age of 42 in the census tract. They have access to a larger pool of potential employment, at the center of the 4^{th} largest metropolitan area of California. Wofford Heights is an unincorporated Census Designated Place, under direct administration of KernCoutny, as are many rural communities in California. Midtown Sacramento is part of a large city with extensive infrastructures. If Wofford Heights and Midtown Sacramento's situation look similar regarding income and household structure, their relative accessible resources tell a contrasting story. One of these communities has access to much fewer resources than the other.

Communities with low purchasing power non-identified as DACs. The area North-West of the rail station in San Juan Capistrano (Block Group 3, Census Tract 423.12), in Orange County, illustrates how household structure influences relative affluence. The area is not a DAC by the official definition, with a MHI of 51 028 $ in 2010, and the city of San Juan Capistrano itself had a MHI of 76 686 $, below the state median. Orange County is a relatively expensive part of the state, along the coast of Souther California between Los Angeles and San Diego. As a result, real estate prices can be high. What distinguishes this part of San Juan Capis-

Figure 15: Density of CBGs by MHI and IPPI, by DAC status

trano, however, is the large average household size of 6.91. This area is visible on figure 18, showing that, in regards to household size, it is an outlier in the municipality. As a result, the area has a low IPPI of 2.96. The station area of San Juan Capistrano illustrates that even when two areas are very comparable in term of household income and rent prices, the actual affluence of an household can vary widely depending on the number of household members that this income supports.

The IPPI offers a simple alternative to MHI, that is still legible. However, one should still be cautious of the block group level real estate conditions that are not captured by a contextual indicator such as the Zillow Rent Index. The Naval Amphibious Base on Coronado Island in the port of San Diego illustrates this caveat. Coronado Island is a fairly wealthy and expensive neighborhood in

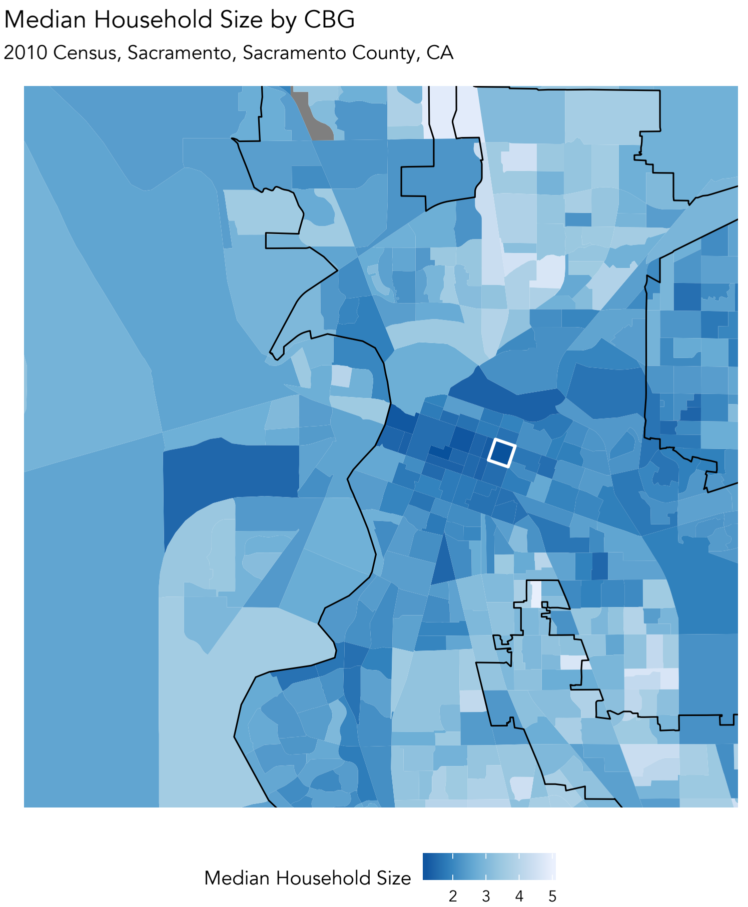

Figure 16: Map of median household size by Census block group, 2010, Sacramento, CA. Highlight on Midtown Sacramento, Block Group 1 of Census Tract 14.

San Diego county. Therefore, the ZRI index is relatively high (4 851). Figure 19's map shows that the base is in the immediate vicinity of oceanfront condominiums and wealthy individual houses abutting a golf. Military personnel tend to have larger household size than the rest of the population (the average household size is 3.52 on the base). They have more children. They also tend to have a stay-at-home spouse more often. Although military personnel often have a modest income (the MHI is 49 943 $ on base), their accommodation is provided on base. As a result, Naval Amphibious Base on Coronado has a very low IPPI of 2.9, reflecting its status as a lower-income community in a generally well-off environment. But the IPPI score does not reflect benefits that military personnel enjoy, especially regarding housing, and that makes it not a disadvantaged community.

Figure 17: Map of Wofford Height, Census Tract 52.01, Kern County, California

Median Household Size by CBG

2010 Census, San Juan Capistrano, Orange County, CA

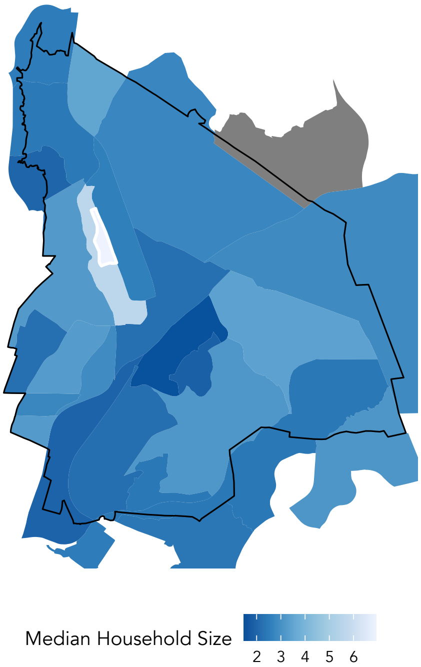

Figure 18: Map of median household size by Census block group, 2010, San Juan Capistrano, Orange County, CA. Highlight on Midtown Sacramento, Block Group 3, Census Tract 423.12.

Figure 19: Map of Coronado Island Naval Amphibious Base, Census Tract 216, San Diego County, California

5 Conclusion

5.1 Multiple scales of measurement provide opportunities for exploit

Measuring a spatial aggregate on multiple scales increases chances of false positives, and multiplies opportunities of policy exploit in consequence, as I have demonstrated in section 4.1. These false positives are due to the Modifiable Areal Unit Problem (MAUP). Larger entities present risks to lump together wealthy neighborhood with struggling communities, in a aggregate appearing as the latter excusively. In regards to policy goals, this is a potential exploit because it could direct funds earmarked for disadvantaged communities to serve affluent neighborhoods.

To avoid this problem, **I recommend measurement on one scale only, the scale presenting the lowest risk of MAUP, the Census Block Group**. Census Block Groups are small enough to be relatively homogeneous, but large enough to enwrap neighborhoods or large portions thereof.

5.2 Geographic realities need to be measured in their geographic context

Absence of context in the current DAC measurement is a major hindrance to the policy efficacy. Spatial statistics such as the census aggregates used as a criterion to delineate DACs in Prop. 84's definition are meaningful in their geographic context. Spatial autocorrelation, the fact that realities close to each other look more alike than realities more distant from each other, must be accounted for in any use of spatial statistics, especially for policy purposes. Prop. 84 fails to do so on two different grounds, and this double geographic shortcoming undermines policy efficacy. Spatial autocorrelation—geographic context—must be taken into account both outside units of statistical aggregation—i.e. regional geographic context—and inside of them—i.e. local geographic context.

First, on a macro-scale, spatial units of statistical aggregation (Census Bloc Groups, Census Tracts & Census Places) are located in very different context all over the state of California. As a result, the same aggregate statistic conveys a potentially different information depending on the overall context. In regards to the metric set by Prop. 84, **income is only indicative to economic hardship when compared to cost of living, and cost of living varies with geographic context**. For a household, an annual income of 50 000 $ could mean living relatively comfortably in a rural part of the state where cost of living is low, but be effectively in poverty in an expensive metropolitan area. In this research, I used rent index as a proxy for cost of living, and shown in section 4.2 that bringing relative cost of living into the picture already undermines Prop. 84's DAC metric.

Second, on a micro-scale, spatial units of aggregation (CBG, Ctr & CPl) are different from each other in ways that are not captured by the simple Median Household Income (MHI) metric. Because of spatial autocorrelation, the same MHI captures a different information between two places with different household types, as I have demonstrated in section 4.3. An annual household income of 50 000 $ can be insufficient for a family of five and put them through severe economic hardship. The same income would be a healthy income for a single, young professional tarting her career without any dependent to support. Neighborhoods, and therefore spatial units of statistical aggregation for MHI, tend to concentrate one type of household structure.

Taking into account both regional and local geographic context exposes the failure to Prop. 84's DAC definition to truthfully delineate communities experiencing a real economic disadvantage from the others. Further, it fails to do so in both direction, producing false positives and false negatives. On the one hand, Prop. 84 fails to identify struggling communities because their MHI is above the threshold, where in context their income is insufficient to live out of struggle. On the other hand, Prop. 84 labels as DACs communities that in context are not experiencing serious economic hardship.

5.3 *A continuous metric effective in regards to policy goals*

Measurements of disadvantage metrics made at all stages of this analysis, from the original MHI to the final IPPI taking geographic context and household structure into account, are continuous metrics. Communities do no fall naturally from one side or the other of an obvious separation between struggle and ease. In effect, all distributions of these metrics approach a log-normal distribution, where the logarithm of measurement is normally distributed. There is no intrinsic way of dividing such a distribution into different categories, and the challenge becomes all the more difficult with the fewer categories we want to use. Rather, ad-hoc, contextual considerations can be used to decide on a threshold. However, in the case of disadvantage communities, such an obvious threshold is lacking. The 80% of statewide MHI has no particular meaning, not more than 75% or 85%, nor would have any arbitrary cutoff along the IPPI scale.

Furthermore, because the distribution is log-normal, measurements are concentrated on the lower-end, and form a long-tail on the higher-end. This *right skew* helps distinguishing wealthy communities from the others more than it helps telling struggling communities apart, consequently countering the policy-driven purpose of effectively delineating disadvantaged communities.

Therefore, there is no good way of separating disadvantaged from not disadvantaged communities in a binary fashion using these metrics. Nonetheless, this measure of disadvantage can still be used effectively to achieve the policy purpose of providing resources to disadvantaged communities in priority. California DWR uses a point-based system to allocate Prop. 84 and Prop. 1 grants, judging applications and allocating point along a diversity of dimensions, one of these dimensions being involvement of disadvantaged communities. I propose that **points be allocated in inverse proportion to the Individual Purchasing Power Index (IPPI), or the log thereof, of Census Block Groups (CBG) served by the project**. This would ensure that projects benefiting to a higher number of actually economically struggling households are moved up in the ranking for projects for grant allocation.

I propose to use the CBG scale exclusively because CBGs are small enough to not cross community borders and be relatively homogeneous, not subject to the Modifiable Areal Unit Problem (MAUP) as much as Census Tracts, and, even more so, Census Places. The number of points allocated to this IPPI should be calibrated with other dimensions to ensure impact on disadvantaged communities has the desired weight compared to other dimensions. This would have the additional effect of making the policy trade-off between social justice and environmental goals transparent. Moreover, I recommend that the point scale take into account the number of CBGs served, favoring projects that serve large disadvantaged communities.

In addition, Prop. 84 sets a minimum goal to be met by all IRWM submitting grant applications, for 25% of projects to serve disadvantaged communities. This minimal threshold can be handled in different ways, using the IPPI metric. The simplest way is to use the same point allocation system as for general project evaluation, setting a minimum average of DAC points by allocated grant. This average by allocated grant allows trade-offs between projects serving large disadvantaged communities and projects serving none. This trade-off can be exploited by IRWMs by including modest, high-DAC projects compensating for expensive, low-DAC ones. If this trade-off is not desired by policy proponents, the program can mandate that a proportion of projects be above a certain number of DAC points. Because DAC points are a finer metric, it would pose less discretization problems than the current binary threshold, but would still create arbitrary threshold effects. To eliminate threshold effects and mitigate trade-off exploits potential, I propose to weigh the contribution of each project to the average by the grant amount requested. Large projects not serving any DAC would have a greater negative effect on the weighted average compared to smaller project serving DACs, coherent with the policy goal.

5.4 *A better metric to delineate disadvantaged communities*

In regards to the four criteria I have defined in the research question (section 2)—truthfulness, robustness, legibility & fitness—, Proposition 84's measure of disadvantage communities based on a unique threshold on median household income has a single strong point: its legibility. Because the measure is so simple, it is easy to understand and to use in a grant application. Applicants, however, sometimes feel the need to justify the DAC focus of their projects with other measures.

I have shown that MHI is neither truthful nor robust to delineate disadvantaged communities. When taking geographic context into account, MHI fails to distinguish economic disadvantage. The information conveyed by MHI is highly dependent on geographic context—how far a dollar goes in this place—and household structure—how many individuals does this income support. For these reasons, it appears that Proposition 84's measure sacrifices truthfulness for simplicity. A MHI threshold is also not robust, because of the degree of freedom introduced by multiple scales of measurement, especially by allowing definition at the scale of Census Places. And because it is binary, it creates arbitrary false positives and false negatives around the threshold value.

A definition based on IPPI is, in practice, less legible, because it requires more operations. In principle, however, it captures a simple concept of purchasing power: how far a dollar goes in a specific place. Geographic differences of purchasing power is common enough in everyday conversations that the concept is accessible to lay persons. Differences in rental prices is a well known, and much discussed, phenomenon.

IPPI measured at the scale of the Census Block Group allows is a more truthful and robust metric than a multi-scale MHI threshold. IPPI captures economic struggle, in context. The metric is closer to actual experienced disadvantage. It is more robust because it does not introduce MAUP biases. Implementing IPPI in a point based system, closer to a continuous measurement, also eliminates the majority of false positives and false negatives, therefore rendering it both more truthful and more robust. It is more truthful because it better identifies disadvantaged communities, and it is more robust because it does not create arbitrary false positives and false negatives when the threshold is moved.

References

Abdulkadiroğlu, A, PA Pathak, and AE Roth (2005a). “The Boston public school match”. In: *American Economic Review* 95.2, pp. 368–371.
— (2005b). “The New York City high school match”. In: *American Economic Review* 95.2, pp. 364–367.
Abdulkadiroglu, A and T Sönmez (2003). “School choice: A mechanism design approach”. In: *The American Economic Review* 93.3, pp. 729–747. DOI: 10.1257/000282803322157061.
Borgers, Tilman, Daniel Krahmer, and Roland Strausz (2015). *An Introduction to the Theory of Mechanism Design*. Oxford: Oxford University Press, p. 246. ISBN: 9780199734023.
Bun, Yeng (2012). *Zillow Rent Index: Methodology*.
Bureau of Labor Statistics (2016). *Guide to Available CPI Data*.
Cain, Bruce E. (1985). “Assessing the Partisan Effects of Redistricting”. In: *American Political Science Review* 79.02, pp. 320–333. ISSN: 0003-0554. DOI: 10.2307/1956652.
California Department of Water Resources (2012). *IRWM Grant Program Guidelines - Propositions 84 and 1E*. Tech. rep. Sacramento, CA: California Department of Water Resources.
— (2016a). *2016 Integrated Regional Water Management Grant Program Guidelines - Volume 1 – Grant Program Processes*. Tech. rep. Sacramento, CA: California Department of Water Resources.
— (2016b). *Disadvantaged Community Involvement Request for Proposals*. Tech. rep. Sacramento, CA: California Department of Water Resources.
— (2016c). *Summary of Prop 84 IRWM Grant Program Awards*. Tech. rep. Sacramento, CA: California Department of Water Resources.
California State Board of Equalization (2014). *Sales and Use Taxes: Exemptions and Exclusions*. Tech. rep. Sacramento, CA: California State Board of Equalization.
Cassel, G. (1918). “Abnormal Deviations in International Exchanges”. In: *The Economic Journal* 28.112, p. 413. ISSN: 00130133. DOI: 10.2307/2223329.
Cervero, R (2002). “Induced Travel Demand: Research Design, Empirical Evidence, and Normative Policies”. In: *Journal of Planning Literature* 17.1, pp. 3–20. ISSN: 0885-4122. DOI: 10.1177/088122017001001.
Cervero, R and M Hansen (2002). “Induced travel demand and induced road investment: a simultaneous equation analysis”. In: *Journal of Transport Economics and* 36.3, pp. 469–490.
Cherlin, Andrew J. (2010). “Demographic Trends in the United States: A Review of Research in the 2000s”. In: *Journal of Marriage and Family* 72.3, pp. 403–419. ISSN: 00222445. DOI: 10.1111/j.1741-3737.2010.00710.x.
Cheung, Yin-Wong (2009). “Purchasing Power Parity”. In: *The Princeton encyclopedia of the world economy*. Ed. by Kenneth A. Reinert, Ramkishen S. Rajan, and Amy Joycelyn Glass. Princeton: Princeton University Press, p. 942. ISBN: 069112812X.
Cliff, A and JK Ord (1973). “Spatial autocorrelation”. In:
Cronbach, Lee J. and Paul E. Meehl (1955). “Construct validity in psychological tests.” In: *Psychological Bulletin* 52.4, pp. 281–302. ISSN: 0033-2909. DOI: 10.1037/h0040957.
de Souza Briggs, Xavier, Susan J. Popkin, and John Goering (2010). *Moving to opportunity: The story of an American experiment to fight ghetto poverty*. Oxford University Press. ISBN: 978-0195392845.
Durlauf, Steven N. (1996). “Associational Redistribution: A Defense”. In: *Politics & Society* 24.4, pp. 391–410. ISSN: 0032-3292. DOI: 10.1177/0032329296024004008.
— (2004). “Neighborhood Effects”. In: *Handbook of Regional and Urban Economics*. Ed. by J. Vernon Henderson and Jacques-François Thisse. Vol. 4. Elsevier. Chap. 50, pp. 2173–2242. ISBN: 9780444509673. DOI: 10.1016/S1574-0080(04)80007-5.
Erikson, Robert S. (1972). “Malapportionment, Gerrymandering, and Party Fortunes in Congressional Elections”. In: *American Political Science Review* 66.04, pp. 1234–1245. ISSN: 0003-0554. DOI: 10.2307/1957176.
Favre-Bulle, Thomas (2009). “Le People’s Rule en Californie”. FR. Master Thesis. Lausanne (Suisse): Ecole Polytechnique Fédérale de Lausanne.
— (2015). “The Urban Diffusion of Local Direct Democracy between Switzerland and the United States”. EN. In: *The Diffusion of Law: The Movement of Laws and Norms Around the World*. Ed. by Sue Farran. Farnham: Ashgate, pp. 109–124. ISBN: 9781472460417 | 9781472460400.
Fowler, Floyd J. Jr. (2013). *Survey research methods*.

Abbreviations

ABAG Association of Bay Area Governments
ACS American Community Survey
BG (Census) Block Group
BLS Bureau of Labor Statistics
CDP Census Designated Place
CPI Consumer Price Index
DAC Disadvantaged Community
DWR (California) Department of Water Resources
HPPI Household Purchasing Power Index
HUD U.S. Department of Housing & Urban Development
IPPI Individual Purchasing Power Index
IRWM Integrated Regional Water Management
MAUP Modifiable Areal Unit Problem
MHI Median Household Income
MTO Moving to Opportunity for Fair Housing
PPP Purchasing Power Parity
PRC (California) Public Resources Code
ZCTA ZIP Code Tabulation Areas
ZRI Zillow Rent Index

Fudenberg, Drew and Jean Tirole (1991). *Game Theory*. Boston: MIT Press, p. 579. ISBN: 9780262061414.
Garrett, Thomas A., Gary A. Wagner, and David C. Wheelock (2007). "Regional disparities in the spatial correlation of state income growth, 1977–2002". In: *The Annals of Regional Science* 41.3, pp. 601–618. ISSN: 0570-1864. DOI: 10.1007/s00168-007-0114-x.
Gehlke, C. E. and Katherine Biehl (1934). "Certain Effects of Grouping upon the Size of the Correlation Coefficient in Census Tract Material". In: *Journal of the American Statistical Association* 29.185A, pp. 169–170. ISSN: 0162-1459. DOI: 10.1080/01621459.1934.10506247.
Graham, B (2011). "Econometric methods for the analysis of assignment problems in the presence of complementarity and social spillovers". In: *Handbook of social economics,Volume 1*. Ed. by Jess Benhabib, Alberto Bisin, and Matthew O. Jackson. Elsevier. Chap. 19, pp. 965–1052. ISBN: 978-0-444-53713-3. DOI: 10.1016/S0169-7218(11)01024-0.
Griffith, Daniel A. (2003). *Spatial Autocorrelation and Spatial Filtering : Gaining Understanding Through Theory and Scientific Visualization*. Berlin: Springer Berlin Heidelberg, p. 250. ISBN: 3540248064.
Her Majesty's Treasury (1988). *Policy Evaluation: A Guide for Managers*. Tech. rep. London: Her Majesty's Stationery Office.
Hines, James R (1999). "Three Sides of Harberger Triangles". In: *Journal of Economic Perspectives* 13.2, pp. 167–188. ISSN: 0895-3309. DOI: 10.1257/jep.13.2.167.
Hotz, V. Joseph, Guido Imbens, and Jacob Klerman (2006). "Evaluating the Differential Effects of Alternative Welfare-to-Work Training Components: A Re-Analysis of the California GAIN Program". In: *Journal of Labor Economics* 24.3, pp. 521–566. DOI: 10.3386/w11939.
Housing Requirements for Residential and Live/Work Development Projects.
Ludwig, J et al. (2008). "What can we learn about neighborhood effects from the Moving to Opportunity experiment". In: *American Journal of*.
MacCorquodale, Kenneth and Paul E. Meehl (1948). "On a distinction between hypothetical constructs and intervening variables." In: *Psychological Review* 55.2, pp. 95–107. ISSN: 0033-295X. DOI: 10.1037/h0056029.
Mceldowney, J. J. (1997). "Policy Evaluation and the Concepts of Deadweight and Additionality: A Commentary". In: *Evaluation* 3.2, pp. 175–188. ISSN: 1356-3890. DOI: 10.1177/135638909700300204.
Openshaw, Stan (1984). *The Modifiable Areal Unit Problem*. Norwich, England: Geo Books, p. 40. ISBN: 9780860941347.
Pitzer, Gary (2013). *Layperson's Guide to Integrated Regional Water Management*. Tech. rep. Sacramento, CA: Water Education Foundation, p. 11.
R v Sussex Justices, ex p McCarthy (1924).
Rey, Sergio J. and Brett D. Montouri (1999). "US Regional Income Convergence: A Spatial Econometric Perspective". In: *Regional Studies* 33.2, pp. 143–156. ISSN: 0034-3404. DOI: 10.1080/00343409950122945.
Rey, SJ (2004). "Spatial analysis of regional income inequality". In: *Spatially Integrated Social Science*. Ed. by Michael F. Goodchild and Donald G. Janelle. Oxford University Press. Chap. 14, pp. 280–299. ISBN: 9780195348460.
Roth, AE and M Sotomayor (1992). "Two-sided matching". In: *Handbook of game theory with economic*.
Roth, Alvin E. (2015). *Who Gets What - and why: The New Economics of Matchmaking and Market Design*. 1st ed. Boston, New York: Houghton Mifflin Harcourt, p. 260. ISBN: 9780544291133.
Sanbonmatsu, L et al. (2011). *Moving to Opportunity for Fair Housing Demonstration Program - Final Impacts Evaluation*. Tech. rep. U.S. Department of Housing, Urban Development | Office of Policy Development, and Research, p. 330.
Schwartz, AF (2014). *Housing policy in the United States*.
Sharkey, P (2013). *Stuck in place: Urban neighborhoods and the end of progress toward racial equality*. Chicago: University Of Chicago Press, p. 264. ISBN: 978-0226924250.
Taylor, Paul and Richard Fry (2012). *The Rise of Residential Segregation by Income*. Tech. rep. Washington, D.C.: Pew Research Center.
Tokila, Anu, Mika Haapanen, and Jari Ritsilä (2008). "Evaluation of investment subsidies: when is deadweight zero?" In: *International Review of Applied Economics* 22.5, pp. 585–600. ISSN: 0269-2171. DOI: 10.1080/02692170802287631.
U.S. Census Bureau (1994). *Geographic Areas Reference Manual*. Ed. by Nancy K. Torrieri. U.S. Census Bureau.
Von Arx, Nicolas (2002). *Ähnlich, aber anders. Die Volksinitiative in Kalifornien und in der Schweiz*. Deutsch. Collection Genevoise. Schulthess. ISBN: 3719020967.

Chapter III

THE PLACE AND SCALE OF CONSENT

INDIVIDUAL SUPPORT FOR LOCAL GOVERNMENT COLLABORATION IN CALIFORNIA METROPOLITAN AREAS

The Place and Scale of Consent: Individual Support for Local Government Collaboration in California Metropolitan Areas

Metropolitan areas are the space of urban life, the space of housing, job and transit markets: they are functionally integrated. Many local governments (cities, towns, counties) coexist in this integrated space: metropolitan areas are institutionally fragmented. In consequence, policies conducted in metropolitan areas have strong externality effects, beyond the boundaries of a single municipality or county. Scholars have proposed ways to address this discrepancy between functional integration and institutional fragmentation, from competing jurisdictions to metropolitan consolidation. Yet, popular support for these proposals is not abundantly researched.

In this paper I study individual support for collaboration between local governments on policies presenting strong metropolitan externalities: land-use, transportation and transit, water supply.

I conduct a fully randomized survey experiment and ask respondents to express support or opposition to collaboration plans. Institutional features of these plans are randomly drawn from a set of possible values, derived from existing collaboration arrangements. Features include scale of collaboration, coordination with other policies, cost, or the type of power the new board will hold. This experiment is designed to measure the average marginal effect of each institutional feature, understanding how the shape of a collaboration plan causes popular support.

I find that coordination between policies is one of the few factors driving popular support towards more collaboration. Moreover, individuals favor small to medium-scale collaboration inside a metropolitan area rather than an all-encompassing proposal. In addition, features prompting support for collaboration varies geographically between different metropolitan areas in California.

I recommend that policies aiming at fostering metropolitan collaboration adopt a cross-policy approach, flexible enough to adapt to the policy mix driving more support in different metropolitan areas, and focus on fostering mid-scale collaboration between neighboring municipalities.

Policy take-aways

- People are not averse to metropolitan collaboration.
- One size does not fit all. Preferences of respondents vary geographically.
- Focus on solving the policy problem, not the institutional setup. People are swayed by a specific policy mix relevant to their metropolitan area.
- Arguments on cost savings brought by metropolitan collaboration are ineffective. However, respondents are deterred by cost increases.

Contents

1 *Literature review*

1.1 *Metropolitan areas are functionally integrated*

The White House's Office of Management and Budget (OMB) uses two criteria to identify metropolitan areas: one or several urban centers, and a high degree of commuting integration between counties.[1] Metropolitan areas' definition and delineations are revised every decennial census since 1950,[2] grounded in the same concept of a socially integrated space measured by the daily movement of people. Because they are based on commuting, American metropolitan areas are job markets by definition.[3] Two counties with a high level of commuting integration—i.e. many commuters living in one county and traveling on a regular basis to their workplace in the other county—are identified as part of the same metropolitan area. On a first level, the OMB mandates the US Census to identify statistical areas around a single urban core, delineating Core-Based Statistical Areas (CBSA). On a second level, if several CBSAs have themselves a high level of commuting integration, they form Combined Statistical Areas (CSA), in effect clusters of CBSAs. CSAs allow multi-polar metropolitan areas to be properly recognized. Lastly, CSAs and lone CBSAs that have not been combined in a CSA form together the group of Primary Statistical Areas (PSA). Figures 1 and 2 illustrate the difference between these definitions in California. The San Francisco Bay Area, as well as the Greater Los Angeles, are multi-core metropolitan areas. In these two areas, single-core CBSAs are grouped together in CSAs because of a high degree of commuting integration.

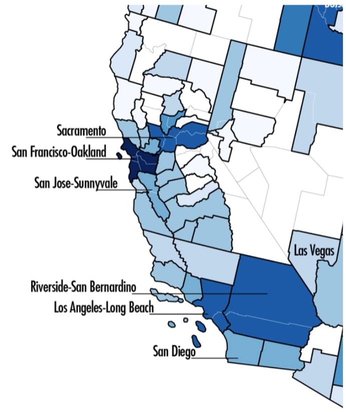

Figure 1: California Core-Based Statistical Areas, 2010 Census.

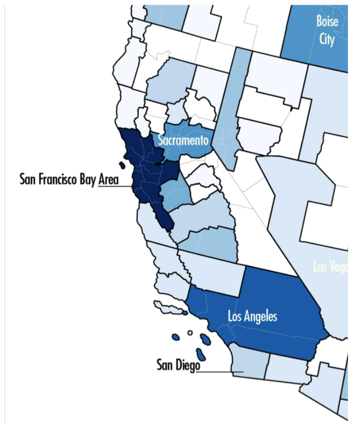

Figure 2: California Primary Statistical Areas, 2010 Census.

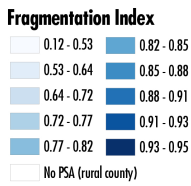

Figure 3:

Metropolitan areas are the product of a growing daily mobility of Americans from the beginning of the 20th century onward. The United States have evolved from a clear separation between small rural places and large cities to a realm of poly-centric metropolitan areas.[4] Until the first half of the 20th century, Americans were mostly living either in small rural places or mono-centric industrial cities.[5] Since then, the bulk of urban growth has happened in small municipalities or unincorporated communities within multi-core large urban environments.[6] This suburban growth, at first fueled by the creation and extension of rail transit, driving the growth of the *streetcar suburbs*,[7] was later encouraged further by the development of the highway system.[8]

The measurement of metropolitan areas by commuting is a proxy for general socio-spatial integration between places. If individuals commute between their residence and workplace, there is a good chance they will conduct their other social activities chiefly in the same space. Metro areas are also integrated housing markets, transportation sheds, water provision areas... Although using counties as units of measurement, the definition of metropolitan areas set by the OMB is a *statistical definition*, not administrative or political. This definition delineates an existing spatial reality, the most

[1] Office of Management and Budget 2010.

[2] Klove 1952.

[3] Adams, VanDrasek, and Phillips 2013; Duranton 2013; Morrill, Cromartie, and Hart 1999.

[4] Oliver 2001, p.35.

[5] Wallis 1994a.

[6] Wallis 1994b; Jackson 1985.

[7] S. Warner 1962.

[8] Baum-Snow 2007; Walker and Schafran 2015.

approachable functional unit of urban organization in the United States.

1.2 Metropolitan areas are institutionally fragmented

Despite their deep socio-economic integration, American Metropolitan Areas are not governed by overarching integrated institutions. The advent and extension of metropolitan areas has not left the pre-metropolitan institutional landscape unscathed. New municipalities[9] and special districts[10] have multiplied within their boundaries. On the contrary, the map of counties, rapidly evolving through the colonization and the expansion of western settlements, has been largely unchanged since the beginning of the 20th century. Urbanization and metropolitanization, therefore, have had very little impact on the number and shape of American counties. County governments are, in metropolitan areas, a legacy form of government engulfed in urban regions they precede.[11] This static map, superimposed but not corresponding with urban settlements, creates measurement problems, as metropolitan areas are largely defined on a county basis. The San Francisco Bay Area, for instance, comprises 9 to 11 counties, some entirely urban and some sparsely populated. The Greater Los Angeles, in turn, encompasses relatively large counties. Some of these counties, like San Bernardino and Riverside, comprise both populous cities and large areas of desert. Counties are the default form of local government in the United States, and especially in Western states, among them California. Given their importance, their spatial structure inherited from the 19th century causes palpable metropolitan governance effects today. For instance, the relatively large number of counties in the San Francisco Bay Area, and the small size of San Francisco itself, a consolidated city and county, creates coordination problems in metropolitan policies typically managed by counties, like public transit. By contrast, the centrality and large size of Los Angeles county facilitates the integration of the core of the Greater Los Angeles served by a common integrated transit service.

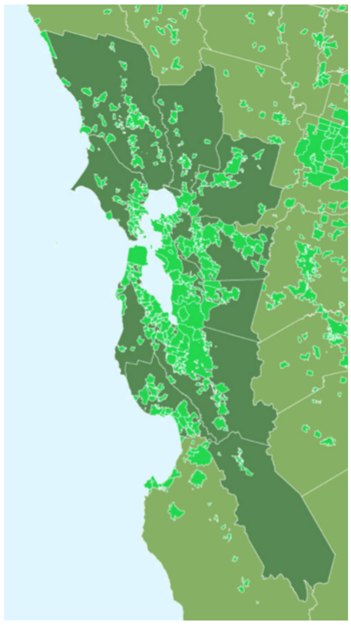

Figure 4: Fragmentation of local governments in the San Francisco Bay Area.

[9] Burns 1994.

[10] Foster 1997.

[11] William M. Scholl Center for American History and Culture at The Newberry Library 2016.

Although county boundaries have been stable over the 20th century during the extent of metropolitan areas, numerous new municipal and special purposes governments have been created in that period. Before the Civil Rights Act of 1968, Nancy Burns shows, new municipalities were mainly created at the fringes of extending metropolitan areas to provide services for newly developed areas.[12] The success of the civil rights movement, however, put an end to the most obvious segregation strategies and land-use became a key component for community and community leaders to restrict who could in effect own property in that community. Municipal incorporation became the vehicle to control land-use, and access to land-use powers explains the bulk of incorporations after 1968.[13] Dis-incorporation, the dissolution of a municipal government and return of the municipal land under direct county administration, is

[12] Burns 1994.

[13] Burns 1994.

possible, but rarely happens.[14] These rare dis-incorporation events are motivated by economic and fiscal hardship.

[14] Anderson 2011.

Special districts, by contrast with municipal general purpose governments, are created to conduct one or a limited set of policies. Often, they are directed at service provision. While special districts add the institutional fragmentation of metropolitan areas, they are often designed as a mean to address this very fragmentation, by creating a policy instrument shared by several general purpose governments.[15] The public has typically very little knowledge of special districts and, when their board is directly elected by voters, special districts' elections prompt very low turnout.[16] Special districts are often a financing instrument for capital intensive services and infrastructure.[17]

[15] Nunn and Schoedel 1997.

[16] Burns 1994.

[17] Stephens et al. 1998.

This multiplicity of governments in a single functional space results in institutional fragmentation. This fragmentation, however, varies in the United States. The difference between the functional dimension captured by commutes and the political structures of metropolitan areas can be measured by an index of institutional fragmentation. This index is a generalization of the Herfindahl-Hirschman Index (HHI), developed independently by Albert Hirschman[18] and Oris Herfindahl[19] to measure industrial concentration. The Federal Reserve has been using this index for market concentration of firms[20]. Daniel Kubler applied the HHI to metropolitan fragmentation in the Swiss context, taking only municipalities into account.[21] In figures 1 and 2, I present a generalized measurement of fragmentation accounting for counties and municipalities in California metropolitan areas.

[18] Hirschman 1945.

[19] Herfindahl 1950.

[20] Rhoades 1993.

[21] Kubler 2005.

Herfindahl-Hirschman Index
For every metropolitan area M, with a number N of institutions i, every institution with a population of Pop_i, the Herfindahl-Hirschman Index of Concentration HHI_M is:

$$HHI_M = \sum_{i=1}^{N} \left(\frac{Pop_i}{\sum_{i=1}^{N} Pop_i} \right)^2$$

In contrast with Europe, where many countries have implemented a new government layer to govern metro areas,[22] attempts to create such metropolitan governments have largely failed in the United States.[23] Metropolitan denizens today spend more and more of their time outside of their jurisdiction of residence. Yet, they continue to vote, and potentially have a voice to influence policy, in a single town or city. This discrepancy matters because policies conducted by a local government in a metropolitan area has potential effects in the whole area.

[22] Sellers 2013; Heinelt and Kübler 2005.

[23] Phares 2004.

1.3 *Metropolitan policies have strong externalities*

In metropolitan areas, policies and services have externalities outside of the boundaries of a specific jurisdiction. Carl Dahlman identifies externalities as a "divergence between private and social cost"[24]. In the context of metropolitan policies, the private cost is the cost borne by the jurisdiction setting the policy, and the social cost is the cost supported by other jurisdictions in the area. These jurisdictions endure an involuntary cost even though they had no say in setting the policy at the origin of the cost. For these services and goods, it is difficult to exclude potential beneficiaries or constrain negative effects, whether they are common-pool or public

[24] Dahlman 1979.

goods.[25] Building new road infrastructure or new traffic generators will influence traffic in other cities.[26] Likewise, restraining development in a city will affect the housing market in other cities.[27] Running water doesn't know about local government boundaries. For transportation, jobs, housing or water, the market is the size of the metropolitan area, not a single local jurisdiction. There is a spatial spillover and feedback effect of these policies, because metropolitan denizens move around every day to access goods and services.

[25] V. Ostrom and E. Ostrom 1999.
[26] Duranton and Turner 2011.
[27] Cervero and Wu 1997.

1.4 Addressing the discrepancy between social space and political space

Debate is extensive on the theoretical merits and demerits of metropolitan institutional arrangements, from consolidation of metropolitan governments[28] to small competing jurisdictions[29] and complex networks of collaborating actors[30].

[28] Briffault 1996; Jones 1942.
[29] C.M. M Tiebout 1956; V. Ostrom, Charles M. Tiebout, and Warren 1961; Frey and Eichenberger 2004.
[30] E. Ostrom 1972.

The apparent discrepancy between the scale of local governments and the scale of the policy effects of these governments has first led to calls to resolve the discrepancy by creating a level of government large enough to enwrap these policy effects entirely, resulting in the area's **consolidation**. From the 1940s to the beginning of the 1960s, metropolitan consolidation was the major effort to deal with the growing fragmentation. New local governments were continually incorporated at the edge of metropolitan areas, predominantly to provide services to newly developed areas,[31] rendering the fragmentation of public service provision more salient. In this context, the "metropolitan problem"[32] was to be solved by creating a new layer of local government that would either replace or complement existing local governments. Often touted as merits of replacing the existing governments altogether are the simplicity of the new structure, and its possible seamless integration into the current local government legal architecture. A unique government for the metropolitan area is easier to understand, therefore easier for voters to hold accountable. Moreover, this consolidated government can simply be created by merging existing jurisdictions together, avoid the need for crafting, and negotiating, a new legal structure. As in the United States, local government levels are created and regulated by state laws,[33] a merger keeps the solution local and shuffles off the necessity of escalating the issue to the State legislature. This is the reasoning behind municipal mergers and county-city consolidations.[34] However, never have two counties merged together in this setting and mergers have been constrained to the core of metropolitan areas. Wyandotte county, Kansas, created a unified government approved by referendum in 1997, to consolidate county and municipal governments around Kansas City.[35] Kansas City's metropolitan area, however, straddles the border between Kansas and Missouri, and a merger does not address this bi-state dimension of the area. Mergers are still advocated today. They are rare events and often fail in the ballot.[36] Notwithstanding, a large merger of cities and

[31] Burns 1994.
[32] Reed 1941.
[33] Novak 2000; Zimmerman 1981.
[34] SM Leland and Thurmaier 2010; SM Leland and Thurmaier 2004.
[35] S Leland and Thurmaier 2000.
[36] Linebaugh 2011.

counties of the San Francisco Bay Area is regularly proposed.[37]

Beyond merging existing governments, the second form of metropolitan consolidation is the creation of a whole new level of government, not replacing but supplementing the existing local governments, municipalities and counties. Metropolitan governments offer the potential to be more largely encompassing than mergers, engulfing the metropolitan area in its entirety, where mergers happen at the core. Often touted in the 1950s to the 1970s, attempts to create metropolitan governments have largely failed in the ballot in the United States.[38] They are, however, common in European countries.[39] Portland, Oregon, is one of the rare case of a successful implementation of a metropolitan government in the United States.[40] Started as a specialized district for managing solid waste, Portland Metro grew into a multi-purpose metropolitan government with a directly elected council.[41] Portland Metro's history is reminiscent of the European Union, started as a vehicle to manage a common resource, coal, and progressively built into a tight political integration.[42] Metropolitan governments usually require voters' approval and a provision from the State legislature, making them particularly difficult to conjure into existence. Consolidation never stopped being advocated as the solution to metropolitan fragmentation. For David Lowery, metropolitan areas are the lowest level at which policies might be provided.[43]

Early on, the growing fragmentation of local governments in metropolitan areas appeared to some scholars not as a problem but as a solution, an opportunity to manage public resources more efficiently. The **public choice** theory understands competition between local governments for fiscal resources as an incentive to be responsive and to align policies with their constituents' preferences. In a metropolitan area with multiple and diverse local governments, people have always the choice to *vote with their feet* and move to the municipality fitting their preferences the most.[44] Public choice approaches were influential from the 1970s to the 1990s,[45] offering an alternative to failed consolidation attempts, and more largely inscribed in a growing interest for market mechanisms and more direct accountability in public administration. Today, Bruno Frey advocates for Functional Overlapping Competing Jurisdictions, smaller autonomous jurisdictions competing for fiscal resources.[46] Residential mobility, however, is limited for metropolitan residents,[47] who realize this choice in a constrained space.[48] Small municipalities' social homogeneity renders them more prone to civic participation, and more democratic, for Eric Oliver.[49]

In 1972, Elinor Ostrom proposed to go beyond proposals of hefty institutional overhaul of metropolitan local governments and focus on metropolitan governance conducted by **networks of interacting actors**.[50] She conducted an attempt to be on the one hand more descriptive of the actions of actors on the field, and on the other hand to work within the existing institutional landscape of metropolitan areas. Her proposal avoids the political cost of re-architecturing

[37] Mendoza 2013.
[38] Phares 2004; Savitch and Vogel 1996.
[39] Jouve and Christian Lefèvre 2004; C. Lefèvre 1998.
[40] Aoki 2005.
[41] Briffault 1996.
[42] Dinan 2014.
[43] Lowery 2000, p.65.
[44] C.M. M Tiebout 1956.
[45] Lowery 2000.
[46] Frey and Eichenberger 2004.
[47] Ferreira 2010.
[48] Nall and Mummolo 2016.
[49] Oliver 2001; Oliver 2000.
[50] E. Ostrom 1972.

institutions, preferring instead a progressive change of their mode of operation. Consolidation, Ostrom argues, might not be the way to efficiency.[51] Since then, metropolitan governance has indeed focused on how existing institutions interact to manage common problems. More recently, scholars have integrated actors beyond governments in their assessment of metropolitan governance, including actors from civil society to describe collaborative modes of governance.[52]

[51] E. Ostrom, Parks, and Whitaker 1973.

[52] Ansell and Gash 2007.

There is no consensus on which arrangement would be the most efficient and democratic, in part because there is no consensus of what constitutes a measure of efficiency and democracy and how these measures could be optimized.[53] Cost reduction and increases in efficiency is not a given in any form of metropolitan governance and depends on contextual factors.[54] This study is indifferent to the actual efficiency of institutional arrangements and does not advocate for one or the other as a premise. I do not make an assumption that one mode of governance of the discrepancy between social and political spaces, be it consolidation, competition or collaboration, is more efficient or more democratic than the others.

[53] Allers and Geertsema 2016; E. Ostrom 1973.

[54] G Bel and ME Warner 2015.

1.5 Understand metropolitan residents' preferences towards governance

Whether scholars conclude that governance should be divided between many small competing local governments or concentrated into a consolidated metropolitan government, prescriptive works seldom describe a path to actual implementation of their propositions, instead focusing on what ought to be the institutional end-goal. Empirical research on popular support for institutional arrangements is scarce. Researchers have focused on perceptions and preferences of governments officials, both elected and staff members.[55] A multiplicity of fiscal, spatial, and organizational factor seem to influence willingness to cooperate.[56] Studies are often conducted through survey of local government officials.[57] Yet, understanding individual support is especially relevant since every major metropolitan collaboration plan since 1950 had to go to the ballot for approval and often failed to convince a majority of voters.[58] Moreover, local elected officials are more trusted and more responsive to their constituents' preferences than federal congress members. Rather, growing distrust government at the federal level in the United States has not translated in a corresponding distrust of state and local government.[59]

[55] G Bel and ME Warner 2015.

[56] Germà Bel and M. E. Warner 2015.

[57] M. Warner and Hefetz 2002.

[58] Hamilton 2014; Linebaugh 2011, p.122.

[59] Jennings 2003.

There is extensive research, however, on preferences for governance institutions in general and individual perceptions of democratic legitimacy.[60] An important distinction in democratic legitimacy is between what the governance instrument produce—output—and what how it operates—input & throughput. On the one hand, people can support governance institutions because they are efficient and produce good results. On the other, they can

[60] Norris 1999.

value public input and responsiveness as democratic. Normative has theory has emphasized one or the other,[61] noting that the two are sometimes incompatible. Public input can hinder as it can foster efficiency. Another dimension of legitimacy in the context of metropolitan governance is the question of scale. The question of governance scale is orthogonal to input and output legitimacy and can interact with both. If there is indication that the upscaling of functional integration in metropolitan areas reshapes local identification towards metropolitan areas,[62] there is no clear evidence of it in the United States yet. Local governments are generally more autonomous than in Europe and in many cases created to enforce homogeneity in communities through land-use policy.[63]

[61] Cohen 1997.

[62] Kübler 2016.

[63] Burns 1994.

The open question is therefore whether individuals value metropolitan governance plans on the merits of their efficiency or of their public process, and if they value smaller or larger scale cooperation.

1.6 Metropolitan California, a diverse and fragmented field

The State of California offers seminal ground to study metropolitan governance in America, for a series of reasons. First, California is the most **populous state** of the Union, with more than 39M residents in 2015, and the third largest with 155,000 sq mi. Second, California comprises **multiple and diverse metropolitan areas**. In this research I use the US Census' definition of Primary Statistical Areas as metropolitan areas, because this is the definition that reflect the most closely social use of space, allowing for metropolitan areas to contain one or multiple urban cores. The four main metropolitan areas of California who will be the focus of this study are the Greater Los Angeles, the San Francisco Bay Area, San Diego and the Greater Sacramento. These metropolitan areas are diverse in structure and governance. Especially, they offer an balanced sample of institutional fragmentation. The San Francisco Bay Area, with its 9 counties and more than 100 municipalities, is one the most fragmented metropolitan areas in the United States. San Diego, with a single county and a large central city is one of the least fragmented for its size. Texas is the other large state comprising multiple large metropolitan areas. But Texan metro areas are much more similar in having a relatively low institutional fragmentation with very large central cities and few incorporated suburbs. Third, **local governments are relatively autonomous** in California. Cities and counties can design their own organization rules by adopting a charter, although the State provides a default structure for local governments who do not do so.[64] California ranks 18th over 50 on Zimmerman's local autonomy ranking.[65] Local governments are governed by state laws in the United States. Combined with the large extent of the state, California presents a diversity of metropolitan areas governed by the same legal regime. Lastly, California's metropolitan areas are **confined inside state borders**. This is an exception rather than the rule in the United States, where many

[64] Richardson et al. 2003; Albuquerque 1997.

[65] Zimmerman 1981.

large cities border state boundaries. Their metropolitan areas, as defined by people's commuting patterns, straddle multiple states. This multi-state extent of metropolitan areas is particularly salient in the North-East, but also present in the West. The metropolitan area of Portland, Oregon, for instance, extends over the Columbia River in Washington state. This adds a level of complexity that I avoid by focusing on California.

The **Greater Los Angeles**, in Southern California, is the second largest metropolitan area in the United States, with more than 18M inhabitants. It is also the densest. For its size, the Greater Los Angeles is relatively less fragmented than other metropolitan areas. the City of Los Angeles is large, with more than 4M residents. Los Angeles County is central, populous, with more than half of the Greater Los Angeles population, and powerful.

The **San Francisco Bay Area**, in Northern California, offers a stark contrast with the Greater Los Angeles. The Bay Area is a rapidly growing 8.4M residents metropolitan area. But the area is very fragmented, with 9 counties and more than 100 municipalities. San Francisco, the only consolidated city and county in California, accounts for only 10% of the Bay's population. San Jose, at the south end of the Bay, is the largest and only millionaire city in the Bay. As a result, the Bay Area is multi-polar, and policy decisions are scattered between multiple local governments with diverging if not competing interests.

San Diego, immediately south of the Greater Los Angeles and bordering the California-Mexico border, is a very integrated metropolitan area of 3M inhabitants. Constrained by topographical and political obstacles on all sides, it is the largest metropolitan area in the United States made of only one county. As a result, policy decisions are often clearly distributed between county and municipalities, and there is little need for another level of specifically metropolitan governance. The city of San Diego itself is large and populous relative to the size of the metropolitan area. The main caveat regarding the insitutional landscape of San Diego is its situation at the Mexico border. There is an urban continuum between San Diego and Tijuana, the city located immediatly south of the border, in the Mexican state of Baja California. The two cities are integrated and complement each otehr functionnaly with intense daily exhanges of people and goods.[66]

[66] Bae 2005.

The greater **Sacramento** is the capital region of California, located in the northern tip of the Central Valley. The Sacremento-Roseville PSA counts 2.5M inhabitants and extends over 7 counties. Its influence spans over Douglas County in the state of Nevada. As illustrated by figure 2, the Greater Sacramento has an average level of fragmentation. The city of Sacramento itself houses only 20% (500 000) of the region's inhabitants. Suburbs and semi-rural communities span over 6 other counties. However, many communities are unincorporated (only 26 incorporated municipalities) and therefore the counties themselves conserve large responsibilities.

2 Research question

In section 1 I showed that metropolitan areas are functionally integrated even though they are institutionally fragmented. They form integrated social spaces where residents commute and live most of their social life. However, citizens only vote, and thus influence policy directly, in a single municipality of this area, although they are affected by policy decisions of other local governments. This discrepancy between social and political space has fostered three main strains of research pointing to the relative benefits of local government consolidation, competition, and collaboration. Recently, research on local government collaboration has focused on elected officials and staff preferences. However, public preferences, and especially voters' approval of collaboration, is an important yet unexplored support if not a driver of this collaboration. Proposals for integration, collaboration and incorporation of new municipal governments often have to be approved on the ballot, particularly in Western states and in California where direct democracy is more prevalent, and often fail there.

In this study I shift the focus from elected officials and government staff to the general public and voters to understand their preferences for collaboration between local governments in their metropolitan area. Collaboration between local governments takes multiple institutional forms and happens at different scales within metropolitan areas. **Which features of inter-governmental collaboration influence citizens' support or opposition?** The experimental setup I describe below is designed to answer this question for residents of California metropolitan areas.

3 Methods

3.1 Focusing on land-use policy

I select land-use policy as a main focus to test individual preferences for collaborations between local governments. The first reason is that land-use is a policy to be defined, not a service to be provided. In consequence, there is **no obvious optimum**, nor is there a clear metric of the efficiency of the service provided. Defining and implementing a land-use policy incur costs. Costs and their distribution is one of the several dimensions of a collaboration plan I test in the experiment.

Numerous previous studies on inter-governmental local collaboration has focused on the provision of services. Their focus on service provision can be explained on the one hand by the relative ease demonstrated by local government in contracting out these services, providing a larger field of observations. On the other hand, service provision is more easily quantified than is a policy. A garbage collection optimum, for instance, is clearly recognized as maximizing coverage while minimizing cost. What a land-use policy optimum would look like, if it existed at all, is not so immediately apparent. These two dimensions, a larger sample and an obvious metric, are related. An evident benchmark facilitates transactions between local governments and begets more collaboration.

Land-use policy is also relatively contentious, which makes the policy issues more salient to the general public, therefore more graspable. The institutional setup of land-use policies is simpler to understand than with many other policies. Municipalities are usually in charge of land-use in the United States, and in California they have extensive powers to define their land-use policy. Land-use has tangible externalities, that anyone who has looked for housing in a metropolitan has experienced at least once. Because a metropolitan area is an integrated housing market, housing built in a municipalities affects availability and prices of housing on other places of the area. Metropolitan residents are more familiar with land-use policy than with other policies.

Compared to other policies, land-use planning is a relatively straight-forward policy process in California today. Land-use planning involves multiple local officials: the legislative body of the local government (city council, board of supervisor), an advisory board (typically a planning commission), administrative staff, and legal counsel. The whole process is usually under the jurisdiction of a single local governments: a city, or a county for unincorporated areas.[67] By contrast, water or transit policies often involve a complex web of interacting institutions. However, environmental concerns have pushed land-use policy towards more complexity. Since 1970, both federal and, in California, state law, mandate the conduct of a thorough environmental impact assessment when a significant environment impact is likely (EIS/EIR).[68]

[67] The Institute for Local Government and Sanders 2010, p.7-12.

[68] The White House 2014.

Since the Federal-Aid Highway Act of 1962, all urbanized area of more than 50 000 people are mandated to have a Metropolitan Planning Organization (MPO), channeling federal fundings for local transportation projects. More recently, the state of California has pushed local governments towards more cooperation to reduce the environmental impact of development, and, specifically, reduce greenhouse gas emissions. The Sustainable Communities and Climate Protection Act of 2008 (SB375) mandates that each MPO develop a strategy integrating land-use and transportation to reduce greenhouse gases.[69] MPOs set a shared vision for the metropolitan area's future development as well as specific goals for every local government in their jurisdiction. However, MPOs lack enforcement power. Therefore, very little effective land-use and housing development coordination actually occurs.[70]

[69] *Senate Bill No. 375* n.d.

[70] Sciara 2014.

While the main focus of the experiment is land-use and planning, I test the support for coordination of this policy with other policies exhibiting metropolitan externalities and strong interactions with land-use. First, I choose **water supply** policy, where the externality lies in the sharing of a rival resource: water. When a municipality or a water district draws from a source of water, this water is not available for other uses in the area. The experiment takes place in California, a state that was at the time of survey completion plagued by a severe drought,[71] drawing public attention to the rival nature of water. The interaction between water supply and development is also clear to the public. More development in an area means that more water should be provided to this area. In California, however, no coordination between development and water supply is currently required. Land-use and water are typically managed by different institutions, namely municipal governments and water districts.

Second, I choose **transportation and transit** policy as a potential coordination with land-use policy. Transportation capacity, either by roads or public transit networks, are goods that are not restricted to the denizens of the jurisdiction laying them out. Many commuters use the roads of cities they do not live and vote in, or use a transit service from another city or county to commute. This is particularly true in metropolitan areas with a high degree of institutional fragmentation, where many different cities create and maintain roads used by people from all over the metropolitan area, and where commuters have to transfer from one transit system to another to reach their destination. The San Francisco Bay Area, for instance, comprises no less than 110 cities and 9 counties having their say in how the road network develops, and at least 26 publicly funded transit operators.[72] In more institutionally integrated metropolitan areas, a small number of institutions plan and manage roads and transit systems. San Diego, the least fragmented of the big four metropolitan areas in California, is composed of a single county and is served by only two urban public transit operators and two commuter rail line operators. The existence of an interaction between land-use and transportation and transit is also clear to the public, in principle if not in details. The abundance of comments on traffic and parking issues in public planning hearings and meetings demonstrates this public awareness.

The scenario tested in the experiment is therefore the **creation of a new land-use board, shared between the respondents' municipalities and its neighbors, and mandated with the definition and operation of the land-use and planning**.

3.2 *Randomized conjoint experiment*

Real-life individual support or opposition to policy arrangements is a multidimensional choice. In California, voters are familiar with being presented policy options in the ballot. The option that they have to decide on is composed of many dimensions.[73] Many studies rely on a declaration of preferences,[74] but to act on a declared preference in a decision context, individuals have to make a trade-off between several competing and sometimes contradictory preferences.[75] Individuals consider the opportunity cost,[76] the cost of alternatives foregone by making a choice, or resort to heuristics

[71] Diffenbaugh, Swain, and Touma 2015.

[72] Amin and Barz 2014.

[73] Hopkins, Yamamoto, and Hainmueller 2013.

[74] Kübler 2005; Sellers 2013.

[75] Nall and Mummolo 2016.

[76] Palmer and Raftery 1999.

to identify their preferred alternative. In order to untangle the dynamics of support or opposition to multi-government collaboration in metropolitan areas, I design a **fully randomized, full factorial, coinjoint experiment**.

The experiment is designed to uncover causal effects. The **experimental** setup observes responses of participants when they are presented with a controlled experimental treatment. The purposeful change of the treatment presented to respondents allows, under the right conditions, to ascribe the corresponding changes in the observed response to the treatment variation,[77] and statistically establish a causal link.

[77] Montgomery 2012, p.1.

The survey takes places in two phases. In order to avoid priming,[78] experimental questions are placed at the very beginning of the survey, while socio-demographic questions follow the experiment. Placing experimental questions first ensures that respondents are not influenced by their answers to previous questions in their choice of collaboration plans. Before the experiment, however, respondents are asked for their residence and work location. Their location is used to adapt question to their specific metropolitan area. For instance, a resident of San Francisco can be asked about collaboration in the "Greater San Jose-San Francisco-Oakland Area" while a resident of San Diego can be asked the same question about the "Greater San Diego-Carlsbad Area". After experimental questions, respondents are presented with extensive socio-demographic questions. These questions largely reproduce questions of the American Community Survey (ACS). The ACS is a long-form, continuous sampled survey of the United States population, complementing the short-formed decennial, un-sampled and exhaustive census.

[78] **Fowler2013**.

The experimental setup itself is twofold. First, respondents express a choice **between two collaboration plans** in a conjoint experiment. Respondents are asked which plan they prefer between two alternatives. Figure 7, in appendix, shows an example of the conjoint question. Then, respondents are asked to express an **independent preference for each of the two plans**, expressing a *No*, *I don't know*, or *Yes* vote. Figure 8, in appendix, shows an example of the independent preference question. The two plans presented to respondents are the same for conjoint and independent preference questions. Plans are **vignettes**, constructed descriptions of a proposal for a collaboration plan between local governments on land-use policies, representing a "systematic combination of characteristics",[79] the vignettes' *dimensions*.

[79] Atzmüller and Steiner 2010, p.128.

Each of the seven dimensions tested takes between 2 and 5 possible values. Each vignette comprises one value for every dimension. I extract dimensions and possible values from features of institutional arrangements in Californian metropolitan areas today. These dimensions, listed in table 2 are *(A)* scale of the collaboration, *(B)* evolution of the service cost, *(C)* distribution of these costs between municipalities, *(D)* type of power of the new board, *(E)* coordination with other policies beyond land-use, *(F)* mode of designating board members, and *(G)* sanctions for municipalities who would not comply with the board's decisions. The whole space of possible combinations for these values amounts to 2 160 vignettes.

The population of vignette is too large to be judged by a single respondent. Therefore, I design a method of selecting a sub-population of vignettes, and a method of partitioning this population to present a limited number of vignettes (2) to each respondent. I use full randomization to generate vignettes for each respondent. Every time a respondent takes the survey, a script generates a new set of vignettes by randomly assembling institutional features. The experiment is **fully factorial** because the vignette sub-population presented to respondents is randomly selected.[80] The experiment is also **fully randomized** because the partitioning of vignettes and their allocation to respondents are both random. There is, in effect, as many vignette sets as respondents.

[80] Jasso 2006; Rossi and Nock 1982.

Confounded main effects are negligible The total population of vignettes is larger than the number of observations, leaving a number of them unobserved, and most of the observed vignettes are observed only once. This design typically creates a potentially complex set of confounding effects.[81] Because of the sheer size of the vignette population, however, it is unlikely that by random chance a dimension only varies with another dimension. For instance, it is unlikely that, by random chance only, the feature *(F1) appointed board members* would always be selected alongside the feature *(D1) strong board* whereas the feature *(F2) elected board members* would always be selected along the feature *(D2) weak board*. There would be no combination *(F1)(D2)* or *(F2)(D1)* presented to respondents. If it were the case, and if respondents were for instance expressing a systematic preference for the latter combination, it would be impossible to ascribe that preference to the feature *elected board members* or the feature *weak board*. The double randomization, of vignette sub-population selection and partitioning along with the target number of respondents (N = 600) ensures that the probability of confounding main effects is small. Table 3 displays the results of Pearson's Chi-squared independence tests for pairs of vignette dimensions,[82] and shows that they are independent. I can safely assume that confounded main effects are negligible with the design. However, confounded effects might still be present for interactions. For this reason I will **focus on main effects to analyze experimental results**.

[81] Atzmüller and Steiner 2010, p.131.

[82] Agresti 2013.

Estimating the average marginal effect of each institutional feature. A large proportion of the vignette population is unobserved, and each respondent expresses a preference on a small number of vignettes. This design does not allow to estimate the effect of each institutional feature for each individual respondent. Respondents express a preference for each potential collaboration plan presented, but there is no way to know which features are more instrumental than others in the formation of this individual preference. The experiment is designed to estimate the **average marginal effect of each institutional feature over the whole population of respondents or groups of respondents**. Given a collaboration plan composed of several dimensions, it is impossible to estimate if the scale of the proposed collaboration, for instance a small scale collaboration between the respondent's municipality and its immediate neighbor, is the feature that sways the respondent in favor of supporting the plan and not other features of the plan. Over the whole population of respondents, this specific feature is randomly presented jointly with all the other features. If respondents consistently prefer plans with the features over plans without the feature, it is possible to conclude that the feature has indeed, on average, a positive effect on individual preference for a plan.

As proposed by Hainmueller et al,[83] I estimate Average Marginal Component Effect (AMCE) of institutional features using linear regression. I use the `R` package `cjoint` in order to do so. [84]

[83] **Hainmueller2014a**.

[84] `https://CRAN.R-project.org/package=cjoint`

PUTTING RESPONDENTS' PREFERENCES IN CONTEXT. Beside the experiment itself, the survey asks questions on socio-economic status and geographic behavior, to put respondents' preferences in a broader context. Socio-economic questions largely reproduce questions from the American Community Survey,[85] the detailed survey conducted every year by the US Census on a sample of the American population. [86] These questions offer two main uses. First, they serve to compare the respondents' sample with the characteristics of California's general adult population, assessing the sample's representativeness. I report on the sample quality in subsection 3.4. Second, these questions allow me to control in what proportion respondents' preference for collaboration between their municipality and others on land-use policy are attributable to institutional features and what proportion is attributable to their basic socio-economic characteristics. For instance, we could expect that younger people are, in general, more prone to collaboration than older metropolitan denizens.

[85] Mather, Rivers, and Jacobsen 2005.

[86] By contrast with the decennial census, conducted every ten years on the whole US population, but gathering less data on each participant with a form shorter than the American Community Survey.

The second set of declarative, non-experimental questions asks respondents about their geographic behavior. I ask for the zipcodes of their place of residence, as well as workplace and place of study. I also inquire of their commute habits. These answers are used to tailor experimental questions to the geographic context of the respondent. Metropolitan areas can be an abstract concept, and I anchor respondents' task by providing question mentioning their municipality and metropolitan areas by name, as table **??** illustrates. For instance, a respondent from Oakland, California, can be asked about a collaboration plan encompassing *Oakland and 3 neighboring cities* or *all cities and counties in the greater San Jose-San Francisco-Oakland area (CA)*. Although not included in this analysis, answers to these questions can also be exploited to study their main effect on collaboration preferences, or their interaction with the effects of institutional features. For instance, respondents who have a more extensive commute in the metropolitan areas could be more disposed to support collaboration than respondents living and working in the same municipality. In that case, commute extent would have an effect of its own. Similarly, respondents with an extensive commute could be more prone to support coordination of land-use with transportation, since they are more affected than others by traffic conditions and transit infrastructure. In this case, the interaction between commute extent and the institutional feature of policy coordination would be significant.

I test for differences between sub-groups of respondents. Most important sub-groups are residents of different metropolitan areas in the State of California. I thus divide respondents into five groups, based on their declared place of residence: Greater Los Angeles, Greater San Francisco, Greater San Diego, Greater Sacramento, and Others. Respondents' location is determined by their declared zip-code of residence. For boundaries of Metropolitan areas, I take OMB's 2010 Primary Statistical Areas (PSA). In addition to location, I also test for differences by gender, household income, party affiliation, age and race. All these characteristics are declared by respondents in the socio-demographic part of the survey, after the experimental part where respondents express preferences between and for plans. Age and income are discretized into ordered categories of age and income, each category comprising on third of respondents. For instance, respondents are divided between the third youngest, third oldest, and in between.

Differences between sub-groups are estimated by calculating Average Marginal Component Effects conditional on respondent's membership to each sub-group, as proposed by Hainmueller et al.[87]

[87] **Hainmueller2014a**.

3.3 *Institutional features*

Institutional features are listed in table 2. They are extracted and generalized from features of institutional arrangements existing today in metropolitan areas of California. They are randomly drawn and assembled for each plan presented to a respondent. These features can be present individually in plans. The specific combination of features produced by random draw can, and often is, unseen on the ground, as there is 2 160 possible arrangements. Additionally, these features are drawn from inter-governmental collaboration devices beyond land-use. Land-use is a prerogative of cities and counties in California.

Scale of participation. The first feature is how many municipalities participate in the collaboration plan. I divided the dimensions in three scales. The small scale is the respondent's city and 3 neighboring municipalities. The medium scale is the respondent's city and 15 neighboring municipalities. Lastly, the large scale is the entire metropolitan area of the respondent. Features are adapted to the respondent's declared location. For instance, a respondent from Oakland, California, is presented *all municipalities in the Greater San Jose-San Francisco-Oakland, California* as the large scale feature. For the sake of consistency, metropolitan areas are identified by their census designation, and not a vernacular name like the *Bay Area*. Census names make clearer which urban cores does the area revolve around. In California today, metropolitan associations of governments are mandated by state law to coordinate planning, for climate regulation purposes, but often lack enforcement powers.[88]

[88] Barbour and Deakin 2012.

TYPE OF POWER. This dimensions expresses the powers held by the new board, with two possible values. First the board can be a *weak board*, simply coordinating participating municipalities' planning policies together, without doing the planning itself. Depending on other features drawn for other dimensions, especially sanctions, decisions of a coordinating board can still be more enforceable than the typical inter-governmental coordination in place in California today. Second, the board can be a *strong board*, replacing participating municipalities' planning departments altogether. In this case, cities simply transfer their planning power under the law to the new board. Considering a large number of municipalities were created to capture land-use planning in the first place,[89] I expect the *strong board* feature to negatively affect respondents' support for collaboration.

[89] Burns 1994.

POLICY COORDINATION. This dimensions tests coordination of land-use with either water supply, transit and transportation, neither, or both. Inter-governmental collaboration has focused on single policy arrangements, often around service provision. However, rising concerns on the environments consequences of growth, as well as on spillover effects like insufficient housing development to support a growing economic base, have brought the focus on coordination between policies as well. Political contentions in the San Francisco Bay Area around the merger of MTC and ABAG, coordination boards for transit and land-use, respectively, exemplify this growing attention.

BOARD MEMBERS. Board members can be elected or appointed by other elected officials, such as a mayor, or a city council. Both configurations exist in California today. Appointed members are more common, for most often the collaboration instrument is a creation of local governements, and there is no intent to make them independent. However, independent, directly elected boards, are sometimes created to take over all or part of a policy area, or to fund, build and manage an infrastructure. In the San Francisco Bay Area, the Bay Area Rapid Transit system (BART) is operated by a special purpose transit district, the San Francisco Bay Area Rapid Transit District. BART Board members are directly elected by the population of San Francisco, Alameda and Contra Costa Counties. The district can raise taxes of its own, but is also depending on other local governments to provide operating funds and capital for maintenance and expansion. Californians are therefore familiar with an elected board.

Cost of planning and infrastructures. This feature is simply the evolution of the cost of running both the planning department and the infrastructural costs of development. I expect the effect of this dimension to be linear, in the sense of cost reduction fostering support and cost increase to deter it. This dimension and the following other two dimensions related to cost partly reproduce institutional dimensions tested by Michael Bechtel and Kenneth Scheve on popular support for global climate agreements.[90]

[90] Bechtel and Scheve 2013.

Distribution of costs. A new collaboration device between municipalities on land-use creates a cost sharing problem. How will these costs be divided between participants? Bechtel and Scheve tested this dimension for global climate agreements and found it significant.[91] I present three different possible features to respondents. First, costs can be divided proportionally by *population*, more populous cities paying more for the service in proportion to their population, regardless of the socio-demographics characteristics of this population. Second, costs can be divided proportionally by the current *tax base*. Wealthier municipalities, and also municipalities with more economic activity, will pay more in this case. Lastly, costs can be divided proportionally to the *new development*. In this case, growing cities will pay more, while cities with no new development will contribute very little financially. This last option represents a proportionality with expected growth in tax base.

[91] Bechtel and Scheve 2013.

Sanctions for non-complying cities. At last, this feature represents how participating municipalities are financially incented to comply with decisions of the collaborative planning board. Bechtel and Scheve found that a moderate level of sanctions drives popular support for global climate agreements.[92] I test three levels of sanctions: no sanctions, moderate and high. Sanctions are expressed in dollars per household per month for non-complying cities.

[92] Bechtel and Scheve 2013.

3.4 *A large sample*

I recruited survey participants from California on Amazon Mechanical Turk (MTurk) during the summer of 2015. With a goal of 600 responses, respondents were compensated $0.5 for their participation. Designed as a marketplace to outsource menial computer tasks better performed by a human than by a computer program, Amazon MTurk has emerged in the last decade as a viable and cheaper alternative to survey vendors. Notably, thanks to its low cost, Amazon MTurk permits an important increase in the number of respondents within a given budget. The data obtained in Amazon MTurk is as reliable as with traditional providers,[93] especially for experimental purposes.[94] Respondents do not appear to be primarily motivated by financial gains.[95] Although respondents can be less representative than national probability samples, their experimental response is consistent with respondents from more traditional recruitment methods[96] and population-based samples.[97]

[93] Buhrmester, Kwang, and Gosling 2011.
[94] Paolacci, Chandler, and Ipeirotis 2010.
[95] Buhrmester, Kwang, and Gosling 2011; Ross et al. 2010.
[96] Berinsky, Huber, and Lenz 2012.
[97] Weinberg, Freese, and McElhattan 2014.

Out of 730 respondents, 620 were indeed from California and gave complete responses. Figures 5 and 9 reveal that respondents are relatively well sampled in regard to their geographic origin. The two largest metropolitan areas of Los Angeles and San Francisco are slightly under-sampled. The largest sampling bias occurs with Sacramento, whose weight in the survey is almost 50% higher than its share of the State's population.

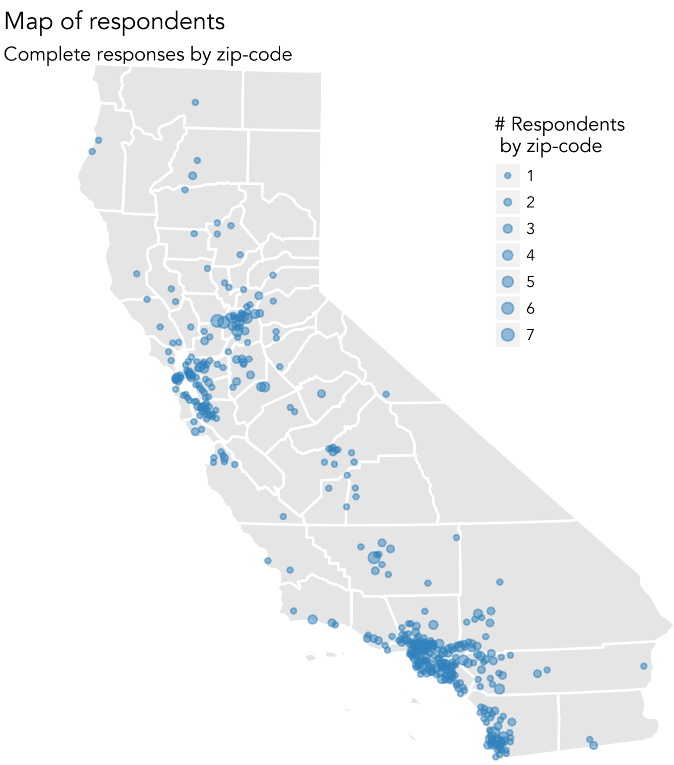

Figure 5: Map of respondents, complete responses by zip-code, California.

Figures 10 to 13 compare the socio-demographic composition of the sample relative to the State of California. They expose a relatively representative sample in regards to gender, with a slight over-representation of men, and income, with an under-representation of the highest income categories. However, survey respondents' distribution is skewed towards a younger (figure 11) and whiter, non-Latino (figure 12) sample compared to the State of California. The bias exhibited by the respondent sample is consistent with usual biases documented for the collection method, Amazon Mechanical Turk.[98] To address this bias, I weight survey respondents to correct for race and ethnicity and age, following weighting specifications of the American National Election Studies.[99] I compare the results of AMCE models with unweighted and weighted samples, displayed in figures 20 and 21 respectively. Weighting causes very little change to the estimated effect size, bringing confidence that the sample can be relied upon despite biases. The weighted model conserves the direction of the effects and their general scale. However, the weighted model tends to display a larger uncertainty. For the analysis of the survey, I rely on the weighted sample to estimate the effects of each institutional feature in different groups of respondents.

98 Weinberg, Freese, and McElhattan 2014.

99 Pasek 2010; Pasek 2011.

4 *Results*

4.1 *Respondents are in general favorable to a collaboration plan*

For all groups considered—all respondents, likely voters, and groups of respondents in the four largest metropolitan areas in California—respondents express in aggregate a slight preference for approving the collaboration plan, as figures 14 to 19 show. The support score for every group of respondents is above 0.5, indicating a slight preference for supporting a collaboration plan on the ballot.[100]

100 Support score is the average of expressed preferences for a plan in the respondents' group scored as 1 for *Yes*, 0.5 for *I don't know* and 0 for *No*. Therefore, an average support score below 0.5 for a respondents group indicates a tendency to reject collaboration plans, and a score above 0.5 indicates a tendency to support collaboration plans.

Support score across all respondents is 0.53. Support score is the highest among respondents from the San Francisco Bay Area (figure 17), and the lowest among San Diego respondents (figure 18). The relative proportion of respondents having formed a preference for the plan increases among likely voters, shows figure 15, as expected considering these respondents are more motivated by a ballot. Only a third of respondents state that they are likely to some degree to cast a vote if such a plan was on the ballot in their town or city.

The *likely vote* question is articulated to emphasize the cost of voting for the respondent. The question asks if they would cancel or rearrange their plans to vote in an off-cycle ballot two weeks from when they answered the survey. For that reason, the question leans on the side of a more conservative estimate of the proportion of likely voters in the respondents' sample, underestimating rather than overestimating their number.

Support for inter-governmental collaboration is surprising, given the low level of general identification with metropolitan areas. General support for collaboration, however, includes respondents who have been presented with large scale as well as small scale collaboration. Support could indicate, therefore, that metropolitan residents favor inter-governmental collaboration, but not necessarily at a large scale, and with carefully chosen parters.

Support for collaboration is confirmed by results of an additional question, asked after the choice of collaboration plan. This question tests respondent's perception of interdependence between municipalities in their area, [101] prompting them to choose between three statements: 1. "We are all in this together." 2. "They do what they want, it does not concern my community." and 3. "We compete with them, and they compete with us." These three answers respectively capture a perception of interdependence and solidarity, independence, and competition.

[101] "Thinking about what other towns and cities in your area are doing, how do you feel about how their policies affect your own community?"

Figure 6 reveals that respondents overwhelmingly (56%) perceive their municipality as being interdependent with others in the area, in a way that favors collaboration. Only 13% of respondents have a competitive view and 23% perceive their municipality as being independent.

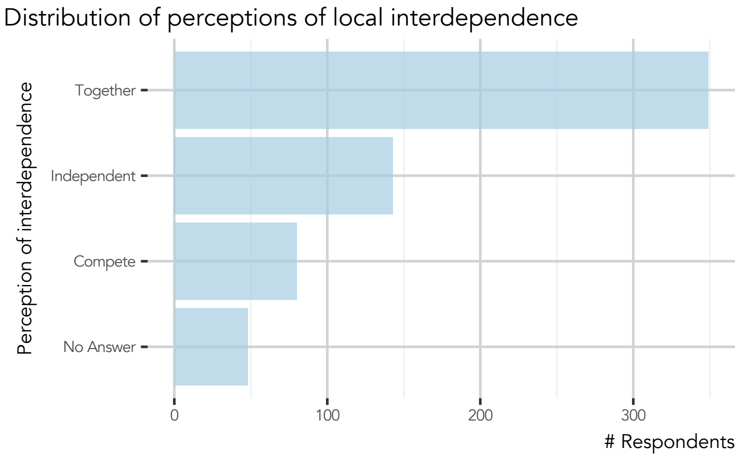

Figure 6: Distribution of respondents by perception of local interdependence.

Widespread perceptions of interdependence and solidarity combined with support for inter-governmental collaboration could appear as paradoxical with low levels of identification with metropolitan areas. The paradox is resolved, however, if we understand that supporting collaboration does not necessarily mean identifying with a larger scale in which this collaboration takes place. Metropolitan externalities, perceived in their everyday life, are recognized by metropolitan residents and suffice to motivate them to support collaboration. Resolving this paradox depends on examining the scale of collaboration favored by metropolitan residents.

4.2 *Respondents favor non-committal, economical collaboration around policy coordination*

Respondents demonstrate a sensitivity to the collaboration features that are being presented to them. In other words, respondents express a choice that is informed by the details of the plan, and they do not reject or approve metropolitan collaboration on the whole regardless of what is proposed to them. As figure 21 shows, respondents display a general aversion towards costs increase and sanctions, while cost decrease does not conversely causes more support. Stronger collaboration drive respondents' opposition. They generally want their municipality to retain the bulk of land-use policy power, and limit collaboration to policy coordination. Respondents are swayed by coordination between land-use and water policies. While other coordination scenarios, with transport and with both transport and water, fail to be significant, their general direction is also positive. Respondents also favor a board composed of directly elected members over appointed experts.

Likely voters exhibit the same preferences, shows figure 22 , with a higher uncertainty due to the smaller size of the sample.

4.3 *Respondents are more sensitive to cost increase than to cost decrease*

Respondents react negatively to cost increase, but do not answer positively to cost decrease. Three types of effects could cause this asymmetry. First, respondents could be confused by the **survey language**. Indeed, this dimension is formulated rather neutrally, as table 2 shows, and could be more confusing than if the question wording was closer to everyday language. For instance, *cheaper service* would convey the right information to the respondents more efficiently than *20$ less than today per household per month*.

The second possible cause for the asymmetry of cost preferences could be **loss aversion**. Amos Tversky and Daniel Kahneman[102] show that people prefer avoiding losses over obtaining gains. That is, people feel a loss more strongly than they feel an equivalent gain. Following this explanation, respondents are more prone to avoid losses than to seek gains. In the case of a collaboration plan, the losses that respondents are trying to avoid are increases in the cost of running the planning service. Their preferences for avoiding losses drives them to reject plans that would result in a cost increase that does not conversely translate in a support for plans that would reduce costs.

[102] Tversky and Kahneman 1991.

Lastly, the cost preferences asymmetry could be caused by an **asymmetry of expectations**. In this situation, respondents expect a cost increase to materialize, while they do not expect a cost decrease to do so. They expect government project to cost more than advertised. This asymmetry of expectations can reflect a broad distrust in the ability of local governments to run cost efficient policies. It can also reflect a disbelief in the cost efficiency of policy upscaling in metropolitan areas. In that case, respondents do not believe that a reduction of cost is among the merits of inter-governmental collaboration, even if they are swayed in favor of this collaboration by other features of the arrangement. It is indeed unclear that local government consolidation or collaboration generally results in cost efficiencies, and cost reductions seem to be the exception rather than the rule.[103]

[103] Bish 2001; Fox and Gurley-Calvez 2006; G Bel and ME Warner 2015.

4.4 *Respondents' preferences vary between metropolitan areas*

If institutional features of a collaboration plans have robust effects on individual preferences for the plan, figures 25 to 28 reveal a number of variations between the four biggest metropolitan areas in California: the Greater Los Angeles, the San Francisco Bay Area, San Diego County, and the Greater Sacramento. I summarize these differences in table 1.

In line with respondents of the whole State of California, Los Angeles respondents (figure 25) are more likely to favor a weak collaboration shifting costs to a proportion of the tax base, with a board composed of directly elected members. Los Angeles respondents, however, do not particularly care about multiple policy coordination, with effect sizes being not only insignificant, but close to 1, revealing their indifference. Cost features fail to sway them in favor of disfavor of a plan, with the exception of cost structure.

San Diego respondents (figure 27), just south of Los Angeles, also care about cost, in that they strongly disfavor potential sanctions for municipalities that would not comply with the collaboration board decisions, as well as potential cost increase. San Diego respondents do not display a preference for a specific type of cost structure. In accordance with their Angelino neighbors, however, they do not seem to care about policy coordination either.

San Francisco respondents, however, do care about policy coordination (figure 26), both land-use water and land-use and transport, but fail to be swayed by an all-encompassing coordination instrument comprising all three policies of land-use, water and transport. The effect is positive, but not significant. All other institutional features fail to drive their preference for a plan over another, including cost features that are important for their Southern California counterparts in Los Angeles and San Diego.

Sacramento respondents are similar to San Francisco respondents is being swayed by policy coordination at the exclusion of other plan features. They exhibit a specificity, however, in favoring coordination of three policies, land-use, water and transport, over coordination between land-use and transport, over coordination between land-use and water and a focus on land-use exclusively. Sacramento respondents are almost perfectly indifferent to the composition of the board, cost, or strength of the collaboration instrument. Although not significant, a collaboration encompassing the whole Greater Sacramento seems to have a positive effect.

As table 1 illustrates, there is a divide between respondents from Northern and Southern California. Northern California respondents exhibit a preference for policy coordination that Southern California respondents do not express. Moreover, Northern California residents are not averse to stronger forms of collaboration, whereby a new shared land-use planning board would completely take over their cities' planning boards. By contrast, Southern California participants do reject strong collaboration. To the extent that they support collaboration, they favor mere coordination between existing municipal planning boards that would retain all their powers.

	Large metro	*Medium metro*	
NorCal	**San Francisco Bay Area**	**Greater Sacramento**	
	+ Policy coordination	+ Policy coordination	+ Policy coordination
	= Weak / strong collaboration	= Weak / strong collaboration	= Weak / strong collaboration
	= Cost changes & sanctions	- Cost changes & sanctions	
SoCal	**Greater Los Angeles**	**San Diego County**	
	= Policy coordination	= Policy coordination	= Policy coordination
	- Strong collaboration	- Strong collaboration	- Strong collaboration
	= Cost changes & sanctions	- Cost changes & sanctions	

Table 1: Summary of significant effect by California Metropolitan Area.

Is geographic variation anecdotal or systemic? The source of respondents geographic variation of preferences remains unknown in this study. On the one hand, geographic variation of preferences could be purely **anecdotal**. In this case, residents of a given metropolitan area express preferences that are dependent to the historical path of the area. Even if we measure perfectly comparable conditions in two different metropolitan areas today, preferences for collaboration would be different if the history of these two areas was different. On the other hand, preferences can be **systemic**, explained by the conditions currently witnessed by metropolitan residents. Two metropolitan areas exhibiting the same conditions today would cause the same type of preferences in their residents.

The source of this systemic variation can lie in the institutional setup of the metropolitan area, the broader metropolitan context, or regional conditions beyond the scope of the metropolitan area *per se*. The institutional fragmentation of the area could explain an appetite for coordination in very fragmented areas where multiple local governments conduct mutually contradictory policies. Residents of the San Francisco Bay Area could be swayed in favor of policy coordination at a larger scale by witnessing local governments competing to build new economic development without providing enough housing to support it, therefore driving housing prices up around the Bay. By contrast, San Diego respondents reside in a metropolitan area comprising only one county, San Diego County, and where population is distributed in a relatively low number of cities. Political power in the metropolitan area is concentrated. San Diego County does not experience a housing shortage as acute as the San Francisco Bay Area. These factors could explain the low appetite of San Diego respondents for policy coordination and strong collaboration forms on land-use. The problems to solve, pertaining to both institutional and policy dimensions, are simply more stringent in the Bay Area.

Both causal mechanism, anecdotal and systemic, are likely to explain each a portion of the respondents' preferences geographic variation. The experiment I conduct here does not offer enough variance between metropolitan areas to decide between the two explanations. Another experiment should be performed with a larger sample, expanded to the contiguous United States. This experiment would provide enough metropolitan contextual variance to test these two hypothesizes.

4.5 *Respondents' preferences depend on their political affiliation and socio-economic profile*

Partisanship. As would be expected, partisan affiliation influences individual preferences for plan features (figures 32 to 34). To evaluate these effects, I have grouped together respondents declaring being registered as Democrat or Republican with respondents simply leaning towards a party. Pure independents, declaring no leaning towards either one party, form another group. Cost effects are stronger for Republicans than for Democrats and Independents. If all groups care about a strong increase in policy cost, Republicans are the only ones that are swayed favorably by a cost decrease. Considering Republican combine a general higher distrust in government with a preference for small government,[104] a possible explanation is that respondents view cost as a proxy for the size and importance of the service provided, and not necessarily as a pure question of efficiency. Following that hypothesis, Republican would prefer to decrease cost to decrease the level of service provided, as much or more as they want more efficiency in the service provision. Moreover, Democrats display a strong preference for an elected board, and a cost structure proportional to tax base, therefore shifting the burden of cost to wealthier areas. Democrats also tend to car about policy coordination, where Republicans do not.

[104] **PewResearchCenter2015**.

Gender. Respondents' preferences vary along gender (figures 30 & 31). Female respondents care more about policy coordination, an elected board and are averse to strong forms of collaboration. Their male counterparts are more sensitive to cost, being strongly averse to cost increase and sanctions for non-complying municipalities. In line with the influence of cost features, male respondents are also convinced by a cost structure proportional to tax base, making wealthier areas pay more for the policy.

Race and ethnicity. There are significant race and ethnicity effects (figures 35 to 39), although they are harder to ascribe to a specific cause. White, non-Latino respondents tend to prefer a cost structure proportional to tax base or new development, while disliking sanctions and strong collaboration. They are also taken aback by any change in cost, even to reduce policy costs. Asian respondents care about coordinating land-use with transport, and dislike sanctions. Black respondents care about lowering policy costs and dislike sanctions, while favoring strong collaboration over mere coordination between municipalities. Latino respondents are swayed by a decrease in policy cost. These effects are hard to interpret because race and ethnicity often correlate with other socio-economic factors. Moreover, spatial segregation is still strong in the United States. Consequently, race and ethnicity also conveys geographic information. For these reasons, I will not hypothesize here about race and ethnicity causes for specific preferences, as further studies should be undertaken to specifically untangle these different dimensions.

INCOME. Dividing respondents in three annual income groups—less than $33,000, between $33,000 and $72,000 and over $72,000—offers a contrasting picture of preferences (figures 40 to 42). Poorer respondents do not express significant preferences, as an income group. Middle-income respondents seem to primarily dislike strong collaboration, preferring mere coordination between local governments. Higher income respondents are the ones expressing clearer preferences, with a strong dislike of cost increases, and a significant preference for coordination between policies, in all possible combinations.

AGE. Lastly, age is also a discriminant of respondents' preferences (figures 43 to 45). When divided into three groups—from 18 to 31, 31 to 47 , and more than 47—younger respondents dislike strong collaboration and cost increase. Middle-age respondents are the ones primarily swayed by policy coordination, although cost effects also get stronger for them, disliking both cost increase and potential sanctions. Lastly, older respondents do not express many significant preferences, apart from cost increase.

5 *Conclusion*

PEOPLE ARE NOT AVERSE TO METROPOLITAN COLLABORATION. Metropolitan residents of California do favor collaboration between their local governments on land-use policy, by a slight but consistent margin. People are swayed in favor of collaboration by a coordination between different policies, namely water and transportation and transit, in a way that is related to the specific issues pertaining to their area of residence and the existing institutional structure addressing these issues.

INSTITUTIONAL FEATURES OF COLLABORATION MATTER. This study shows that people are not indifferent to the shape taken by a collaboration plan when they decide to support or oppose it. They tend to prefer small to middle-scale collaboration, coordinating multiple policies. Respondents are averse to cost increase. They generally prefer a weaker coordination device, focused on coordinating multiple local governments, to a stronger institution taking power away from their municipality. Young, democratic voters are also more prone to support a collaboration.

THE POLICY PROBLEM IS WHAT MATTERS. By contrast with cost, a specific policy mix addressed by the reform plan is one of the only drivers for popular support of collaboration in metropolitan areas. By comparison, the effect of institutional design elements, such as the composition of the board (elected or appointed members), is weak. Solving the way development impacts traffic or water consumption, when perceived as a problem by respondents, seems to be what people actually care about, more than the specifics of the institutional arrangement. The focus of the research in public policy has been for a long time on institutions, and their impact on the efficiency of policy making and service provision. This experiment suggests however that researchers and policy-makers alike should direct their attention to the specific of the policy issues facing metropolitan areas. These issues differ from region to region and inform the preferences of people living in these areas. The focus on policy, however, offers more leeway to reform proponents to find an arrangement that works inside the current constraints of the metropolitan area.

COST ARGUMENTS ARE INOPERATIVE. Respondents are sensitive to cost increase arguments but by and large indifferent, or even hostile, to cost reduction arguments. In section 4.3 I outlined several possible explanations for these preferences. However, this preference has policy implications. Arguments for metropolitan reforms often focus on efficiency and legitimacy. Cost preferences uncovered in this study point to the inefficiency of these arguments to sway voters. Hopeful reformers should therefore not make cost arguments a central point of their argument, but rather focus on how their proposal solves actual policy problems perceived by residents. Respondents' aversion for cost arguments reflects the uncertainty of actual efficiency effects in metropolitan reform.

PREFERENCES VARY GEOGRAPHICALLY. In every metropolitan area of California, respondents express a slight preference in favor of collaboration, but the features driving this support vary greatly between metropolitan areas. There is no single collaboration formula that would be *the right one* and unmistakably sway people in favor of the plan. Rather, the features of collaboration favored by residents of the San Francisco Bay Area, a medium scale collaboration with multiple policies, with no aversion to strong power transfers or cost changes, are very different than the ones exhibited by Greater Los Angeles residents, namely a small scale coordination restricted to land-use, and a shift to cost distribution to all economic actors.

The institutional solution to the policy problem is local. This study shows that there is no global institutional optimum that would drive popular support for metropolitan collaboration regardless of the specifics of the local context. Although I do not address neither efficiency nor legitimacy in this research, previous research suggests there is no global optimum along these dimensions either (see section 1.4). Copious resources are dedicated to solve the social space / political space discrepancy in each of these metropolitan areas, but very rarely is popular support for potential solutions gauged. This absence of research makes political capital difficult to build for these solutions, relying on efficiency claims difficult to support empirically, and heuristics reinforcing local political fault lines. This study has been conducted with a research grant of $2,000, offering a glimpse on how local aspirant reformers could build an experimentally driven reform proposal in tune with metropolitan residents preferences and perceptions of the actual policy problem to solve at an affordable cost.

Metropolitan policies are rival in context. The geographic variation demonstrated by survey respondents hints at the local functional and institutional context of diverse metropolitan areas interacting with the typology of goods produced and managed by policies. In particular, how local conditions makes a good more or less rival matters in how respondents are driven to support institutional reform to alleviate the competition. In particular, institutional fragmentation in the growth oriented environment of the San Francisco Bay Area could accentuate the rival dimension of economic development and population growth. Cities compete for economic growth, providing an expansion of tax base without consuming much more public services. By contrast, cities are leery of population growth, much less lucrative and requiring costly public services. Thus, local governments try to offset their housing needs to other local governments in the area, welcoming the jobs, but not the new population. In a fragmented environment where local governments can effectively compete for land-use, the rival dimension of this mis-alignment is markedly salient to residents and could make them sensitive to policy reform to alleviate this rivalry. Understanding the specific conditions of rivalry in different metropolitan contexts is therefore promising to reveal the potential levers of metropolitan reform.

How to understand geographic variation. The realization that one size does not fit all in terms of metropolitan governance reform and that local context and preferences have a potential to influence and support diverse reform plans in different metropolitan areas in the United States begets the question of the nature of this geographic variation. Are comparable local conditions fostering comparable popular preferences across multiple metropolitan areas in the country? Or is every metropolitan area a single case too specific for researchers to uncover common causal mechanisms at work? Focused on California, with four large metropolitan areas, this study does not offer the sample size and representativity to answer this question. A larger, comparable study should be conducted, this time sampling respondents from all metropolitan areas in the United States, to address the question of geographic variation. This sampling would provide enough of a variation of geographic context to answer it. Providers such as Amazon MTurk offer the possibility of conducting such a study at a reasonable cost, compared to traditional survey recruitment methods. Broadly, two types of questions should be engaged with. First, how does the metropolitan context influence people preferences? Housing prices, traffic conditions, among others, could influence willingness of residents to collaborate on multiple policies across municipal boundaries if they perceive it would solve their problems. Second, how does the existing institutional architecture of metropolitan governance influence people's preferences for collaboration? Residents of very fragmented metropolitan areas, experiencing first-hand the effect of fragmentation, for instance, could be driven to support collaboration. By contrast, residents of metropolitan areas where power is more concentrated could not see the need for collaboration.

References

Adams, John S., Barbara J. VanDrasek, and Eric G. Phillips (2013). "Metropolitan Area Definition in the United States". en. In: *Urban Geography* 20.8, pp. 695–726. ISSN: 0272-3638. DOI: 10.2747/0272-3638.20.8.695.

Agresti, Alan (2013). *Categorical Data Analysis*. 3rd ed. Hoboken, NJ: Wiley, p. 744. ISBN: 9781118710944.

Albuquerque, Manuela (1997). "California and Dillon: The times they are a-changing". In: *Hastings Const. LQ* 25, p. 187.

Allers, Maarten A. and J. Bieuwe Geertsema (2016). "The effects of local government amalgamation on public spending, taxation, and service levels: evidence from 15 years of municipal consolidation". In: *Journal of Regional Science*. DOI: 10.1111/jors.12268.

Amin, Ratna and Sara Barz (2014). *Seamless Transit. How to make Bay Area public transit function like one rational, easy-to-use system.* Tech. rep. San Francisco, CA: SPUR.

Anderson, Michelle Wilde (2011). "Dissolving Cities". In: *Yale LJ* 121, p. 1364.

Ansell, C. and A. Gash (2007). "Collaborative Governance in Theory and Practice". In: *Journal of Public Administration Research and Theory* 18.4, pp. 543–571. ISSN: 1053-1858. DOI: 10.1093/jopart/mum032.

Aoki, Keith (2005). "All the King's Horses and All the King's Men: Hurdles to Putting the Fragmented Metropolis Back Together Again - Statewide Land Use Planning, Portland Metro and Oregon's Measure 37". In: *Journal of Law & Politics* 21, p. 397.

Atzmüller, Christiane and Peter M. Steiner (2010). "Experimental vignette studies in survey research". In: *Methodology* 6, pp. 128–138. DOI: http://dx.doi.org/10.1027/1614-2241/a000014.

Bae, Chang-Hee Christine (2005). "Tijuana-San Diego: Globalization and the trans-border metropolis". In: *Globalization and Urban Development*. Berlin/Heidelberg: Springer-Verlag, pp. 181–195. DOI: 10.1007/3-540-28351-X_12.

Barbour, Elisa and Elizabeth A. Deakin (2012). "Smart Growth Planning for Climate Protection". In: *Journal of the American Planning Association* 78.1, pp. 70–86. ISSN: 0194-4363. DOI: 10.1080/01944363.2011.645272.

Baum-Snow, Nathaniel (2007). "Did highways cause suburbanization?" In: *The Quarterly Journal of Economics* 122.2, pp. 775–805.

Bechtel, Michael M. and Kenneth F. Scheve (2013). "Mass support for global climate agreements depends on institutional design". en. In: *Proceedings of the National Academy of Sciences* 110.34, pp. 13763–13768. ISSN: 0027-8424, 1091-6490. DOI: 10.1073/pnas.1306374110.

Bel, G and ME Warner (2015). "Inter-Municipal Cooperation and Costs: Expectations and Evidence". In: *Public Administration*.

Bel, Germà and Mildred E. Warner (2015). "Factors explaining inter-municipal co-operation in service delivery: a meta-regression analysis". In: *Journal of Economic Policy Reform*, pp. 1–25. ISSN: 1748-7870. DOI: 10.1080/17487870.2015.1100084.

Berinsky, Adam J., Gregory A. Huber, and Gabriel S. Lenz (2012). "Evaluating Online Labor Markets for Experimental Research: Amazon.com's Mechanical Turk". en. In: *Political Analysis* 20.3, pp. 351–368. ISSN: 1047-1987, 1476-4989. DOI: 10.1093/pan/mpr057.

Bish, RL (2001). "Local government amalgamations: discredited nineteenth century ideals alive in the twenty first". In: *Commentary-CD Howe Institute*.

Briffault, Richard (1996). "The Local Government Boundary Problem in Metropolitan Areas". In: *Stanford Law Review* 48.5, pp. 1115–1171. ISSN: 0038-9765. DOI: 10.2307/1229382.

Buhrmester, Michael, Tracy Kwang, and Samuel D. Gosling (2011). "Amazon's Mechanical Turk A New Source of Inexpensive, Yet High-Quality, Data?" en. In: *Perspectives on Psychological Science* 6.1, pp. 3–5. ISSN: 1745-6916, 1745-6924. DOI: 10.1177/1745691610393980.

Burns, Nancy (1994). *The Formation of American Local Governments: Private Values in Public Institutions*. Oxford University Press, USA, p. 208. ISBN: 0195090934.

Cervero, Robert and Kang-Li Wu (1997). "Polycentrism, commuting, and residential location in the San Francisco Bay area". In: *Environment and Planning A* 29.5, pp. 865–886.

Cohen, J (1997). "Procedure and substance in deliberative democracy". In: *Deliberative democracy: Essays on reason and politics*. Ed. by James Bohman and William Rehg. MIT Press. Chap. 13, pp. 407–437. ISBN: 9780262522410.

Abbreviations

ABAG Association of Bay Area Governments (Regional planning agency for the San Francisco Bay Area)

ACS American Community Survey

AMCE Average Marginal Component Effect

BART Bay Area Rapid Transit

CBSA Core-Based Statistical Area

CEQA California Environmental Quality Act

CSA Combined Statistical Area

EIS Environmental Impact Statement

EIR Environmental Impact Report

MPO Metropolitan Planning Organization

MTC Metropolitan Transportation Commission (Regional planning organization for roads and transit in the San Francisco Bay Area)

MTurk Amazon Mechanical Turk

NEPA National Environmental Policy Act

OMB (The White House's) Office of Management and Budget

PSA Primary Statistical Area

Dahlman, CJ (1979). "The problem of externality". In: *The Journal of Law & Economics* 22.1, pp. 141–162.
Diffenbaugh, Noah S., Daniel L. Swain, and Danielle Touma (2015). "Anthropogenic warming has increased drought risk in California". In: *Proceedings of the National Academy of Sciences* 112.13, pp. 3931–3936. ISSN: 0027-8424. DOI: 10.1073/pnas.1422385112.
Dinan, Desmond (2014). *Origins and Evolution of the European Union*. OUP Oxford, p. 430. ISBN: 9780199570829.
Duranton, Gilles (2013). "Delineating metropolitan areas: Measuring spatial labour market networks through commuting patterns". In: *Processed, Wharton School, University of Pennsylvania*.
Duranton, Gilles and Matthew A. Turner (2011). "The fundamental law of road congestion: Evidence from US cities". In: *The American Economic Review*, pp. 2616–2652.
Ferreira, Fernando (2010). "You can take it with you: Proposition 13 tax benefits, residential mobility, and willingness to pay for housing amenities". In: *Journal of Public Economics* 94.9–10, pp. 661–673. ISSN: 0047-2727. DOI: 10.1016/j.jpubeco.2010.04.003.
Foster, Kathryn A. (1997). *The political economy of special-purpose government*. Georgetown University Press.
Fox, WF and T Gurley-Calvez (2006). "Will consolidation improve sub-national governments?" In: *World Bank Policy Research Working*.
Frey, Bruno S. and Reiner Eichenberger (2004). *The New Democratic Federalism for Europe: Functional, Overlapping and Competing Jurisdictions*. en. Edward Elgar Publishing, p. 132. ISBN: 9781843769019.
Hamilton, David K. (2014). *Governing Metropolitan Areas: Growth and Change in a Networked Age*. en. Routledge, p. 417. ISBN: 9781136330049.
Heinelt, Hubert and Daniel Kübler (2005). *Metropolitan governance: capacity, democracy and the dynamics of place*. en. Routledge, p. 232. ISBN: 9780415337786.
Herfindahl, Orris Clemens (1950). "Concentration in the steel industry". PhD thesis.
Hirschman, Albert O. (1945). *National Power and the Structure of Foreign Trade*. en. University of California Press, p. 170.
Hopkins, Daniel J., Teppei Yamamoto, and Jens Hainmueller (2013). "Causal Inference in Conjoint Analysis: Understanding Multi-Dimensional Choices Via Stated Preference Experiments". In:
Jackson, Kenneth T. (1985). *Crabgrass frontier: The suburbanization of the United States*. Oxford University Press.
Jasso, G (2006). "Factorial survey methods for studying beliefs and judgments". In: *Sociological Methods & Research* 34.3, pp. 334–423. DOI: 10.1177/0049124105283121.
Jennings, Kent (2003). "Political Trust and the Root of Devolution". In: *Trust and Governance*. Ed. by Valerie Braithwaite and Margaret Levi. Russell Sage Foundation. Chap. 9, p. 218. ISBN: 9781610440783.
Jones, Victor (1942). *Metropolitan government*. Vol. 39. Chicago: University Of Chicago Press.
Jouve, Bernard and Christian Lefèvre (2004). *Horizons métropolitains*. FR. Lausanne: Presses Polytechniques et Universitaires Romandes, p. 274. ISBN: 9782880745615.
Klove, Robert C. (1952). "The Definition of Standard Metropolitan Areas". In: *Economic Geography* 28.2, pp. 95–104. ISSN: 0013-0095. DOI: 10.2307/141019.
Kubler, Daniel (2005). *La métropole et le citoyen: les agglomérations urbaines en Suisse vues par leurs habitants*. fr. Lausanne: Presses Polytechniques et Universitaires Romandes, p. 166. ISBN: 9782880745622.
Kübler, Daniel (2005). *La métropole et le citoyen: les agglomérations urbaines en Suisse vues par leurs habitants*. fr. PPUR presses polytechniques, p. 166. ISBN: 9782880745622.
— (2016). "Citizenship in the Fragmented Metropolis: an Individual-Level Analysis from Switzerland". In: *Journal of Urban Affairs* Early view. DOI: 10.1111/juaf.12276.
Lefèvre, C. (1998). "Metropolitan government and governance in western countries: a critical review". In: *International Journal of Urban and Regional Research* 22.1, pp. 9–25.
Leland, S and K Thurmaier (2000). "Metropolitan consolidation success: Returning to the roots of local government reform". In: *Public Administration Quarterly* 24.2, pp. 202–222.
Leland, SM and K Thurmaier (2004). *Case studies of city-county consolidation: Reshaping the local government landscape*. M.E. Sharpe. ISBN: 9780765632883.
— (2010). *City-county consolidation: Promises made, promises kept?* Georgetown University Press, p. 322. ISBN: 9781589016224.
Linebaugh, Kate (2011). *Threats to Town Halls Stir Voter Backlash*. New York, NY.

Lowery, David (2000). “A transactions costs model of metropolitan governance: Allocation versus redistribution in urban America”. In: *Journal of Public Administration Research and Theory* 10.1, pp. 49–78.
Mather, M, KL Rivers, and LA Jacobsen (2005). “The American Community Survey.” In: *Population Bulletin* 60.3.
Mendoza, Martha (2013). *Bay Area leaders consider merging region*. San Jose, CA.
Montgomery, Douglas C. (2012). *Design and Analysis of Experiments*. 8th. Wiley Global Education, p. 730. ISBN: 9781118214718.
Morrill, Richard, John Cromartie, and Gary Hart (1999). “Metropolitan, Urban, and Rural Commuting Areas: Toward a Better Depiction of the United States Settlement System”. In: *Urban Geography* 20.8, pp. 727–748. ISSN: 0272-3638. DOI: 10.2747/0272-3638.20.8.727.
Nall, Clayton and Jonathan Mummolo (2016). “Why Partisans Don’t Sort: How Neighborhood Quality Concerns Limit Americans’ Pursuit of Like-Minded Neighbors.” EN. In: *Working Paper*.
Norris, P (1999). *Critical citizens: Global support for democratic government*. Oxford University Press. ISBN: 9780191522345.
Novak, Christopher A. (2000). “Agriculture’s New Environmental Battleground: The Preemption of County Livestock Regulations”. In: *Drake J. Agric. L.* 5, p. 429.
Nunn, Samuel and Carl Schoedel (1997). “Special Districts, City Governments, and Infrastructure Spending in 105 US Metropolitan Areas”. In: *Journal of Urban Affairs* 19.1, pp. 59–72. ISSN: 0735-2166. DOI: 10.1111/j.1467-9906.1997.tb00397.x.
Office of Management and Budget (2010). “2010 Standards for Delineating Metropolitan and Micropolitan Statistical Areas”. In: *Federal Register* 75.123, pp. 37246–37254.
Oliver, J. Eric (2000). “City Size and Civic Involvement in Metropolitan America”. In: *The American Political Science Review* 94.2, p. 361. DOI: 10.2307/2586017.
— (2001). *Democracy in suburbia*. English. Princeton, N.J.: Princeton University Press. ISBN: 0691088799 9780691088792 0691088802 9780691088808.
Ostrom, Elinor (1972). “Metropolitan Reform: Propositions Derived From Two Traditions.” In: *Social Science Quarterly* 53.3, pp. 474–493.
— (1973). “On the meaning and measurement of output and efficiency in the provision of urban police services”. In: *Journal of Criminal Justice* 1.2, pp. 93–111. ISSN: 00472352. DOI: 10.1016/0047-2352(73)90091-3.
Ostrom, Elinor, Roger B. Parks, and Gordon P. Whitaker (1973). “Do We Really Want to Consolidate Urban Police Forces? A Reappraisal of Some Old Assertions”. In: *Public Administration Review* 33.5, p. 423. DOI: 10.2307/974306.
Ostrom, Vincent and Elinor Ostrom (1999). “Public goods and public choices”. In: Ed. Michael McGinnis, Ann Arbor.-University of Michigan Press, pp. 75–105.
Ostrom, Vincent, Charles M. Tiebout, and Robert Warren (1961). “The Organization of Government in Metropolitan Areas: A Theoretical Inquiry”. In: *American Political Science Review* 55.04, pp. 831–842. ISSN: 0003-0554. DOI: 10.1017/S0003055400125973.
Palmer, Stephen and James Raftery (1999). “Economics notes: Opportunity cost”. In: *BMJ: British Medical Journal* 318.7197, p. 1551.
Paolacci, Gabriele, Jesse Chandler, and Panagiotis Ipeirotis (2010). “Running experiments on amazon mechanical turk”. In: *Judgment and Decision Making* 5.5, pp. 411–419.
Pasek, Josh (2010). “ANES Weighting Algorithm A Description The Need For A New Algorithm”.
— (2011). *anesrake: ANES Raking Implementation*.
Phares, Donald (2004). *Metropolitan Governance Without Metropolitan Government?* en. Ashgate Publishing, Ltd., p. 248. ISBN: 9780754610380.
Reed, Thomas H. (1941). “The metropolitan problem”. In: *National Municipal Review* 30.7, pp. 400–460. ISSN: 01903799. DOI: 10.1002/ncr.4110300705.
Rhoades, Stephen A. (1993). “The Herfindahl-Hirschman Index”. In: *Fed. Res. Bull.* 79, p. 188.
Richardson, Jesse J. et al. (2003). *Is Home Rule the answer? Clarifying the influence of Dillon’s Rule on growth management.* English. Tech. rep. The Brookings Institution Center on Urban and Metropolitan Policy.
Ross, Joel et al. (2010). “Who are the crowdworkers?: shifting demographics in mechanical turk”. In: pp. 2863–2872.
Rossi, Peter Henry and Steven L. Nock (1982). *Measuring Social Judgments: The Factorial Survey Approach*. SAGE Publications. ISBN: 9780803918160.
Savitch, H. V. and Ronald K. Vogel (1996). “Regional Patterns in a Post-City Age”. In: *Regional Politics: America in a Post-City Age*. Ed. by H. V. Savitch and Ronald K. Vogel. SAGE Publications. Chap. 1, p. 1. ISBN: 9781452248325.

Sciara, GC (2014). *Evaluating Progress toward SB375 Implementation: A Long-term View*. Tech. rep. Davis, CA: Institute of Transportation Studies, University of California, Davis.
Sellers, Jefferey M (2013). *The political ecology of the metropolis*. English. Colchester: ECPR Press. ISBN: 9781907301377 1907301372 9781907301445 1907301445.
Senate Bill No. 375.
Stephens, G. Ross et al. (1998). "Trends in Special Districts". In: *State & Local Government Review* 30.2, pp. 129–138.
The Institute for Local Government and Steve Sanders (2010). *Understanding the Basics of Land Use and Planning: Guide to Local Planning*. Tech. rep. Sacramento, CA: The Institute for Local Government.
The White House (2014). *NEPA and CEQA: Integrating Federal and State Environmental Reviews*. Tech. rep. Washignton D.C.: The White House.
Tiebout, C.M. M (1956). "A Pure Theory of Local Expenditures". In: *The Journal of Political Economy* 64.5, pp. 416–424.
Tversky, A. and D. Kahneman (1991). "Loss Aversion in Riskless Choice: A Reference-Dependent Model". In: *The Quarterly Journal of Economics* 106.4, pp. 1039–1061. DOI: 10.2307/2937956.
Walker, Richard and Alex Schafran (2015). "The strange case of the Bay Area". In: *Environment and Planning A* 47.1, pp. 10–29. ISSN: 0308-518X. DOI: 10.1068/a46277.
Wallis, Allan D. (1994a). "Inventing regionalism: the first two waves". In: *National Civic Review* 83.2, pp. 159–175.
— (1994b). "The third wave: Current trends in regional governance". In: *National Civic Review* 83.3, pp. 290–310.
Warner, M. and A. Hefetz (2002). "Applying Market Solutions to Public Services: An Assessment of Efficiency, Equity, and Voice". In: *Urban Affairs Review* 38.1, pp. 70–89. ISSN: 1078-0874. DOI: 10.1177/107808702401097808.
Warner, Samuel (1962). *Streetcar Suburbs: The Process of Growth in Boston, 1870-1900*. en. Mass., p. 208.
Weinberg, Jill D., Jeremy Freese, and David McElhattan (2014). "Comparing data characteristics and results of an online factorial survey between a population-based and a crowdsource-recruited sample". In: *Sociological Science* 1, pp. 292–310.
William M. Scholl Center for American History and Culture at The Newberry Library (2016). *Atlas of Historical County Boundaries Project*.
Zimmerman, Joseph Francis (1981). *Measuring local discretionary authority*. Advisory Commission on Intergovernmental Relations.

Appendix: Survey questions

*

By restricting or allowing development, the land-use policy of a town or city can affect economic development and housing prices in other places of the same metropolitan area.
Land-use planning (what can get built where) is decided by your city today, without any obligation to collaborate with other cities around.
Two organizations are proposing a new multi-city board to manage land-use planning, so that some of the land-use planning power will be shared with neighboring cities.
This new board will replace partly or completely your city's planning department. These two proposals are going to the ballot in the next election and you will be given the opportunity to choose.
Between these two plans, which is the one that you prefer? **Choose one.**

	Plan A	Plan B
Participation	San Francisco and 15 neighboring cities	San Francisco and 15 neighboring cities
Cost of planning and infrastructures	20$ more than today per household per month	50$ less than today per household per month
Distribution of cost	Proportional to the new development: places with more new development pay more.	Proportional to the current tax base: places with more population and economic activity today pay more.
Type of power	Replaces San Francisco planning department completely: all planning powers are transfered to the new multi-city planning board, including detailed zoning and building permits.	San Francisco keeps much of the land-use planning power: the new multi-city planning board only does coordination, giving objectives and guidelines for participating cities.
Policy coordination	Regulates land-use and coordinates with water management, transportation and public transit: makes sure there is enough water and transportation infrastructure is adequate for development.	Only regulates land-use.
Board members	Directly elected by the population.	Non-partisan, independant, appointed experts.
Sanctions for non-complying cities	20$ per household per month.	50$ per household per month.
Which plan do you prefer?	○	○

Figure 7: Example of experimental question. Conjoint experiment.

*If these plans were on the ballot in your city, would you vote for any of these plans? These plans are the same as in the last question. Express an independent choice for each plan.

	Plan A	Plan B
Participation	Oakland and 15 neighboring cities	All cities and counties in the greater San Jose-San Francisco-Oakland area (CA)
Cost of planning and infrastructures	Same as today	50$ more than today per household per month
Distribution of cost	Proportional to the population: places with more population pay more.	Proportional to the population: places with more population pay more.
Type of power	Oakland keeps much of the land-use planning power: the new multi-city planning board only does coordination, giving objectives and guidelines for participating cities.	Replaces Oakland planning department completely: all planning powers are transfered to the new multi-city planning board, including detailed zoning and building permits.
Policy coordination	Regulates land-use and coordinates with water management, transportation and public transit: makes sure there is enough water and transportation infrastructure is adequate for development.	Regulates land-use and coordinates with water management: makes sure there is enough water for development.
Board members	Non-partisan, independant, appointed experts.	Non-partisan, independant, appointed experts.
Sanctions for non-complying cities	20$ per household per month.	No sanctions.
Yes		
No		
I'm not sure		

Figure 8: Example of experimental question. Vignette experiment.

Table 2: Institutional arrangement dimensions and values
Each individual plan presented to respondents is made of one value randomly chosen for every institutional dimension.

dimension	*values*
Participation*	- [My city] and 3 neighboring cities - [My city] and 15 neighboring cities - All cities and counties in the greater [metropolitan area]
Cost of planning and infrastructures	- Same as today - 20$ less than today per household per month - 50$ less than today per household per month - 20$ more than today per household per month - 50$ more than today per household per month
Distribution of costs	- Proportional to the population: places with more population pay more. - Proportional to the current tax base: places with more population and economic activity today pay more. - Proportional to the new development: places with more new development pay more.
Type of power	- [Your city] keeps much of the land-use planning power: the new multi-city planning board only does coordination, giving objectives and guidelines for participating cities. - Replaces [your city] planning department completely: all planning powers are transfered to the new multi-city planning board, including detailed zoning and building permits.
Policy coordination	- Only regulates land-use. - Regulates land-use and coordinates with water management: makes sure there is enough water for development. - Regulates land-use and coordinates with transportation and public transit: makes sure that transportation infrastructure is adequate for development. - Regulates land-use and coordinates with water management, transportation and and public transit: makes sure there is enough water and transportation infrastructure is adequate for development.
Board members	- Directy elected by the population. - Non-partisan, independent, appointed experts.
Sanctions for non-complying cities	- No sanctions - 20$ per household per month - 50$ per household per month

* Content in brackets is adapted to the location of the respondent, based on the zipcode provided.

Table 3: Pearson's Chi-squared independence tests for pairs of vignette dimensions

	Participation	Cost	Distribution	Power	Coordination	Board Members	Sanctions
Participation	0.00	0.36	0.01	0.36	0.73	0.98	0.36
Cost	0.36	0.00	0.24	0.60	0.70	0.22	0.40
Distribution	0.01	0.24	0.00	0.62	0.78	0.69	0.57
Power	0.36	0.60	0.62	0.00	0.52	1.00	0.28
Coordination	0.73	0.70	0.78	0.52	0.00	0.45	0.49
Board Members	0.98	0.22	0.69	1.00	0.45	0.00	0.54
Sanctions	0.36	0.40	0.57	0.28	0.49	0.54	0.00

Appendix: Distribution of Respondents

How to read the figures. Figures 9 to 13 display the relative distribution of survey respondents compared to the overall adult population of the State of California, as measured by the American Community Survey from the US Census, dated from 2013 and averaged over a period of 5 years, along several socio-demographic characteristics: primary statistical area of residence, gender, age, race and ethnicity, and annual household income. In each figure, the teal-colored bar shows the distribution of survey respondents along the dimension of interest, while the red bar shows the distribution in the State of California. Both quantities have been graphically normalized to be comparable, and the axis shows the actual number of individuals for each population.

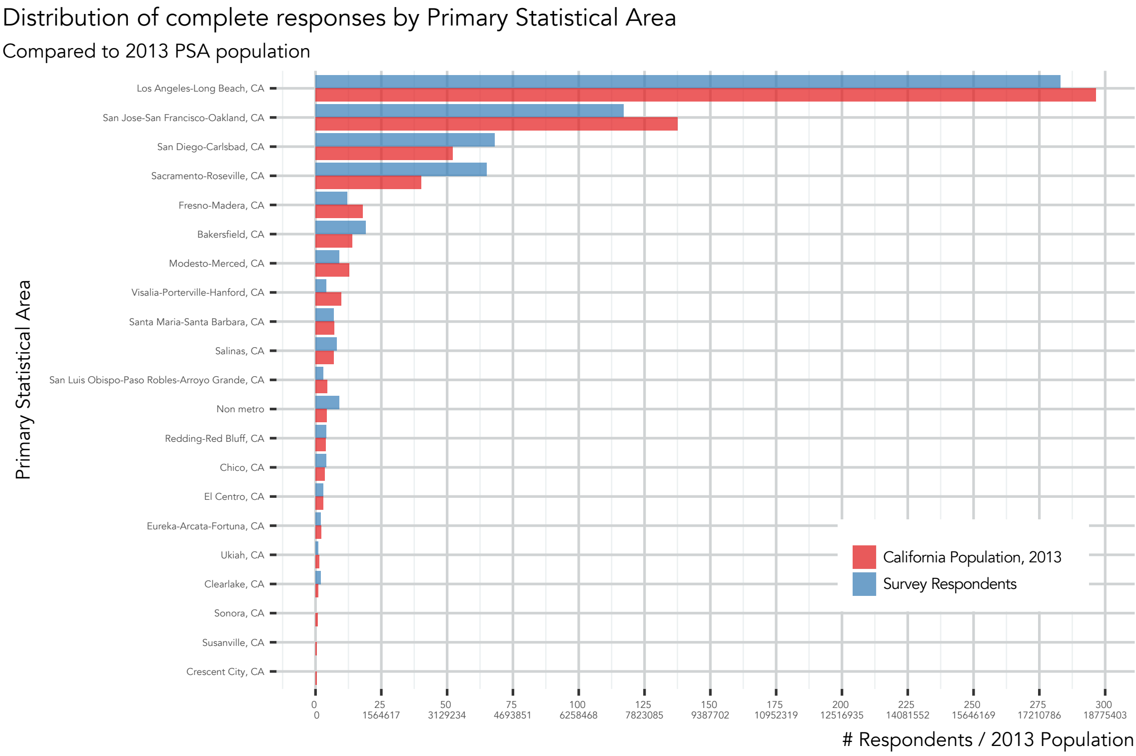

Figure 9: Distribution of responses by Primary Statistical Area (PSA).
Bar size is equally proportional to each PSA share in the survey sample and in California's population. Two bars of equal size for a PSA reflect that the proportion of respondents from the area is exactly the same as the area's weight in the State's total population.

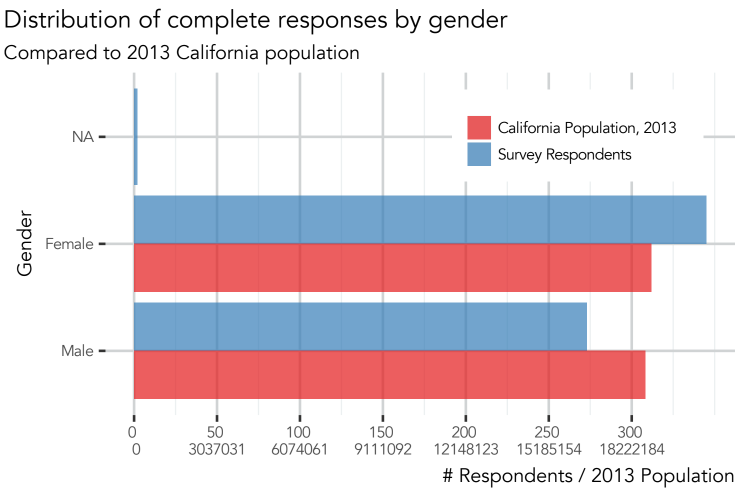

Figure 10: Distribution of complete responses by gender, compared to 2013 California population.

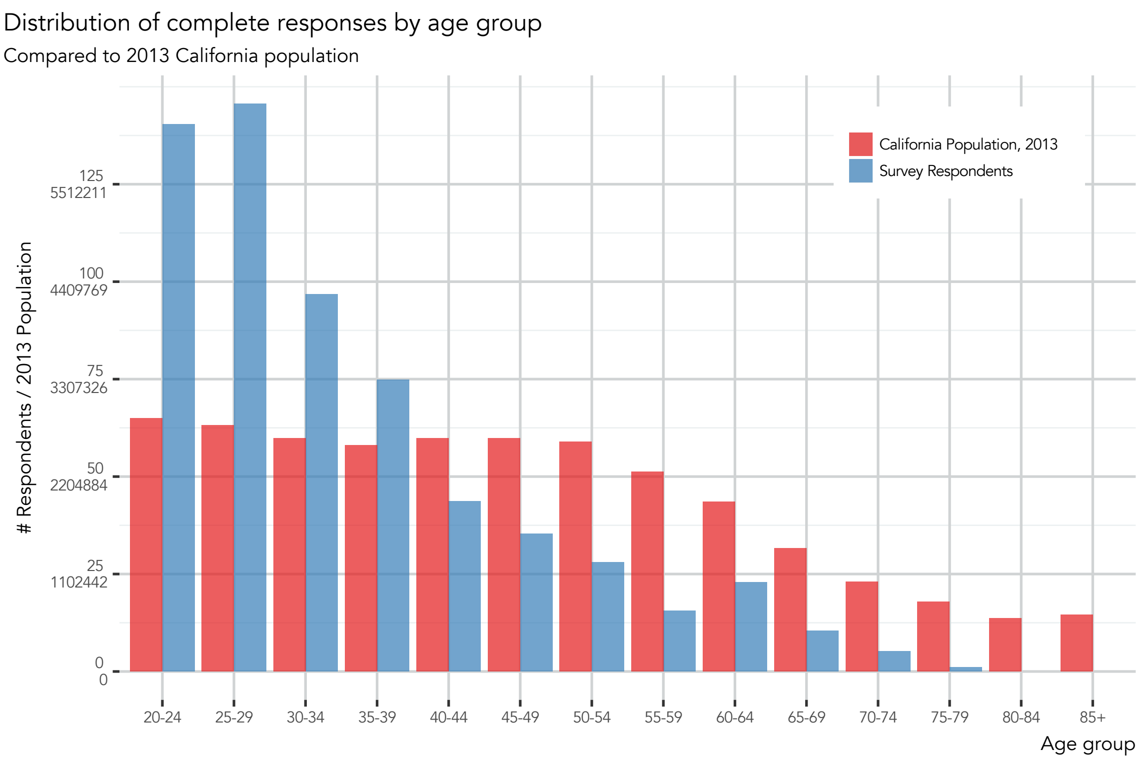

Figure 11: Distribution of complete responses by age group, compared to 2013 California population.

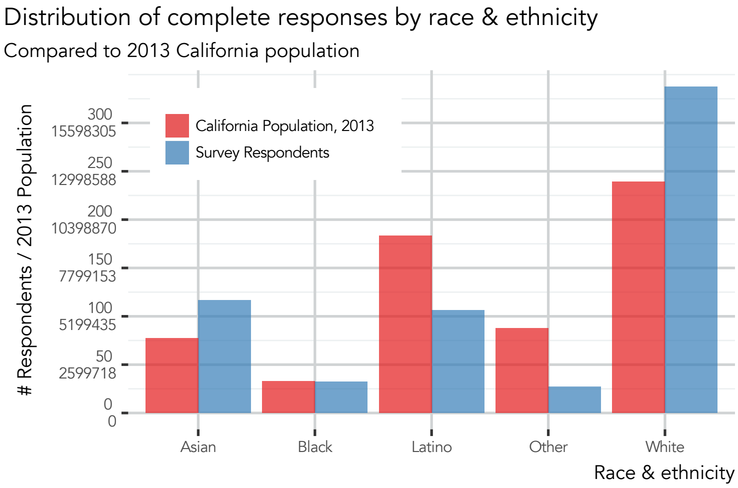

Figure 12: Distribution of complete responses by race and ethnicity, compared to 2013 California population.

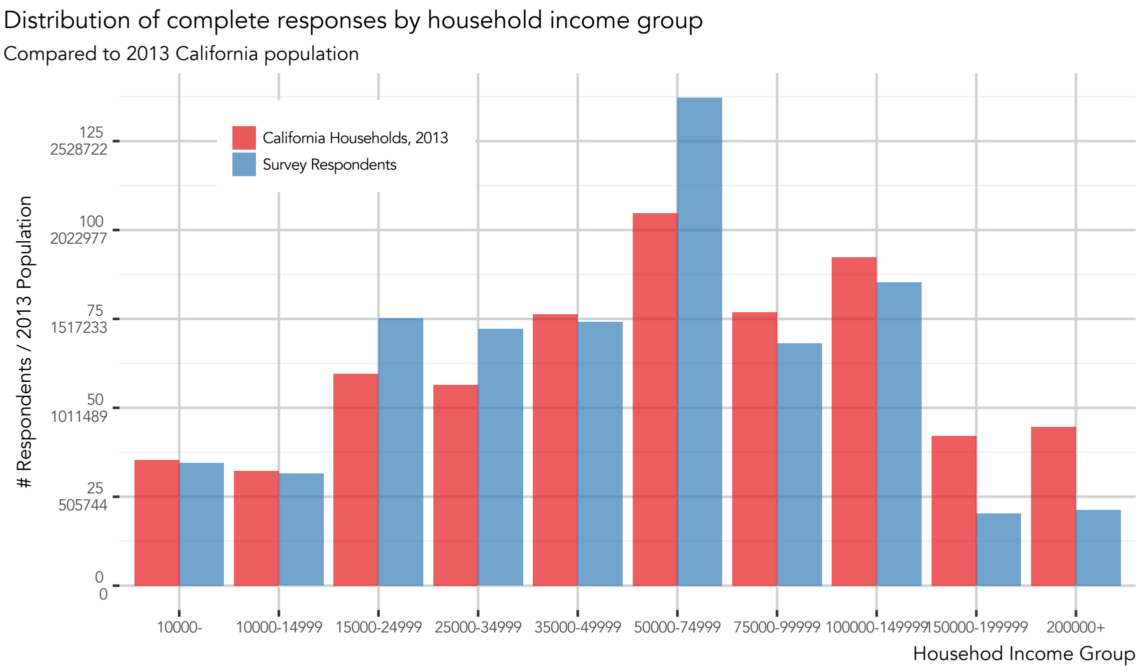

Figure 13: Distribution of complete responses by annual household income, compared to 2013 California population.

Appendix: Statistical Model Figures and Tables

HOW TO READ THE FIGURES. Figures 20 to 45 are visualizations of estimates of Average Marginal Component Effects for the conjoint experiment, the effect of each institutional feature, on the *relative* preference for a plan over an alternative. For convenience of interpretability, the figures display the effect of a feature on the respondent's odds of supporting the plan over its alternative. For instance, an effect of 2 means that the feature makes respondents twice as likely to support the plan on average. Conversely, an effect of 0.5 means that the feature makes the respondents half as likely to support the plan on average. Moreover, the figures show the 95% confidence interval for each effect. A smaller confidence interval means a larger certainty about the true effect. A confidence interval that does not include 0 indicates that the effect is significant with a p-value < 0.05.

Figure 20 and 21 compare AMCE estimates for the whole population of respondents, without and with sampling weights to correct for sampling biases

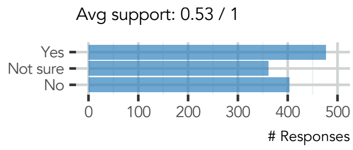

Figure 14: Distribution of expressed individual preferences for a collaboration plan, all respondents.
N = 620, 2 measures/respondent

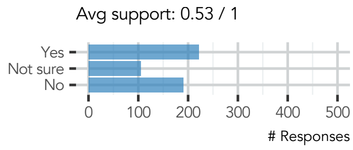

Figure 15: Distribution of expressed individual preferences for a collaboration plan, likely voters.
N Likely Voters = 258, 2 measures/respondent

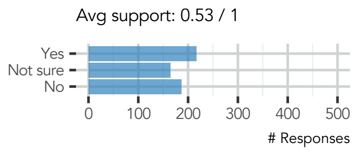

Figure 16: Distribution of expressed individual preferences for a collaboration plan, Greater Los Angeles respondents.
N = 620, 2 measures/respondent

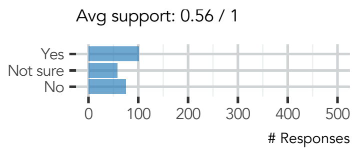

Figure 17: Distribution of expressed individual preferences for a collaboration plan, San Francisco Bay Area respondents.
N = 620, 2 measures/respondent

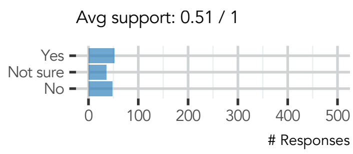

Figure 18: Distribution of expressed individual preferences for a collaboration plan, Greater San Diego respondents.
N = 620, 2 measures/respondent

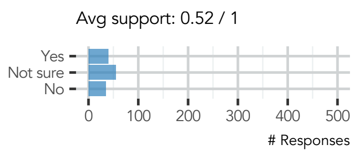

Figure 19: Distribution of expressed individual preferences for a collaboration plan, Greater Sacramento respondents.
N = 620, 2 measures/respondent

Figure 20: Average Marginal Component Effects (AMCE) of plan features. Unweighted, all respondents (unconditional).

Figure 21: Average Marginal Component Effects (AMCE) of plan features. Weighted, all respondents (unconditional).

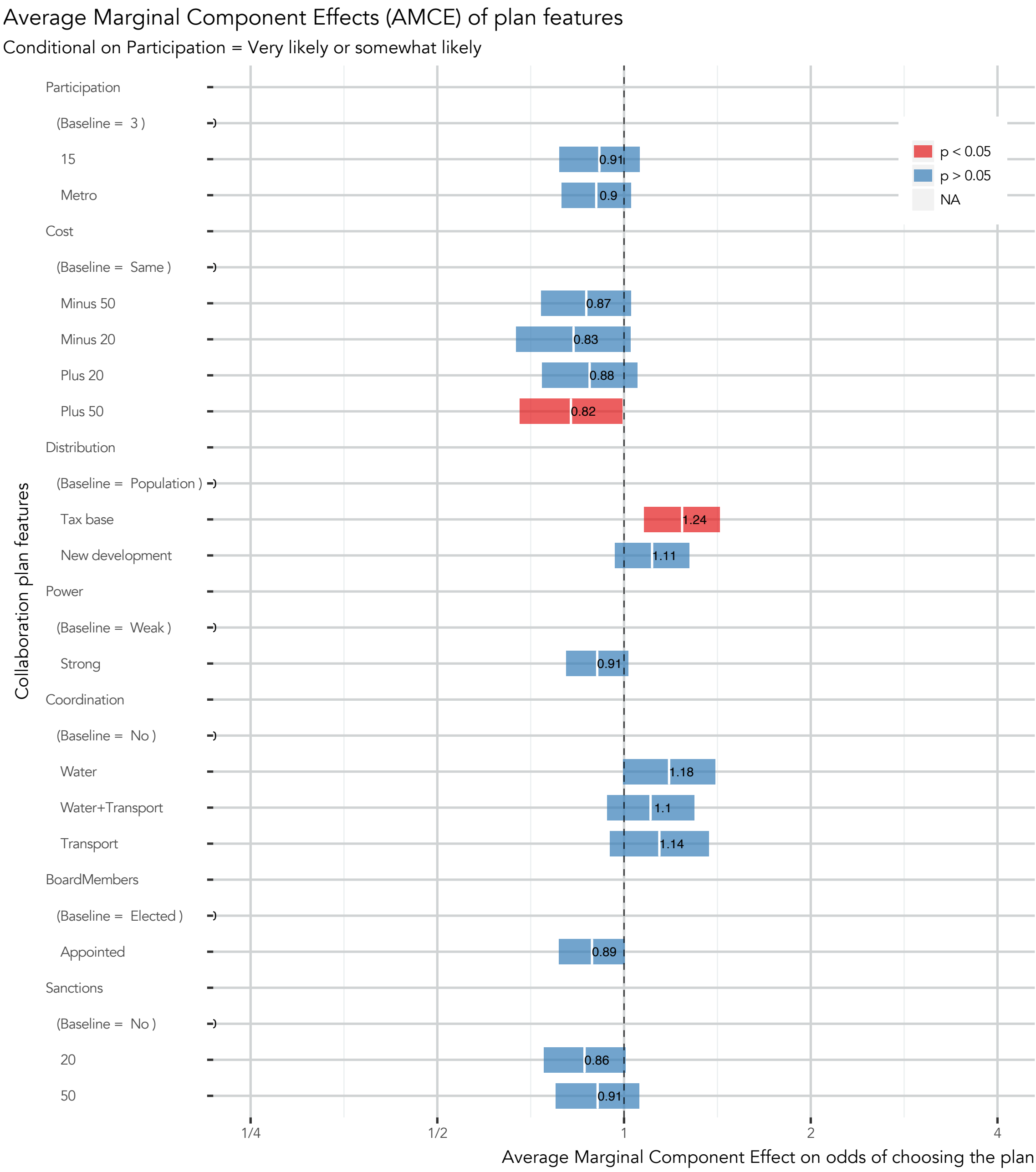

Figure 22: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Participation = Very likely or somewhat likely.

Figure 23: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Participation = Neither likely nor unlikely.

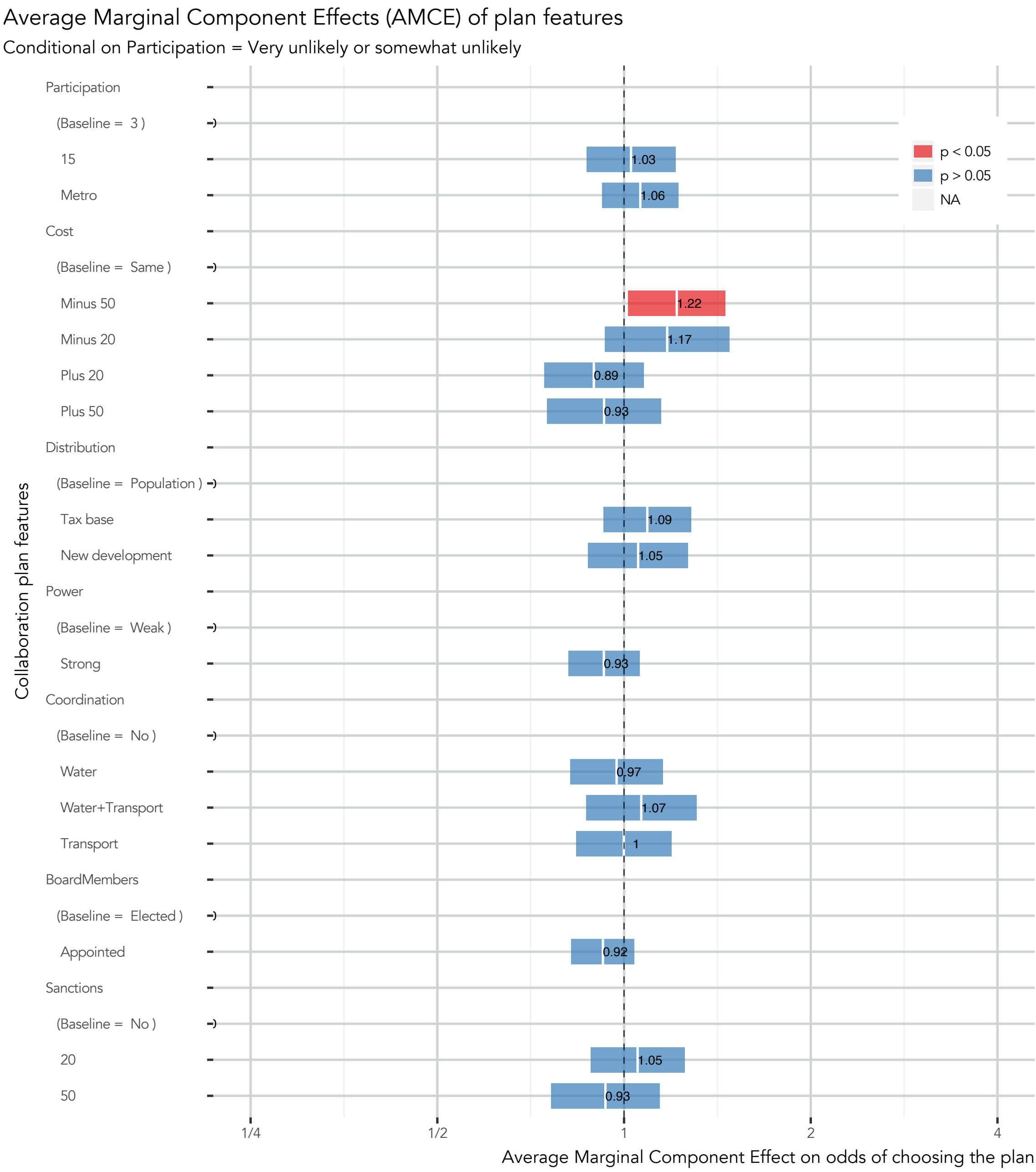

Figure 24: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Participation = Very unlikely or somewhat unlikely.

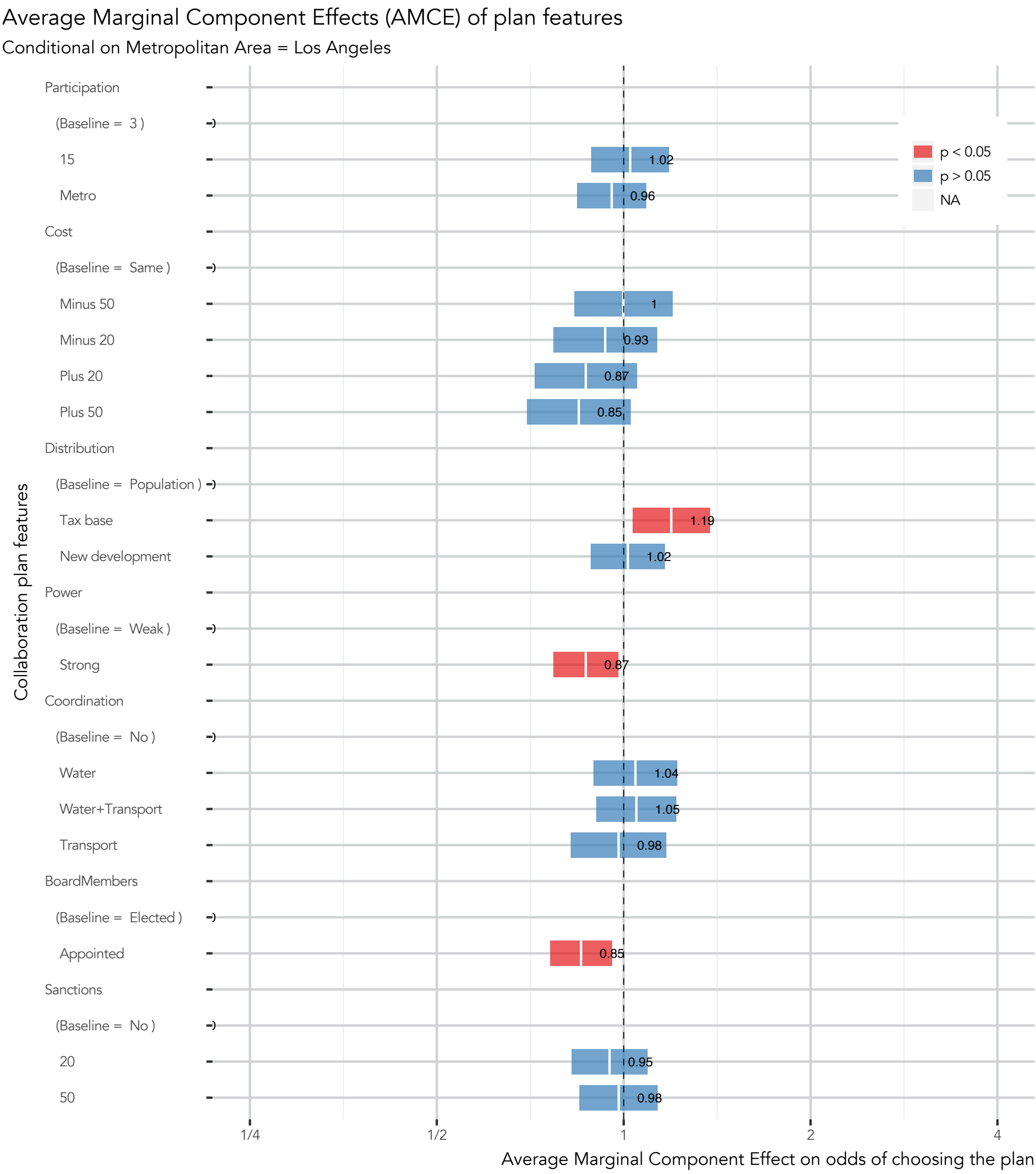

Figure 25: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Metropolitan Area = Los Angeles.

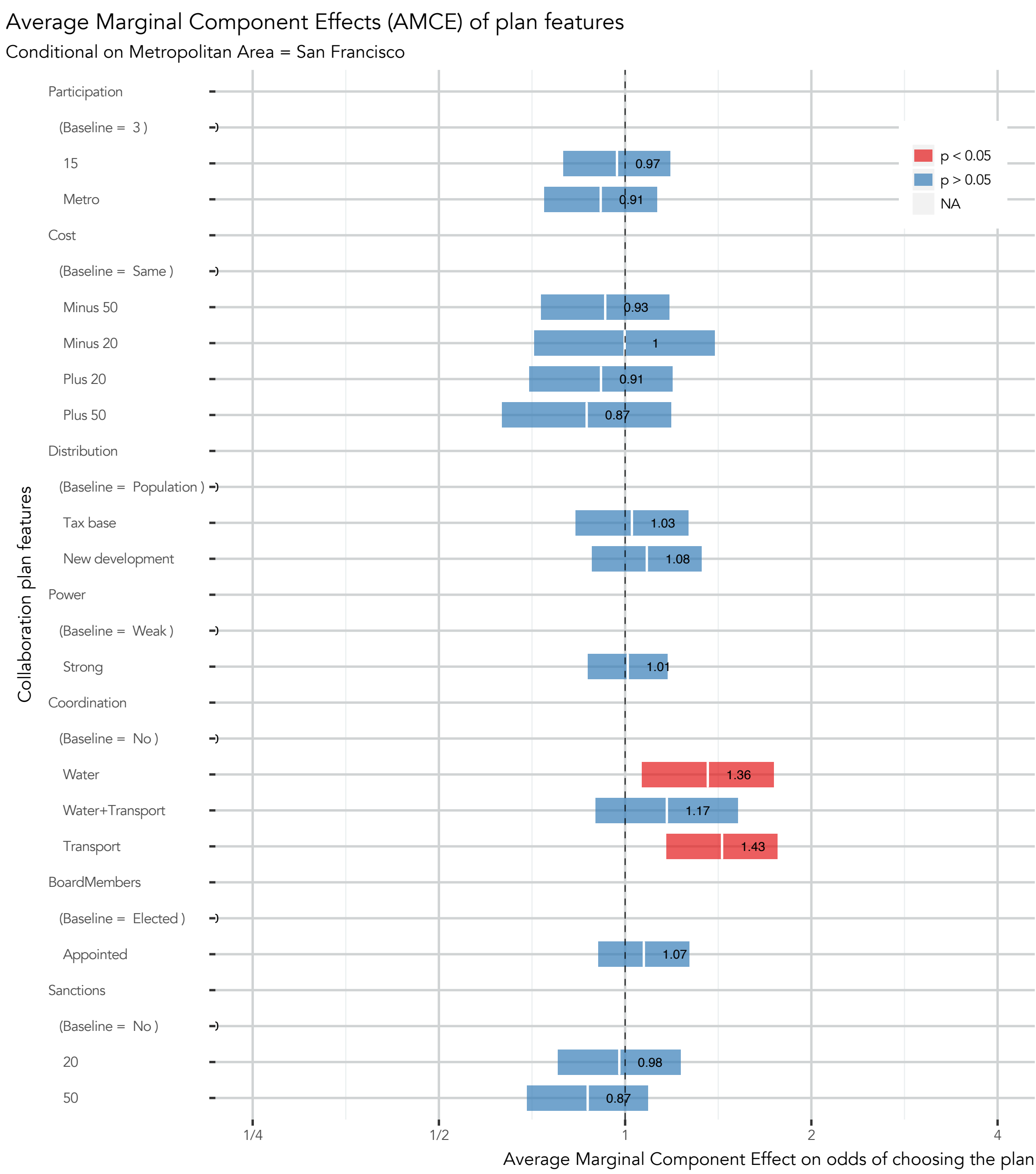

Figure 26: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Metropolitan Area = San Francisco.

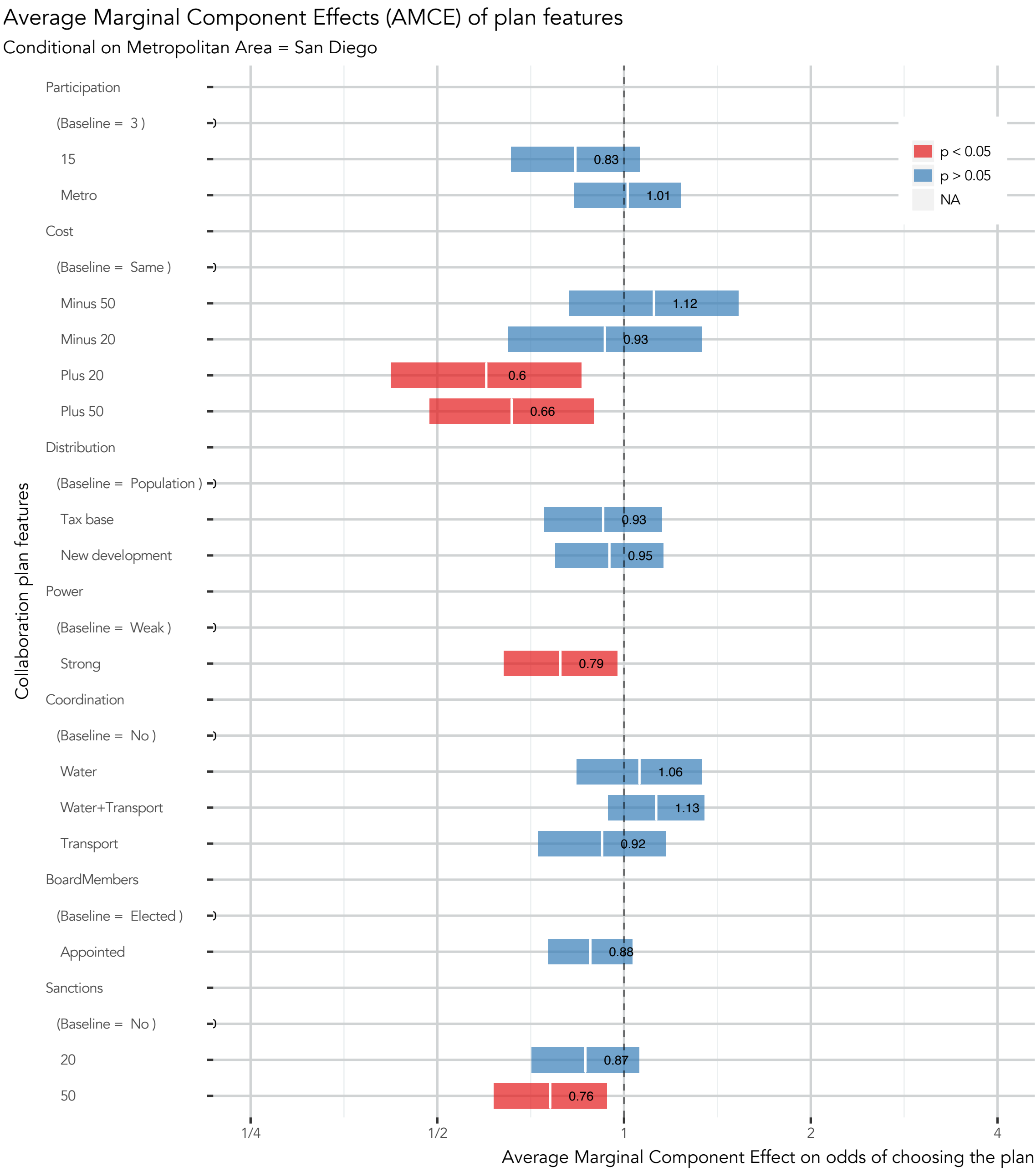

Figure 27: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Metropolitan Area = San Diego.

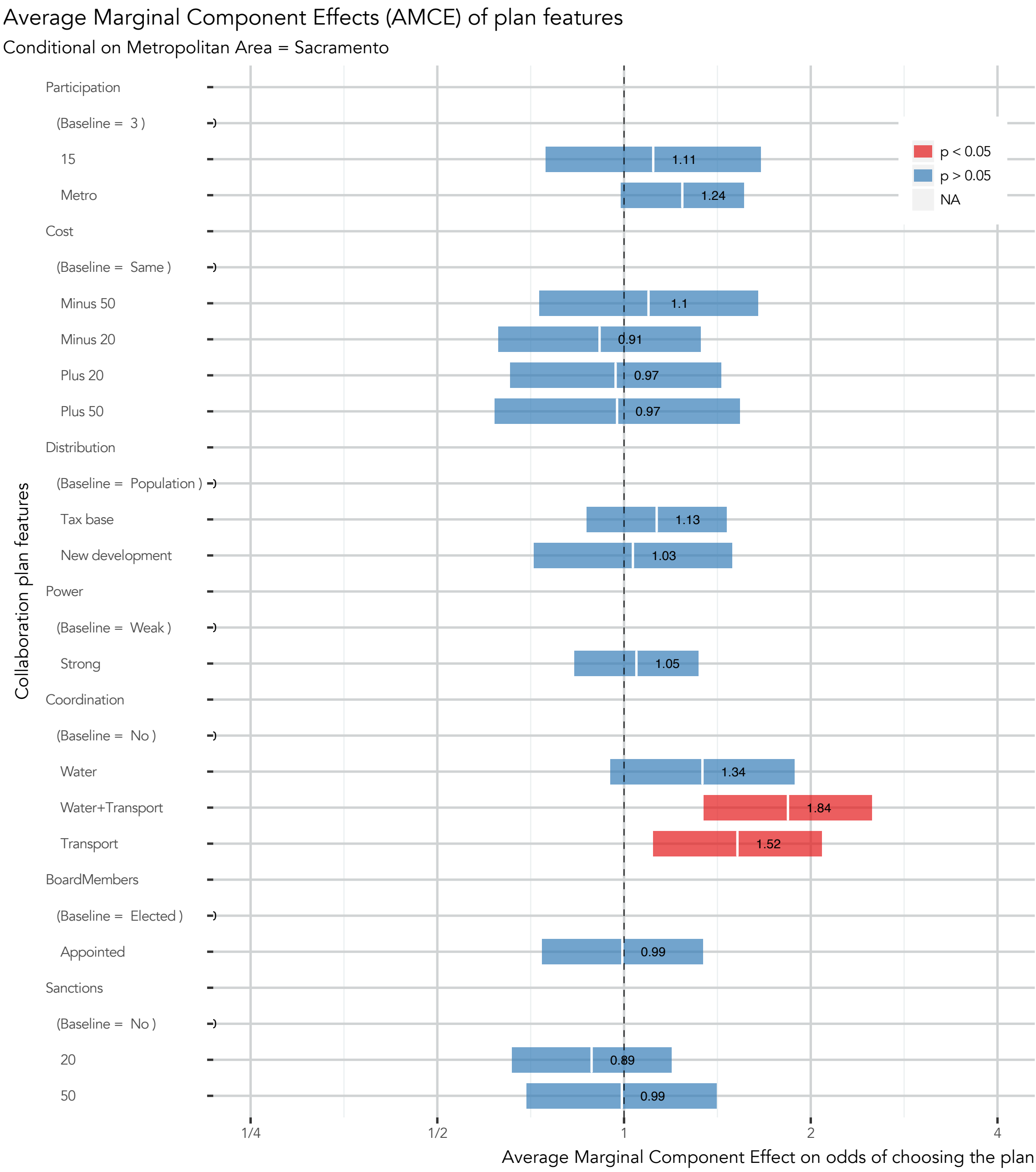

Figure 28: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Metropolitan Area = Sacramento.

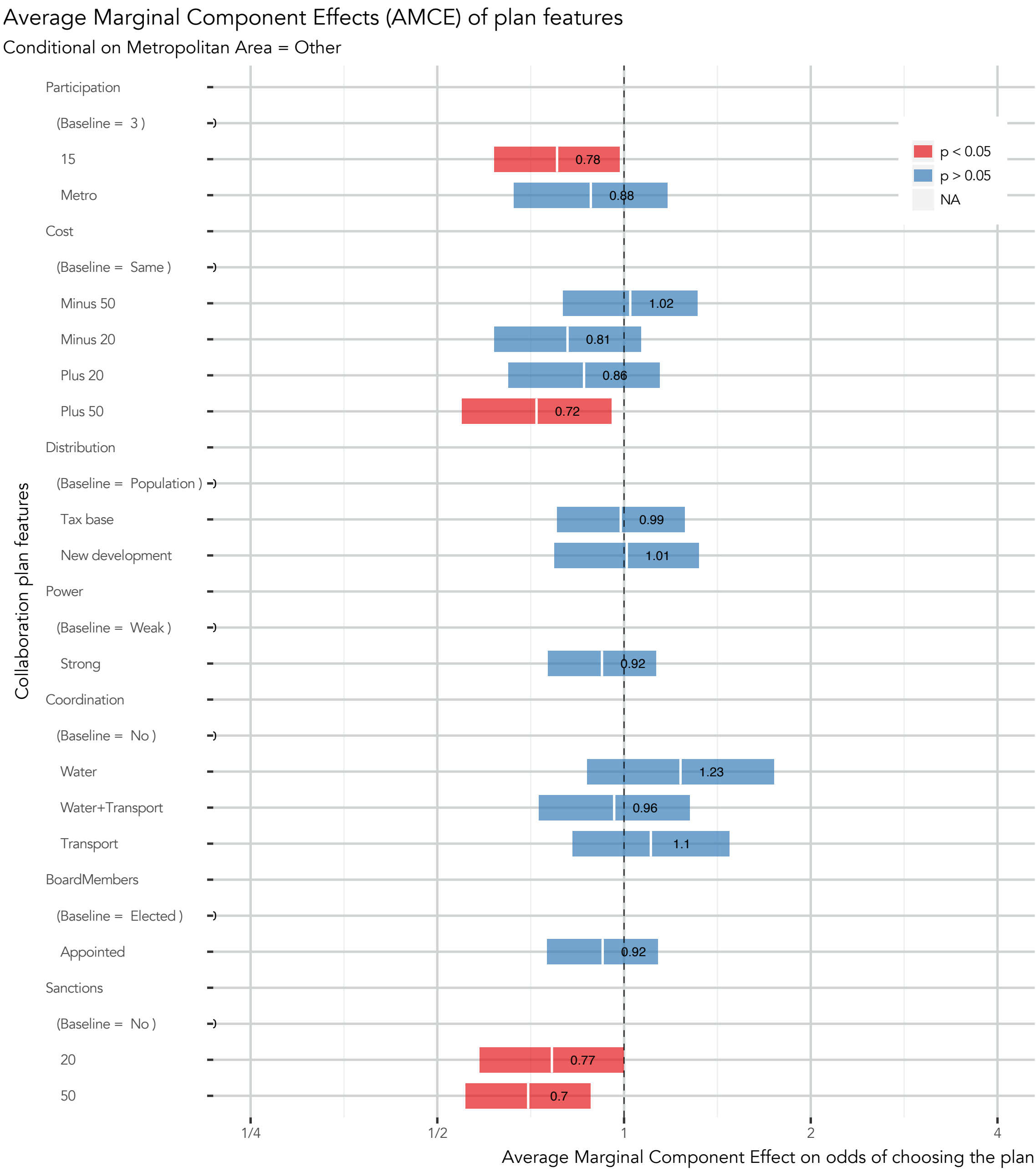

Figure 29: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Metropolitan Area = other.

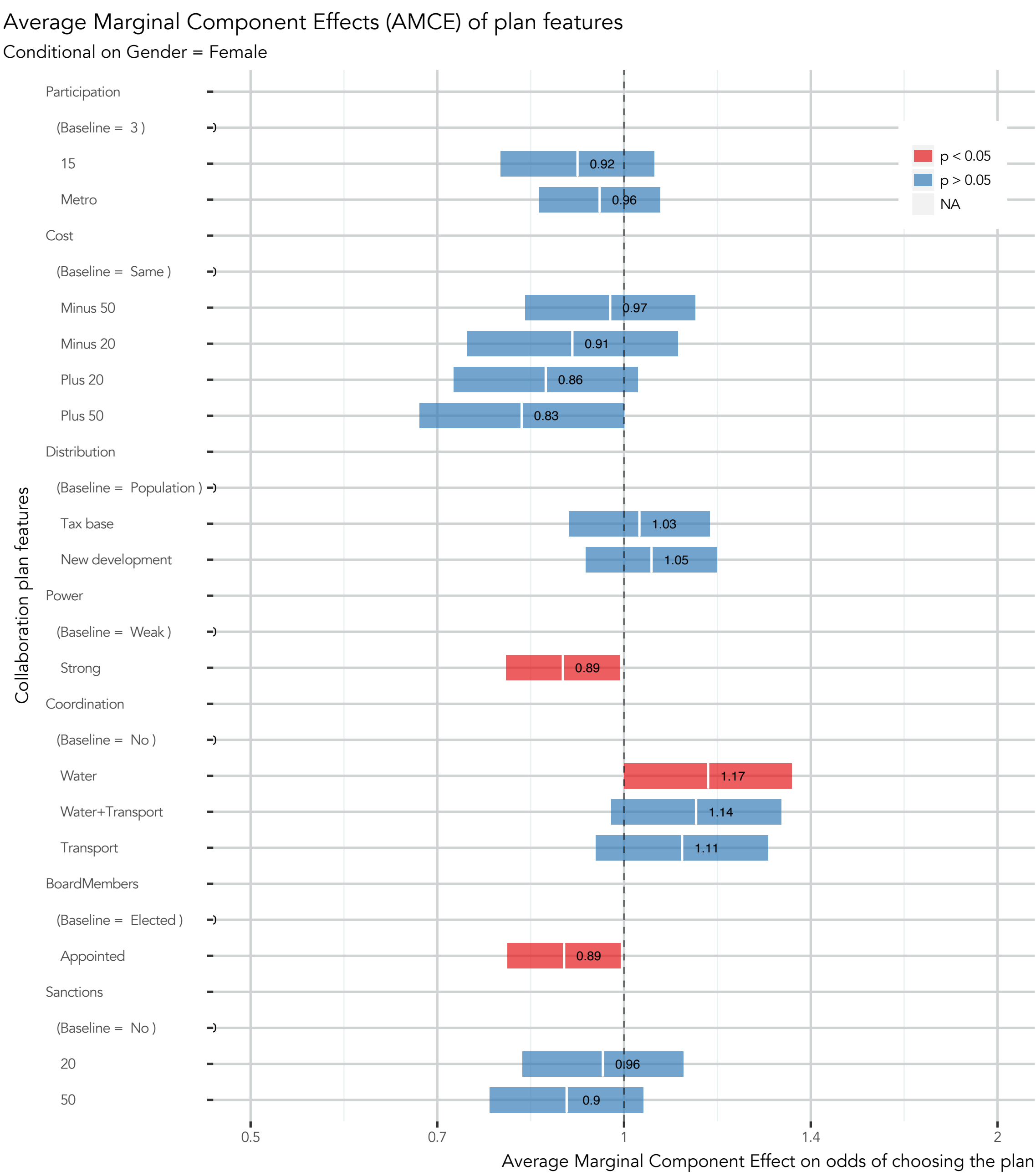

Figure 30: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Gender = Female.

Figure 31: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Gender = Male.

Figure 32: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Party = Independent.

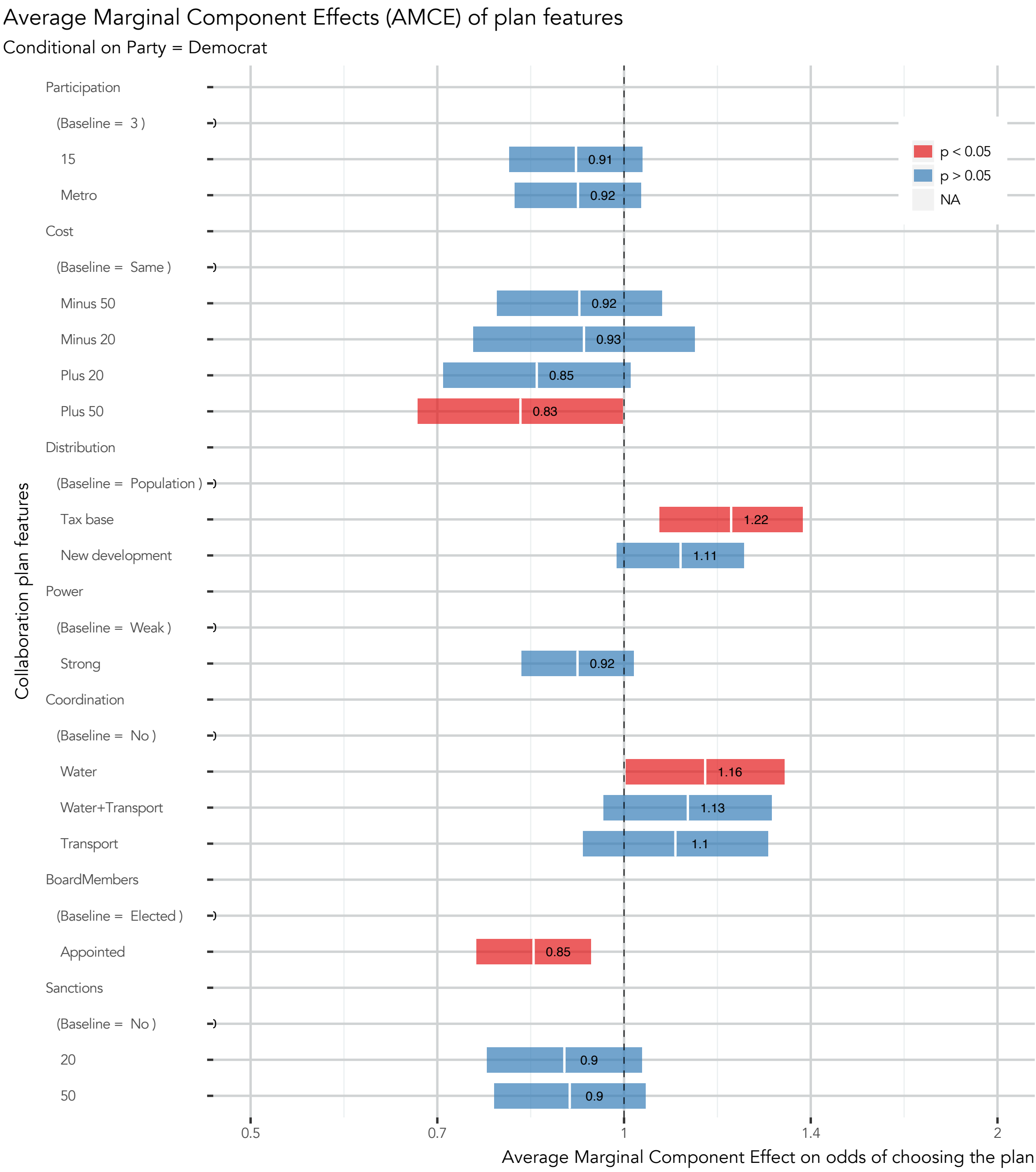

Figure 33: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Party = Democrat (Leaning or registered).

Figure 34: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Party = Republican (Leaning or registered).

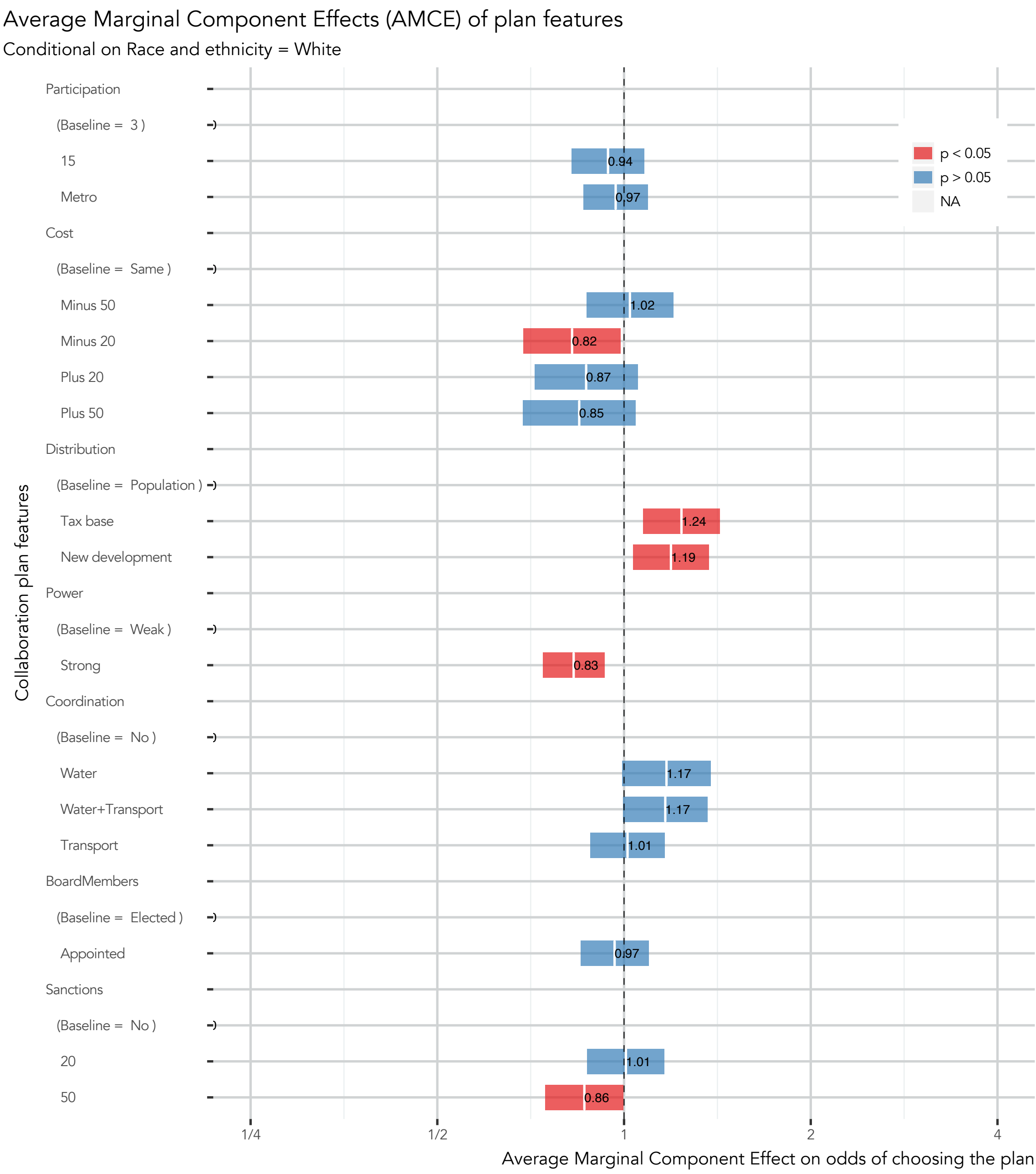

Figure 35: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Race and ethnicity = White.

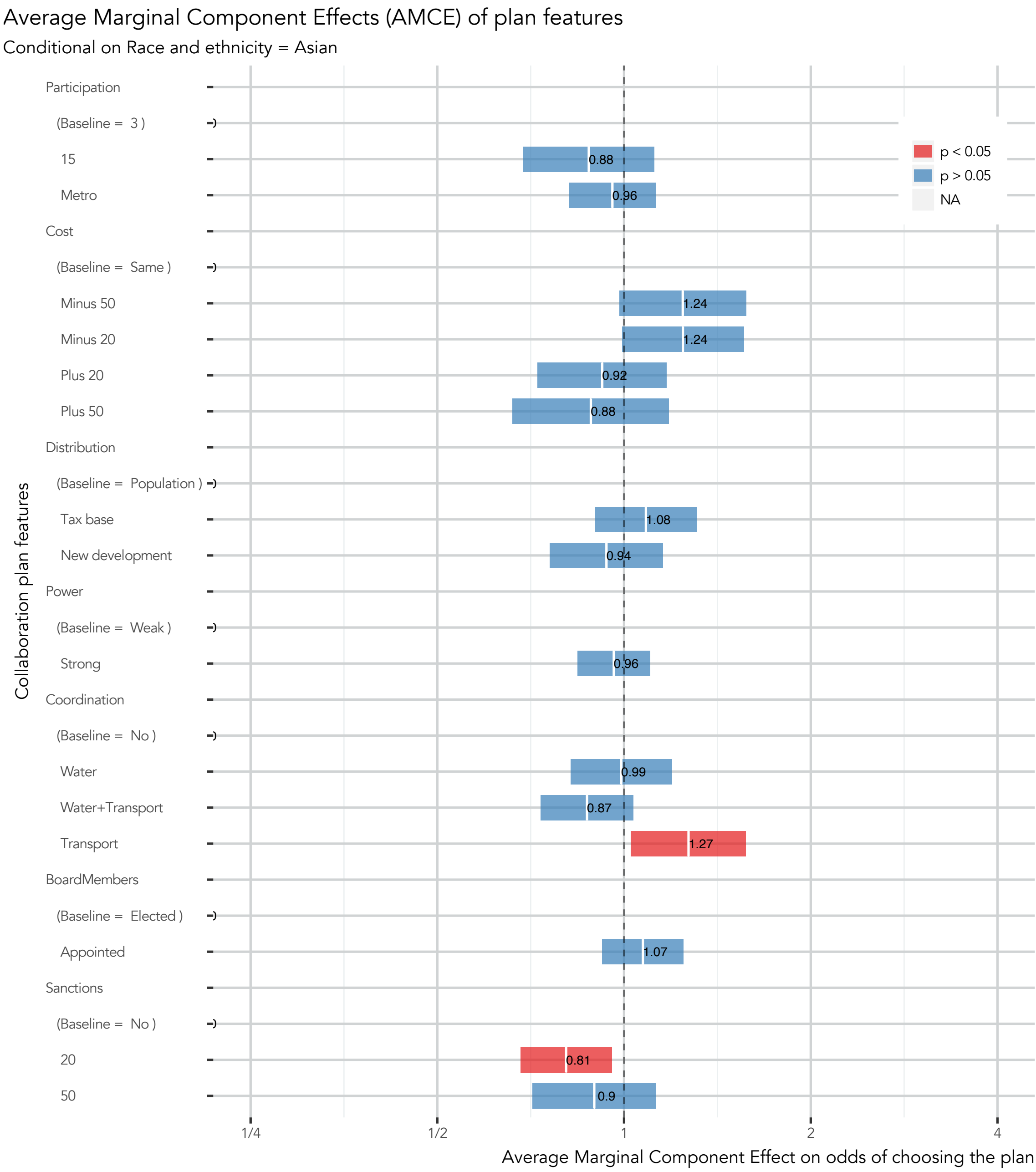

Figure 36: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Race and ethnicity = Asian.

Figure 37: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Race and ethnicity = Black.

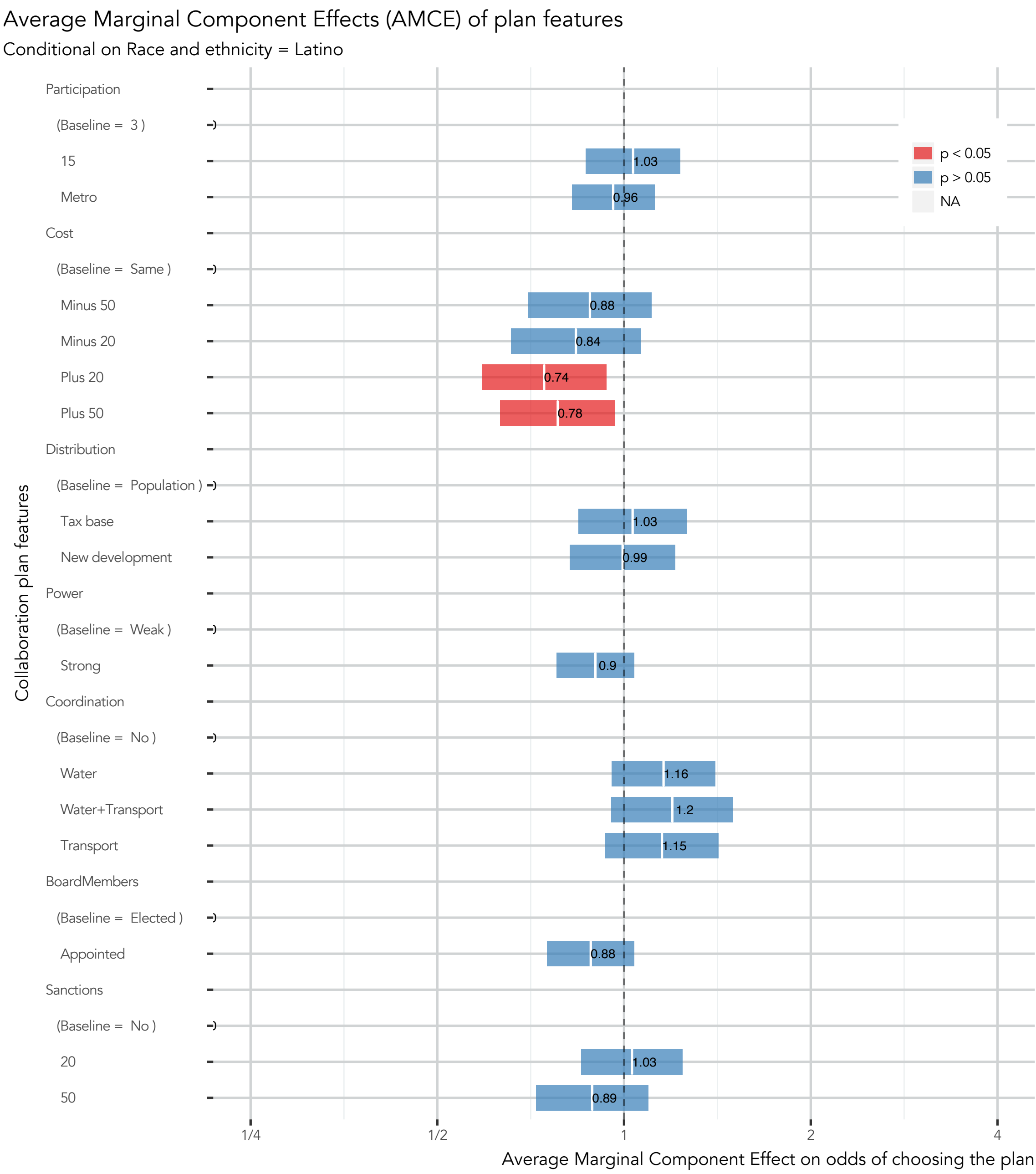

Figure 38: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Race and ethnicity = Latino.

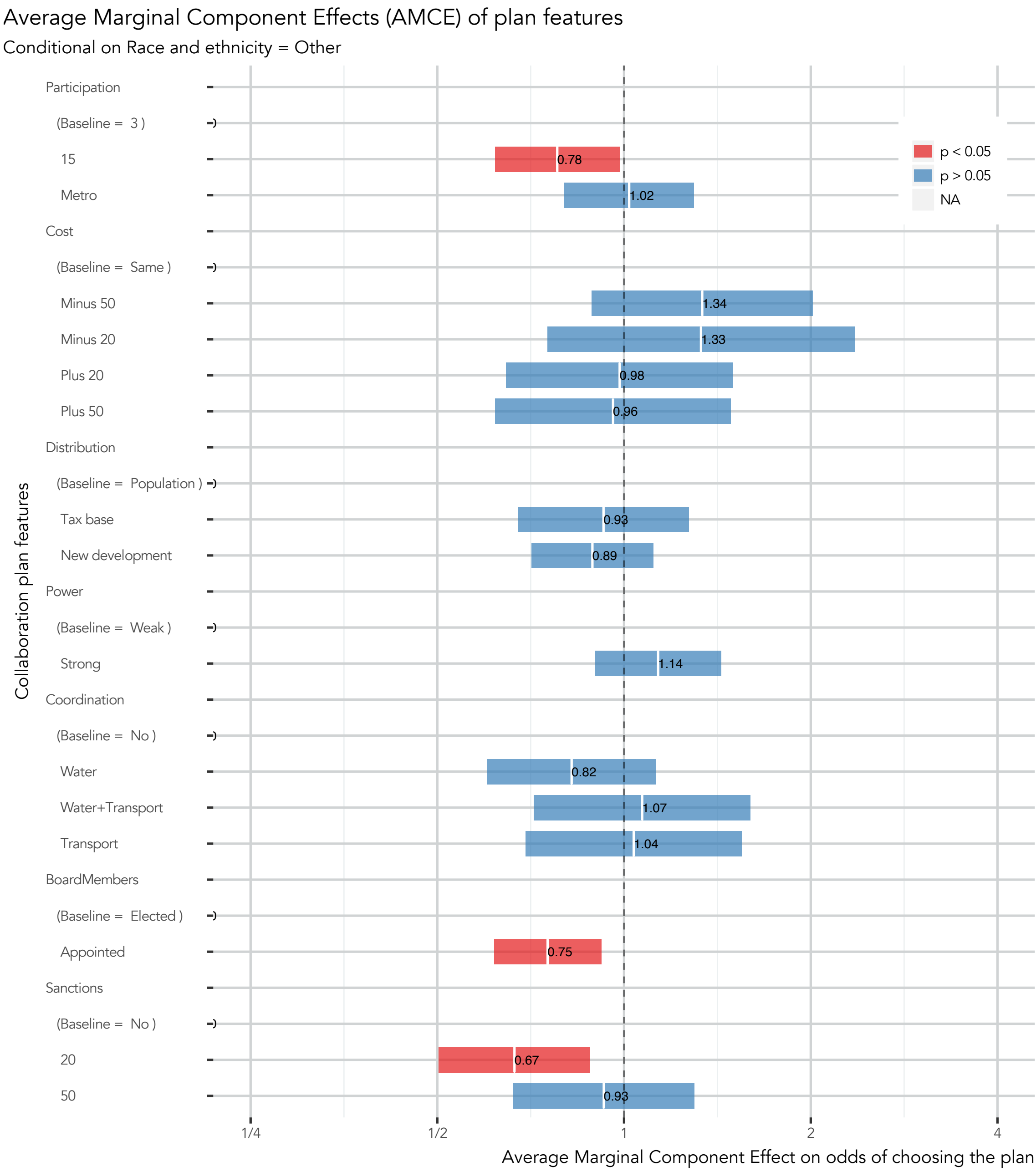

Figure 39: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Race and ethnicity = Other.

Figure 40: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Annual Household Income < $33,000

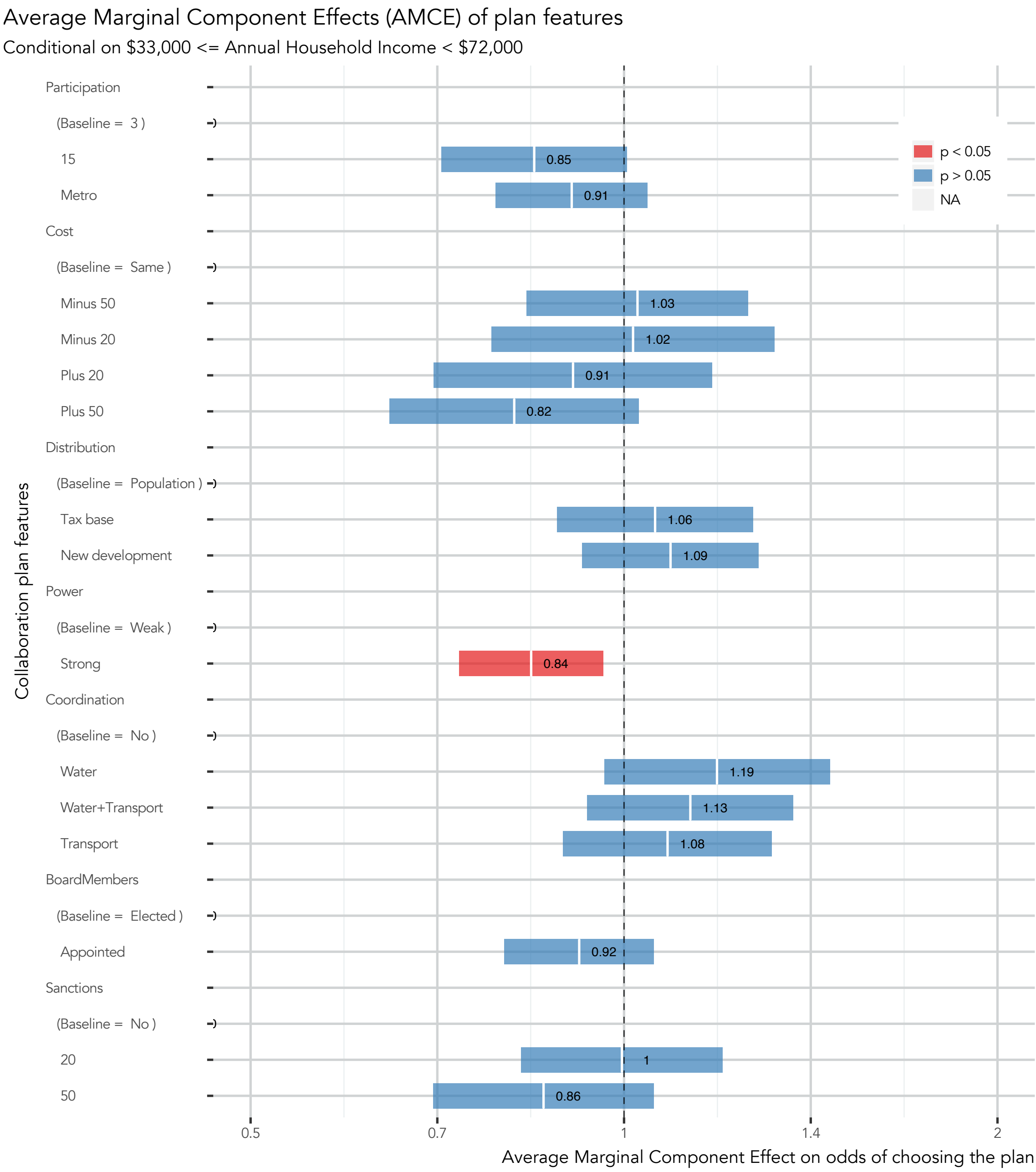

Figure 41: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on $33,000 <= Annual Household Income < $72,000

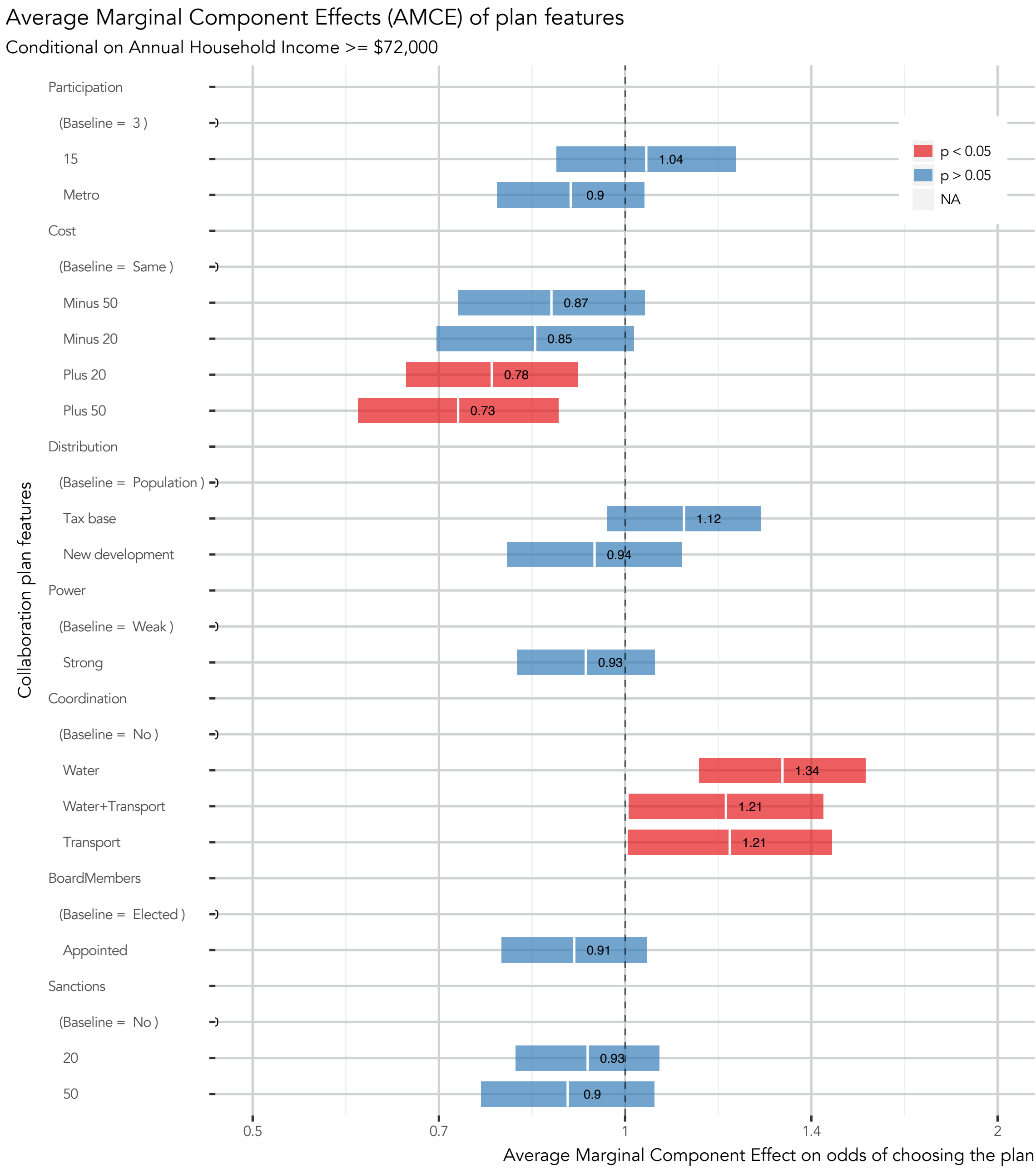

Figure 42: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Annual Household Income >= $72,000

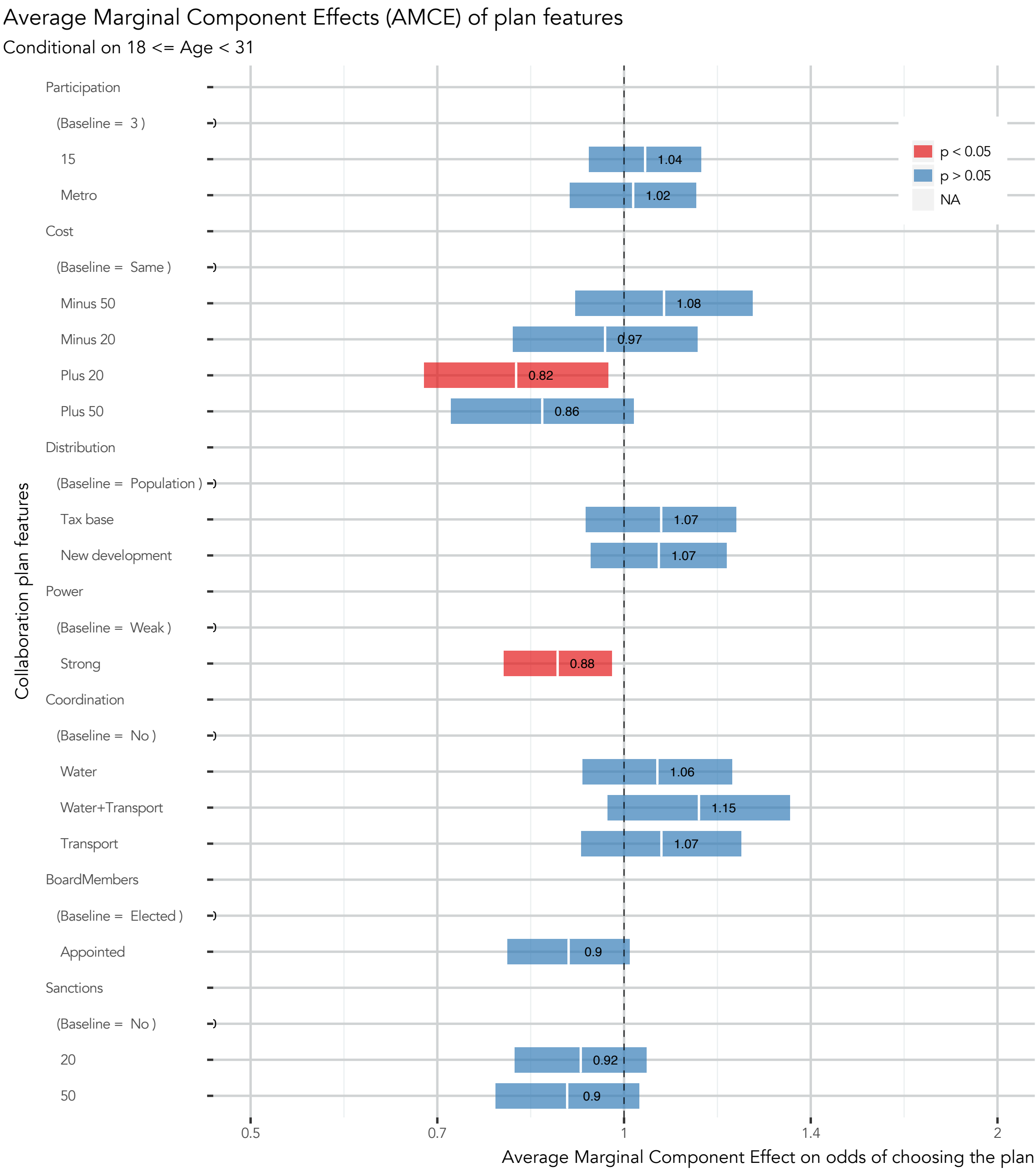

Figure 43: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on 18 <= Age < 31.

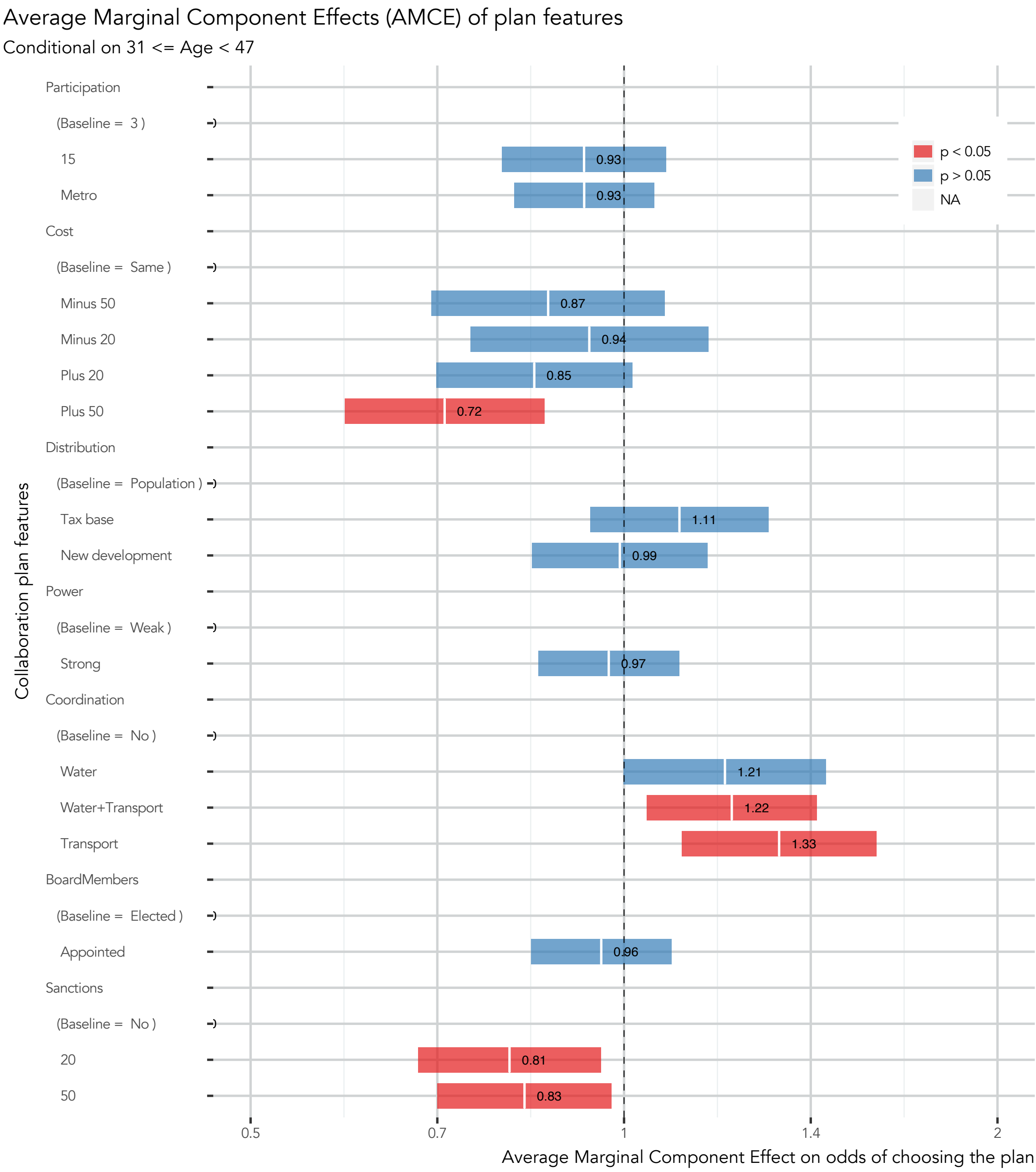

Figure 44: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on 31 <= Age < 47.

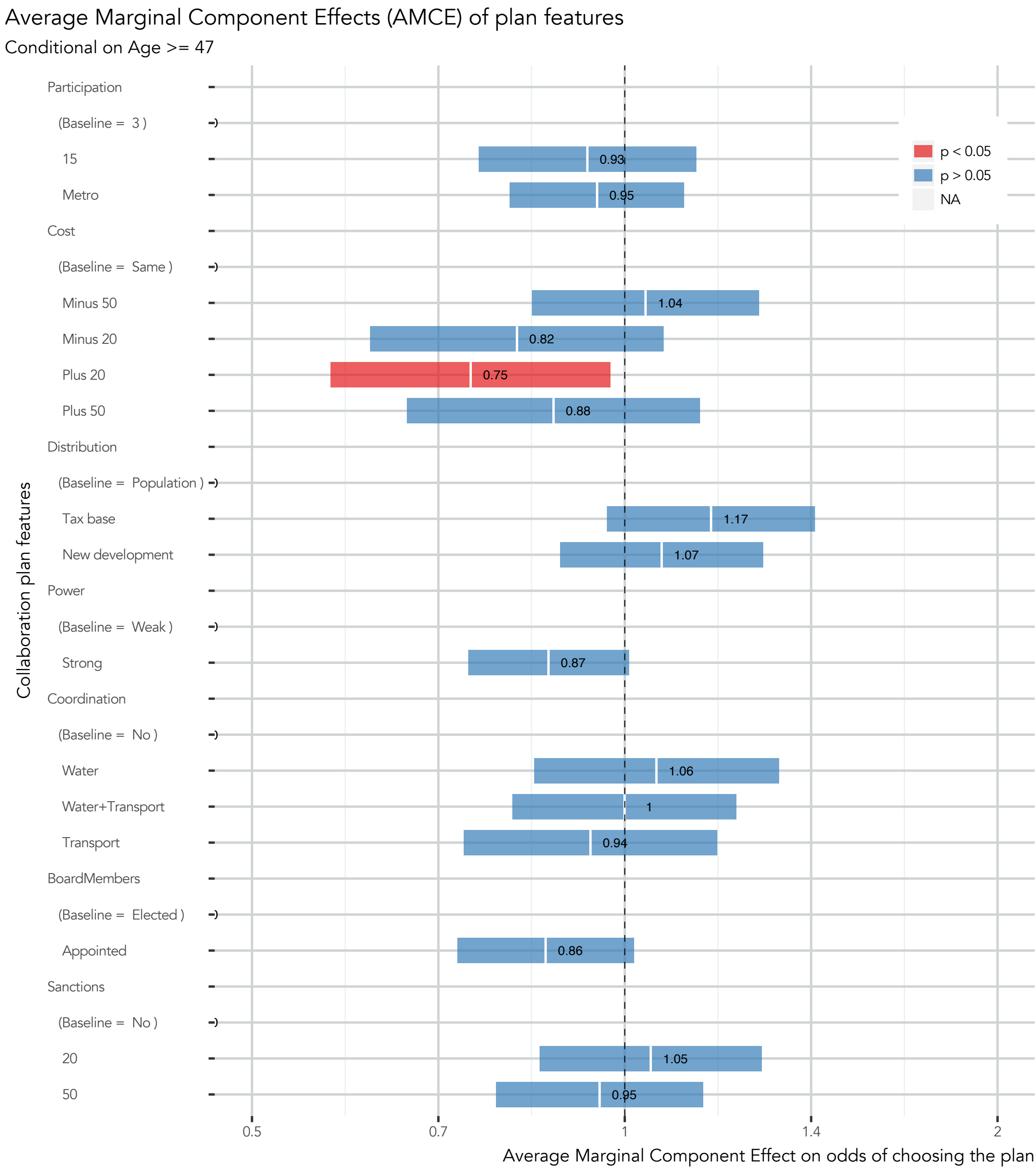

Figure 45: Average Marginal Component Effects (AMCE) of plan features. Weighted, conditional on Age >= 47.

CONCLUSION

Conclusion

Contents

In this research project I have investigated the discrepancy between social and institutional space by examining two spatial realities: metropolitan areas and disadvataged communities. For both, I have evaluated official definitions and proposed alternatives. For metropolitan areas, I have conducted a survey experiment to understand people's preferences for inter-governmental collaboration in land-use, transit and transportation, and water policies. While different in scope and methods, these three specific projects offer common insights to better conduct policies with substantial spatial dimensions. These insights are precious to conduct policies that, as it is the case for both spaces examined here, target spaces do not have a coextensive institution or government.

In this conclusive chapter, I start by summarizing empirical results from the three studies, describing how they constribute to general hypotheses of the research laid out in the introduction (1). Second, I expound how, in a context of networked urban spaces, a local approach is unavoidable. This local approach, however, can be undertaken with a comparative mindset and take advantage of a common toolbox (2). A comparative approach combined with experimental methods to explore potential policies opens the door to a rapid-prototyping approach to policy. Involving public participation in a scientifically rigorous setting contributes to expand the domain of possible policies and defuse political caveats of policy implementation (3). This rapid-prototyping approach can be applied to planning, dissolving the border between project and policy (4). If significant, further research should be undertaken to precise the contours of an experimental approach to policy, both in scientific research, and in concrete applications (5).

1 *Summary of empirical results*

General conclusion can be drawn from the three specific studies I conducted on the delineation of metropolitan areas, definition of disadvantaged communities, and individual support for inter-government collaboration on land-use. They support general hypotheses enunciated in the introductory chapter. First, local context is important in these three cases, and a general solution applying across the board is not possible (1.1). Second, the idea of determining a strict boundary between an inside and an outside of these spatial realities is undermined by geographic continuity, context, and the necessity of taking into account multiple dimensions (1.2). Last, an experimental approach to public policy is validated. This experimental approach allows to understand local preferences for policy features (1.3).

1.1 *One size does not fit all: local context matters*

In the three studies that I have conducted, local geographic context takes precedence over a global, *one size fits all* solution. I conclude that delineations of metropolitan areas and disadvantaged communities, as well as scale and features and inter-government collaboration on land-use policies should emerge from local conditions. If methods can be defined globally, their application should be local.

The White House's Office of Management and Budget (OMB) uses a definition of metropolitan areas based on commuting patterns between counties. I validate that there is indeed a lot of information about metropolitan areas' functioning in commuting patterns, and that they reveal different types of relationships between places. However, no one delineation can capture all this information and the relevant delineation should be adapted for each policy. Moreover, the data itself does not display an obvious, internally valid threshold of commuting to identify metropolitan areas. Such a threshold would be a range of stability in the data, around which delineations do not vary significantly. Furthermore, I showed that commuting patterns vary between large regions of the United States (East, South & West), further undermining the possibility of a uniform definition.

In the four largest metropolitan areas of California (Los Angeles, San Francisco, San Diego & Sacramento), I have shown that residents have different preferences for collaboration between their municipalities and other municipalities in the areas on land-use, transportation, and water. If residents do not seem to attach much importance to specific institutional features of the collaboration—board type, sanctions. . . —, their preferences vary regarding their preferred scale of collaboration and the specific policy mix that the collaboration should address. However, people are not adverse to metropolitan collaboration, provided that it solves a problem they think is important and does it at the right scale. Therefore, it is likely that collaboration instruments on metropolitan issues would have a greater chance of gathering support if it stemmed from an understanding of local preferences for scale and policy-mix.

Lastly, I have shown that a uniform definition of disadvantaged communities in California fails to identify communities that are, in context really struggling economically. Local context provides additional information necessary to make sense the metric used to measure economic disadvantage. The State of California uses median household income to identify disadvantaged communities, but is insensible to the fact that a given income means different purchasing powers in different context. I have shown that, for failing to take this context into account, median household income by itself fails to delineate disadvantaged communities.

1.2 Spatial realities are continuous and multi-dimensional

In the three studies composing this dissertation, I have concluded that there is no single, mono-dimensional metric able to capture entirely the relevant information to conduct a policy in a specific space. Rather, policy-makers should build a series of complementary point of views to gain a better understanding and mutually validate their instruments. Social behaviors in space are continuous and the process of simplifying and aggregating them for statistical purposes is one of approximation. A binary measure trying to strictly distinguish what is in and what is out might be blurring the picture more than it sheds light on the reality that the policy intends to target. There is no evidence, for instance, that Metropolitan Planning Organizations (MPOs) have an impact on planning in line with the policy goal of reducing urban sprawl.[1] On the contrary, studies I have produced in this dissertation support that binary definitions undermine policy efficacy by diverting resources away from intended targets.

[1] Carruthers and Ulfarsson 2002.

Taking into account the continuous nature of social space means that policy definitions should not produce mutually exclusive delineations. I have shown in my study of commuting patterns between counties to delineate metropolitan areas that there is significant continuity in regions that are abundantly urbanized. A county sitting between two important metropolitan centers, for instance, is influenced by both and does not need to be in one metropolitan area of the other. Rather, it should participate as a relevant actor in addressing issues of both. By creating a fixed tessellation of metropolitan areas, the OMB undermines local capacity of adaptation where it should be incentivizing it.

Additionally, different issues have different relevant scales of action. Solving local traffic does not need to be addressed at the same scale at solving a regional housing shortage. With hierarchical clustering of counties along the strength of their commuting ties, I have shown that parts of large urban regions can retain a strong local specificity, while metropolitan areas themselves aggregate in larger urban regions. The *right scale* is the one that solves the problem. I have shown that residents are relatively indifferent to the details of institutional architecture, and care more about the problem that the policy intends to address.

With disadvantaged communities in California, I have pointed to the pitfalls of relying on a single dimension of measurement—median household income—to approach a spatial reality when the meaning of this measurement varies considerably with geographic context. The problem is less stringent with metropolitan areas because the use of commuting as a proxy for routine mobility has been validated. However, the county is a relatively coarse scale of measurement. This is especially the case in the West where counties tend to be larger. Therefore, smaller-scale commuting data would be useful for a better understanding of local contexts.

1.3 *An experimental approach to policy is viable*

Lastly, I have demonstrated with the last of the three studies in this dissertation that an experimental approach to public feedback for policy design is possible. I have used fully randomized vignette experiments to uncover causal links between policy features and individual support for the policy. This type of experiments need to be externally validated, to ensure it fits the policy and can integrate in a policy design process to produce a measurably better outcome than the current practice of voluntary public feedback.

However, fully randomized policy vignettes and conjoint experiment have already demonstrated great potential for bringing solid public feedback into policy making. They depart from opinion survey in that respondents are not asked to express an opinion but, to the highest possible extent, to take a decision. The role of the researcher, in that case, is to create an experimental setting in which a cost is attached to this decision for the respondent. The decision must *feel* real for the respondent to reveal their preferences.

The comparative experiment between the four largest metropolitan areas of California reveals the relative unimportance of demographic factors in support for a collaboration policy. Significant demographic factors—age—and party identification effects are consistent across metropolitan areas. Policy features swaying respondents' support, however, varies markedly between metropolitan areas. Scale and policy-mix especially have an effect, by contrast with institutional architecture features such a board composition. It is probable that differences between metropolitan areas could be explained by differences in issues experiences by residents of different metropolitan areas. Respondents would then favor the policy instrument that they think addresses the problem they identify. External validation would be needed to further explain individual preferences, but randomized vignette experiments are a good tool to measure variations between places and understand local concerns.

2 *Local solutions, common toolbox*

Evidence of the importance of local context in identifying target spaces and shape policies in line with residents' preferences should not obfuscate the potential of a shared platform to understand this local context. Indeed, if policies should be local, tools should be shared, so that cities and their policy makers can learn from each other.

2.1 *Policies should be local*

Local context is prime in understanding spatial realities. This is a common conclusion of the three studies I have conducted on the delineation of metropolitan area, the identification of disadvantaged communities as policy targets, and individual preferences for inter-governmental collaboration. Local context prevalence implies that policies, too, should be defined locally, at least in their spatial dimensions.

Different functionings of metropolitan areas have different consequences for planning policies, for instance. A metropolitan area composed of a single core around which suburban developments progressively aggregate faces different challenges than a multi-core area where each part keeps significant specificity. Metropolitan areas are also multidimensional, and they way these dimensions ply together is specific to each. Consequently, the *right scale* to address transportation or housing challenges is different for each metropolis, and can be for each policy.

Conversely, it is impossible to assess a community's economic struggle without consideration for local context. Beyond a universal metric like household income, what does this income mean in context? It is easier to live with a lower income in places with a corresponding low cost of living. The same income in a neighborhood with low rental prices, inhabited by young, single adults captures a different reality than in a place with high rental prices and large families. Access to resources matters, too. Places where economic activity is low and job opportunities rare are harder to live in than places with abundant employment at hand.

Lastly, local context matters because it matters to people. Residents of Los Angeles, San Francisco, San Diego, Sacramento, have a different view on the challenges that their metropolitan area is facing. This perception influences in turn their preferences for collaboration beyond the borders of their municipality.

Policies should be local because local realities are different, and because these differences shape the path of political legitimacy towards public support and implementation.

2.2 *Tools should be shared*

Policies should be local but tools to conduct these policies, and instruments to measure their efficacy and efficiency can be shared. In the three papers composing this dissertation, I have used common tools to identify local specificities and common trends. Indeed, it is precisely because instruments to look at them are the same that local situations become commensurable and comparable.

Accounting for local specificity in public policies does not entail a complete withdrawal from states and federal administrations in how spatial realities should be defined and delineated. On the contrary, they can provide the means to do so in an efficient and comparable way, while leveling the field so that local authorities have access to quality data and instruments. In metropolitan areas, large cities and existing associations of local governments possess human and technical resources to manipulate complex sets of data, but smaller governments in the area do not enjoy these capabilities. Often, the debate over precises delineations that a policy should take are not rooted in data because of this imbalance in access to good resources. By providing accessible tools, central administrations can contribute to improve the quality of local debate, ease the path to consensus, and enhance the quality of policies altogether. Strict, mono-dimensional out-of-the-box delineations of metropolitan areas provided by the OMB today do not achieve these goals.

For instance, debates over housing in the San Francisco Bay Area often trigger accusations that some local communities are not "doing their fair share" by allowing construction of enough housing, or that others seek to attract too many wealthy households without providing housing for lower income populations. Municipalities in the South Bay, benefiting from important economic growth in the technology sector, are often suspected of attracting jobs but refusing to house new residents. Much of the debate is focused on the relations between San Francisco on the one hand, and the Silicon Valley on the other. This debate cannot be addressed, and a solution cannot successfully emerge, without recognizing the effects of job growth on the housing market through commuting. A more precise look at theses dynamics show that the relationship between San Francisco and Silicon might not be as strong as usually portrayed, and points at the role of the Central Valley as San Francisco's Inland Empire, usually ignored. This information, however, is not captured in the official definition of metropolitan areas. By providing more detailed but accessible analysis about functionings of metropolitan areas, both the OMB and the US Census Bureau could contribute to a higher quality of local debate and better policy outcomes.

Compensating for diversity of local access to resources, spatial justice, is another reason to provide a common toolbox. Resourceful communities and local administrations can go beyond official definitions in order to build a case. California DWR's disadvantaged communities grant program, for instance, explicitly allows for arguments beyond the official Proposition 84 definition. However, gathering and treating data is expensive, time-consuming and requires technical capability that can be well beyond the means of struggling communities. By providing tools to access the data necessary to make a case for the identification of a community as a disadvantaged one, and by lowering the barrier to put this data to use, the State of California could be more in line with the policy goal.

State and federal administrations should take a step back in regards to delineations of spatial realities for policy purposes and, instead of providing borders, provide the tools to draw them. This is the best way to ensure both spatial justice, by providing resources to communities who lack them, and improve policy outcomes, by allowing delineations to follow local specificities more closely.

3 *A rapid prototyping approach to policy*

Policy solutions and relevant institutional architectures are local. There is therefore no big solution of universal panacea to problems common to many different places. Public administration research should therefore shift its focus towards shared tools to measure local context and build local solutions, allowing a comparative approach between differing local conditions. But this creates a challenge in designing policies that are locally efficient and politically acceptable. This challenge is even reinforced in a federal country like the United States where local governments collaborating on a given problem enjoy a large degree of autonomy. Policies are often designed in a linear way in regards to contacts with the public. Many policies fail to pass or be implemented because political pitfalls are not defused early enough in their design. Policy-makers go forward in the definition of the policy, only for the policy to fail on the ballot or be buried by elected officials worried about their constituency.

Simultaneously, access to polls and survey has become cheaper and easier. Polls are now widely conducted for local elections in large cities. However, these polls are confined to elections, and stay overwhelmingly declarative, gaging declared support for candidates. Public support for policies is largely conducted through public meetings. There is three problems with the way public opinions is integrated in policy-making today. First, it is confined to a specific phase of the policy definition process. Public opinion is often gathered towards the end, when the policy has been largely defined and several options are still under consideration. Second, public comments are based on voluntary participation, through public meetings or workshops. This creates an significant participation bias, where only specific individuals with high stakes in the project will participate. Lastly, public opinion is collected in a declarative way. Participants are asked to provide their opinion on the project, without being put in the situation of making a decision between different trade-off architectures. Declarative survey, because they do not associate a cost to the opinion being expressed, do not necessarily translate the preferred trade-off of the respondents.

Easy and inexpensive access to surveying methods creates a substantive opportunity to renew the process of gathering and integrating public opinion in policy-making. In the third paper of this dissertation, *The Place and Scale of Consent*, I have placed respondents of different metropolitan areas in California in the situation of making a trade-off between different dimensions of a policy. This method can be generalized and applied to a high number of policies, and mitigates the three aforementioned caveats of current public participation models. Participation bias is reduced because respondents are chosen at random amongst a pool of participants from the survey recruitment provider. With a higher budget than allocated for this specific research project, a better quality of recruitment, closer to random selection among residents of the metropolitan area, is possible. Contrary to public meetings and workshops, potential recruitment bias is not correlated with the policy. Recruited participants are not likely to be recruited because they have a particular stake in the policy. Vignette and conjoint experiments allows a randomization of treatment, the particular policy trade-off, amongst respondents, therefore allowing causal relationships between policy dimensions and support for a policy. Lastly, policy makers can afford to run several rounds of experiments along the policy design process. Public participation conducted through survey experiments can be more iterative, keeping the policy *in check* with people's preferences all along.

Regular causal experiments from a randomly selected group of residents allows policy making to become more akin to **rapid-prototyping**. Rapid prototyping is the process of integrating the production of models of the final product in the design process. Rather than design *in abstracto* and then producing the object, the production of iterative models of the object is integrated in the design process itself. A core idea of rapid prototyping is that this production of models brings valuable information to the designer. Similarly, rapid, frequent experiments on policy trade-offs can inform policy makers in a valuable way. Rather than designing a policy as a big, indivisible and linear process, this suggest a possibility to conduct policy design in a more nimble, iterative and interactive way. Rapid policy prototyping does not replace public workshops and meetings, rather it complements them, and allows a more informed discussion with participants of these meetings.

This idea of causal experiments informing iterative design has been in use in marketing. It is important for firms to design products that people actually want to buy. It is equally if not more important to design policies that people actually support. In representative democracies, this task is delegated to elected representatives. Diminishing trust in elected representatives over the past decades, however, has put a dent in this idea. In countries with direct democracy, such as the United States and Switzerland, important, divisive legislations make their way to the ballot. But the ballot suffers from selection bias, with direct democracy being usually associated with low turnout ascribed to voter fatigue. Moreover, direct democracy is hardly iterative. If the same issue can come back to the ballot several times until it is adopted or until its proponents abandon it, cycles are measured in years. With rapid causal experiments, cycles of feedback can be as fast as weeks.

Strikingly, the idea of random selection has been a regular stream of democratic theory. In ancient Athens, late medieval Northern Italy, and 18th century Switzerland, some official positions were alloted by random draw, or *sortition*. The idea, mirrored in judicial juries, is that random draw better represent the population as a whole, increases fairness of the selection process, and defeats corruption by eliminating career politicians. Numerous democratic theorists have proposed some form of random draw for policy making, either to complement or to replace elected bodies. A drawback of these proposals however, is the time participants would be asked to dedicate to it. Rapid causal experiments alleviate this concern, by reducing participation time to minutes.

Developments of experimental methods in social sciences creates an opportunity to expand random draws and uncover causal mechanisms of people's support for public policies.

Beyond producing better policies, rapid prototyping likely produces policies that are more likely to be accepted by the public, and pass political hurdles. In addition to reveal what people car about, survey experiments also reveal what arguments people respond positively and negatively. For instance, many policies are touted to be more efficient or cost saving. In the context of the specific experiment I conducted on multi-government collaboration for land-use policy, respondents are not swayed by this argument. It seems that, if they trust that a policy can increase spendings, they hardly believe it can decrease them. This insight suggests that arguments about what problems the policy solves and what it accomplishes are more potent than arguments about costs.

4 *Implications for planning*

The two main dimensions of the work I conducted in this research project, regarding the delineation of spatial realities, and the use of experimental methods to understand local preferences, have relevance to planning. In this section I examine how the results of this work informs the fabric of the city and urban infrastructures.

4.1 *Planning is a policy*

The distinction between planning and policy is flimsy. Large scale planning projects do not have a clear beginning or end and can easily span over decades. Infrastructure projects are often phased and amended, containing several overlapping dimensions. In turn, these projects shape the spatial environment of societies around them. The development of the Bay Area Rapid Transit (BART) system, around the San Francisco Bay, has accompanied ans shaped urban development around the Bay for seven decades. The Second Avenue Subway, in New-York, has been in planning, then construction, for more than a century. The Second Avenue Subway will continue to slowly expand in the next decades, exerting potent effects on the city around its stations and beyond. In these conditions, planning looks less like a project and more like an ongoing policy.

At the same time, development of policy evaluation and time limits imposed of policy funding has transformed policies into projects, with a clearer beginning and end. Many policies do not enjoy funding unlimited in time, but are tied to a specific funding instrument, like a bond. This is the case for California's Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006 that I examine in the second paper of this dissertation. Many policies directed to metropolitan areas follow the same pattern. They have a stated goal, a time limit and a funding cap. The way these policies are conducted is closer to projects, making them easier to evaluate, but separating them from their potential externalities.

This double trends creates a convergence between the way planning projects and policies are conducted. In turn, this convergence opens opportunities to share practices and tools.

4.2 *Planning is embedded is socio-spatial realities*

Planning is embedded is the spatial functioning of societies. There is a feedback loop between planned projects and infrastructures and the way people use space. This feedback goes in both directions. New projects changes social use of space. The attachment of the Central Valley to the Bay Area beyond mountain ranges is permitted by the construction of transport infrastructure. If mountain ranges had stayed impervious to daily commutes, California Central Valley wouldn't develop to absorb part of the Bay Area's growing population. This emerging condition, in turn, creates orientations for planning projects: further development of roads, growth of communities in the Central Valley...

Conversely, planning projects become possible or out of reach because of the social and political context, beyond engineering and technical feasibility. For instance, San Francisco's BART system finds more political support for extensions at the periphery of the system than for reinforcing the core of the system. This context should be an integral part of how to frame the planning problem.

Feedback on these dimensions should be incorporated as early as possible in the planning process, lest it be sidetracked or deemed politically infeasible later on.

4.3 Lean planning

For these reasons, a more careful understanding of the spatial realities surrounding planing projects and a nimbler, more iterative public feedback would improve quality and political acceptability of planning projects. Many large scale planning or infrastructure projects are embedded in metropolitan areas. A better understanding of how this metropolitan area functions would allow more precise arguments on how the project addresses local problems. As I have shown in the third paper of this dissertation, *The Place and Scale of Consent*, these are the most potent arguments. Metropolitan residents care about what problems are addressed and at what scale, much less about the precise institutional arrangement to do so. Moreover, residents tend not to trust cost-saving arguments.

Public feedback on planning projects is often dominated by close stakeholders pushing for a specific agenda not necessarily aligned with overall preferences of residents. These stakeholders are motivated by the concentrated costs or benefits that they would incur with the project. The general population enjoys distributed benefits or suffers distributed costs, individually not high enough to motivate engagement in the public participation process.[2] Cycles of rapid feedback based on experimental methods able to uncover causal effects between the project's features and general public support would counterbalance this effect and complement existing voluntary public participation with a wider view of public support. Technical tools for recruitment of respondents, construction of survey experiments and analysis of their answers have become much more accessible in the pas decade. The cost of recruiting a sufficiently large representative panel has also decreased in the recent past, at least in large American metropolitan areas. Compared to the overall cost of the design process and public participation, the cost of running several rounds of experiments is bearable.

[2] Olson 1965.

5 Follow-up research program

The research program permitted by this work is twofold. First, it is possible to build on the analysis of metropolitan areas and disadvantaged communities to build a better understanding of these spatial realities. In particular, I pointed to several directions for better metrics, taking multiple dimensions into account and producing a more nuanced, non-binary understanding of these realities. I have concentrated efforts on internal validity of measurement, and work must be extended to external validation: how to make sure that these measurement actually correspond to the spatial reality that is intended. External validation creates an opportunity to bridge observational with experimental methods. This is the more theoretical dimension of a follow-up research program. There is also an important operational dimension, concerned with how to apply tools and methods defined in this dissertation to policy problems and integrate them in policy making.

5.1 A deeper understanding of spatial realities combining observations and experiments

I have produced an analysis of the official definitions of metropolitan areas and disadvantaged communities, as instance of spatial realities used for policy purposes. I have shown that both these definitions fail at delineations these spatial realities, with implications for public policies based upon them. Especially, I have underlined the importance of understanding these spatial realities in context. This context needs to be researched further, pursuing the analysis in depth. In particular, I ave shown that metropolitan areas have different structures, revealed by their commuting patterns, and evidenced by hierarchical clustering of counties based on clustering. The structural properties of metropolitan areas can be characterized further. Similarities and differences between metropolitan areas should be mapped. Some metropolitan areas are composed of several relatively independent parts, while others aggregate linearly around a single, large core. Theses differences have potentially strong repercussions for policy purposes and must be further understood.

There is a strong potential to bring experimental methods in to understand these spatial realities from the point of view of their users. Further work on the delineation of metropolitan areas disadvantaged communities can be accompanied with experiments putting residents in the position of taking a decision that will reveal their view on this delineation. The survey experiment that I conducted to reveal preferences on inter-governmental collaboration in metropolitan areas is already revealing views about respondents' perceived scale of the metropolitan space of externalities. These two dimensions, observational and experimental, can be further tied together. Using an experimental method, asking respondents to take a decision on a policy question, and varying the features of the policy question at random, yields a causal understanding of the link between policy features and popular support. This link, in turn, can help build an understanding of spatial realities as understood by the people who build them.

The survey experiment I conducted shed light on people's involvement in metropolitan areas. Beyond the question of their identification to the area, the experiment uncovers their willingness to incur costs to share resources in order to solve an issue in common. The experiment, however, has been conducted in California only, with respondents from only four large metropolitan areas: Los Angeles, San Francisco, San Diego, Sacramento. For this reason, it is difficult to infer how characteristics of metropolitan areas—housing prices, traffic conditions, environmental stress, institutional fragmentation. . . —weigh on respondents' preferences. More metropolitan areas, units of respondents' aggregation for a multi-level analysis, are needed to study this relation between local conditions and individual preferences. A nation-wide survey experiment would provide enough variations in metropolitan conditions.

5.2 A toolbox for public policies

I have shown in this work that spatial realities are to be understood in their multiple dimensions, and that public policies should veer away from binary definitions of spatial realities in order to be in line with their policy goals. Integrating multiple dimensions and integrating context in policy definitions is challenging and could potentially generate much obfuscation. Complicated definitions are not legible, therefore not actionable by agents along the policy implementation process. Therefore, conveying local geographic context in a simple and graspable fashion is an important question of policy research. Here again, experimental methods could be employed to test lay persons' understanding of a delineation, finding the best possible trade-off between a definition that truthfully portrays the intended spatial reality, and a simple, legible definition. Local governments and administrations have a diverse degree of technical capability, and bringing tools to measure local spatial realities to a level of accessibility that is productive for small governments lacking data science skills is a challenge. Allowing them to build a case for policy delineations and include it grant applications has potential to enhance the degree to which policies are well adapted to local contexts. In order to do so, however, and bring power of delineation down to local level of governments, the field of data manipulation that is necessary to actually make these delineations must be leveled down to be accessible by local employees without extensive data training.

Additionally, I have illustrated the power of survey experiments to gather public feedback on policy orientations, and uncover causal relationships between policy features and support. The experiment I conducted to understand individual support for multi-governments collaboration around land-use issues in California metropolitan areas is an example of how policy makers could gage public feedback for policy design. For this tool to be usable in real policy design, two elements need to be advanced further. First, it needs to be accessible for use by a wider audience with lower technical skills. Market research tools for conjoint experiments and treatment randomization can serve as a base to build a platform suitable for policy research. Second, the effect of using this additional technique of public feedback should be studied further. Survey are sometimes used for public policy feedback but more rarely at local levels. Moreover, they are often declarative and not based on a randomization of treatment, therefore unsuitable to causal inference. In particular, the integration of several rounds of survey experiments as rapid feedback along the steps of policy design from beginning to implementation has not been researched.

References

Carruthers, John I. and Gudmundur F. Ulfarsson (2002). "Fragmentation and Sprawl: Evidence from Interregional Analysis". In: *Growth and Change* 33.3, pp. 312–340. ISSN: 0017-4815. DOI: 10.1111/1468-2257.00193.
Olson, Mancur (1965). *The logic of collective action*. en. Harvard University Press. ISBN: 9780674537514.

Abbreviations

MPO Metropolitan Planning Organization

OMB (White House) Office of Management and Budget

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Doctoral-Assistant, EPFL ENAC IA ALICE, Lausanne
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Areas of specialization

Urban politics; Political geography; Political campaigns; Data and models for social science.

Education

2011.12 - now	PhD in Science, Program of Architecture and Sciences of the City, EPFL, Lausanne
2010	MSc in Architecture and Territorial Development, EPFL, Lausanne
2010	BLaw University of Paris 1 Panthéon-Sorbonne
2007	BSc in Architecture, Skol Tisavouriezh Breizh, Roazhon

Appointments held

2015.09-now	Board member, Solon Intelligence, San Francisco, CA
2011.12-now	Doctoral-Assistant, Lecturer, EPFL ENAC IA ALICE, Swiss Federal Institute of Technology, Lausanne
2014.09-2016.03	Visiting Scholar, Bill Lane Center for the American West, Stanford University, CA
2012-2015	Lecturer, EPFL ENAC SAR, Swiss Federal Institute of Technology, Lausanne
2011.02-2011.10	Architect, LRS Architectes, Geneva
2010.09-2010.12	Web and UX Designer, World Knowledge Dialogue, Lausanne

2010.09-2010.12 Web and UX Designer, EPFL IC ISIM LDM1, Swiss Federal Institute of Technology, Lausanne

2008.05-2008.07 Trainee Architect, LIN Architecture, Berlin

2007.08-2008.03 Trainee Architect, Office for Metropolitan Architecture, Rotterdam

2006.09-2007.07 Architect, David Cras Architecte, Rennes

2006.07-2006.08 Trainee Architect, Pich Aguilera Equip Arquitectura, Barcelona

2005.07-2006.06 Trainee Architect, David Cras Architecte, Rennes

Publications

Book chapters

2015 Favre-Bulle, T. (2015). *The urban diffusion of local direct democracy between Switzerland and the United States.* In S. Farran (Ed.), *Diffusion.* Farnham, UK: Ashgate Publishing. *In Press*

Articles

2014 Favre-Bulle, T. (2014). *Les murs de la critique.* EspacesTemps.net

2015 Favre-Bulle, T. (2015). *Ethnographie de la metropolisation.* Book Review. Metropolitiques.eu *In Press*

Conference participations

2015.04 Favre-Bulle, T. (2015). *Individual support of multi-jurisdiction cooperation in American metropolitan areas.* Presented at the Annual Meeting of the Internation Society of Political Phychology: *The Phsychology of Encounter and the Politics of Engagement*, April 19-25, 2015, San Diego, California, USA.

2015.04 Favre-Bulle, T. (2015). *Who supports collaboration in American metropolitan areas?.* Presented at the Annual Meeting of the American Association of Geographers, April 19-25, 2015, Chicago, Illinois, USA.

2015.04 Favre-Bulle, T. (2015). *Who feels metropolitan in the United States?.* Presented at the Urban Affairs Association Annual Meeting 2015, April 8-11, 2015, Miami, Florida, USA.

2015.03 Favre-Bulle, T. (2015). *Rural incumbents and urban elected officials: local candidates in rural California.* Presented at the Rural West Conference 2015: *Preservation and Transformation: The Future of the Rural West*, March 4-6, 2015, Troutdale, Oregon, USA.

2014.08 Favre-Bulle, T. (2014). *Metropolitan dynamics and fragmentation in the United States.* Presented at the Annual Conference of the IGU Urban Commission: *Urban Challenges in a Complex World*, August 11-14, 2014, Poznan, Poland.

2014.07 Favre-Bulle, T. (2014). *Digital humanities methods in comparative law: quantitative analysis on a plain text corpus of books to trace the diffusion of legal concepts in public spheres..* Presented at the Annual Meeting of JurisDiversitas: *Comparative Law and...*, July 17-19, 2014, Aix-en-Provence, France.

2014.06 Favre-Bulle, T. (2014). *Faut-il défragmenter les métropoles? Une controverse politique en* *quête de spatialité.* Presented at Géopoint, Biennale of Geography, June 12-13, 2014, Avignon, France.

2014.06 Favre-Bulle, T. (2014). *Les murs de la critique.* Presented at Géopoint, Biennale of Geography, June 12-13, 2014, Avignon, France.

2013.06 Favre-Bulle, T. (2013). *Direct democracy and metropolitan fragmentation in Switzerland and in California.* Presented at the 1st Annual Meeting of JurisDiversitas: *Diffusion*, June 3-4, 2013 ,Swiss Institute of Comparative Law, Lausanne, Switzerland.

2013.04 Favre-Bulle, T. (2013). *Spatial Democracy, a Capability Approach towards Commensurability.* Presented at the Annual Meeting of the American Association of Geographers, April 9-13, 2013, Los Angeles, California, USA.

Accepted

2016.03 Favre-Bulle, T. (2016). *Individual support for collaboration on land-use policies between local governments in Californian metropolitan areas..* Presented at the Urban Affairs Association Annual Meeting 2016, March 16-19, 2016, San Diego, California, USA.

2016.03 Favre-Bulle, T. (2016). *Individual support for multi-jurisdiction cooperation in American metropolitan areas..* Presented at the Western Political Science Association Annual Meeting 2016, March 24-26, 2016, San Diego, California, USA.

2016.03 Favre-Bulle, T. (2016). *Is policy coordination the key to metropolitan collaboration on land-use, water and transportation? Individual support for collaboration between local governments in Californian metropolitan areas..* Presented at the Annual Meeting of the American Association of Geographers 2016, March 29 - April 2, 2016, San Francisco, California, USA.

Teaching material

2013 Dionne C., Koseki S., Favre-Bulle T. and Negueruela Del Castillo D. (2013). *Studio Manual Hypertypologies* Architecture and urban master studio teaching manual, EPFL-ENAC-SAR.

2012 Dionne C., Koseki S. and Favre-Bulle T. (2012). *Studio Manual Architectural Fiction* Architecture and urban master studio teaching manual, EPFL-ENAC-SAR.

Student work

2010 Favre-Bulle, T., Potier, S. and Lévy J. (Dir) (2010). *Régimes d'interaction, Complexité, Territoires* Master Thesis, EPFL, Lausanne.

2009 Favre-Bulle, T., Favre and A-C (Dir) (2009). *Le People's Rule en Californie* SHS Dissertation, EPFL, Lausanne.

Grants

As principal investigator (PI)

2014.10-2015.09 Swiss National Science Foundation Doc.Mobility grant: 12 months visiting researcher grant to the Center for the American West, Stanford University

SNF P1ELP1_155266, Political Science
CHF 58 440, $ 66 850

2013.04 Swiss Academy of Humanities and Social Sciences travel grant: participation at the Annual Meeting of the American Association of Geographers, Los Angeles, 2013.
CHF 1 300, $ 1 487

As redactor

2014-2018 EPFL Requip, Scientific Equipment Funding
For EPFL ENAC IA ALICE, Prof. Dieter Dietz (dieter.dietz@epfl.ch)
CHF 83 000, $ 94 944

Teaching

2014 SS Lecturer, ENAC Week, *Agent-based models for spatial problems*, 48h
Role: Co-lecturer; course design and proposal; theoretical and project teaching; responsible for 3 teaching assistants.
Course: Introduction to the epistemology of agent-based models. Introduction to Netlogo and principles of object-oriented programming. Group project to design, implement and analyse an agent-based model to study a spatial problem.
http://epfl-agentbased-2014.github.io/

2013 FS Co-instructor, Architecture and Urban Studio MA1/MA3, *Circle Lines*, 196h
Role: Co-instructor in a Master's level architecture and urban design studio; leading of student discussions and site visits; coordination studio activities and external partners; feedback during presentations by students to local decision-makers and experts.
Project: Design of a circular subway line around the city of Geneva, study and planning of growth opportunity around the line.

2013 SS Co-instructor, Architecture and Urban Studio MA2, *Hypertypologies*, 196h
Role: Co-instructor in a Master's level architecture and urban design studio; leading of student discussions and site visits; coordination studio activities and external partners; feedback during presentations by students to local decision-makers and experts.
Project: Design of architectural and urban innovative types to afford for emerging ways of life in contemporay cities.

2012 FS Co-instructor, Architecture and Urban Studio MA1/MA3, *An Architectural Fiction*, 196h
Role: Co-instructor in a Master's level architecture and urban design studio; leading of student discussions and site visits; coordination studio activities and external partners; feedback during presentations by students to local decision-makers and experts.
Project: Exploration of emerging social ways of spatially practising the swiss territory. Design of an installation to explain the identified ways.

2012 SS Lecturer, ENAC Teaching Unit, *Spatial Strategies*, 48h Role: Co-lecturer; course design and proposal; theoretical and project teaching.
Course: Introduction to social geography. Group project on identifying a socio-spatial problem; designing and performing an on-site intervention to make the identified problem visible.

Service to the profession

2013.01-2014.10 Conference Geopoint 2014: *Controversies and geography.*
Organization committee.
http://www.groupe-dupont.org/ColloqueGeopoint/geopoint14.htm

Programming projects

2014-now *Metropolitan Atlas*
An atlas of US Metropolitan Areas.
http://metroatlas.github.io/
HTML, CSS, JavaScript, d3js

2014-now *zipmetro*
A web API returning geographical and metropolitan data based on a zipcode.
https://github.com/metroatlas/zipmetro-api
PHP

2014-now *d3.atlas*
D3js module to handle serialized data and asynchronous loading.
https://github.com/erispoe/d3-atlas
JavaScript

2013-now *GCorpusAnalytics*
Python package to serialize queries on Google corpuses to conduct quantitative analysis on time series.
http://github.com/Erispoe/GCorpusAnalytics
Python, SQL, HTML

2010 *Digital Atlas for Peace and Ecological Cooperation, for the World Knowledge Dialogue.*
Prototype of an online digital collaborative atlas to be used by populations on both sides of conflicted borders (Prototyped on Cyprus)
HTML, PHP, CSS, JavaScript, Google Maps API

2010 *Organiseur typologique*
Master Project, with Potier S., Huang J. (Dir) and Lévy J. (Dir)
Algorithms to find spatial solutions under constraints for architecture programs formalized in networks.
http://infoscience.epfl.ch/record/174214?ln=en
Java, Netlogo, XML

Volunteering

2011-2012 Campaign finance manager for a parliamentary candidate
French legislative election, 2012
French citizens abroad, constituency of Switzerland and Liechtenschtein.

Technical skills

OS	Windows 8, Mac OS X, Linux Ubuntu
Documents	MS Office, LibreOffice, $\LaTeX$
Graphics	Adobe Creative Suite (Photoshop, Illustrator, InDesign, Acrobat)
CAD	AutoCad, Rhino
Web	HTML5, CSS3, PHP, JavaScript
Prog.	Java, Python, Netlogo
GIS	QGIS
Stats	R, SciPy, NumPy

Languages

FR	French, mother tongue
EN	English, Full professional proficiency, CEFR: C2
DE	German, Limited working proficiency, CEFR: B2
ES	Spanish, Limited working proficiency, CEFR: B2

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