Smart specialisation strategies and industrial modernisation in European regions—theory and practice[1]

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Based on a seminal policy paper (Foray *et al.*, 2009), the Smart Specialisation Strategies (S3) approach was integrated into the reformed cohesion policy of the European Union for 2014–20. This large-scale European experience provides a unique case study of a new type of industrial policy particularly oriented towards the modernisation of industrial sectors. In this paper, we briefly review the fundamentals of the S3 approach. We identify and discuss the main properties of S3 that make it particularly suited to the problem of sectoral modernisation in the context of a mature economy. In the final part, we describe the designing of this policy, which represents a crucial point: whilst the objective of modernising traditional sectors is not in itself anything new, the way of proceeding within the S3 framework is relatively new and innovative.

Key words: Smart specialisation strategies, Industrial modernisation, Industrial policy, Transformative activity, Regional development
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1. Introduction

Based on a seminal policy paper (Foray *et al.*, 2009), the Smart Specialisation Strategies (S3) approach was integrated into the reformed cohesion policy of the European Union for 2014–20. Member states and regions have developed over 120 S3s, establishing priorities for research and innovation investments for the 2014–20 period. Throughout this period more than EUR 40 billion (and more than EUR 65 billion, including national co-financing) allocated to regions through the European Regional Development Fund will fund these priorities (European Commission, 2017).

Moreover, in order to ensure the application and diffusion of the S3 approach across regions in Europe, smart specialisation strategies need to be in place ('ex ante conditionality') before receiving the financial support of the European Regional

[1] The author is indebted to two referees for very valuable comments.

Development Fund on research and innovation in the 2014–20 period. The impact of the S3 concept has thus been immense in terms of the design and implementation of regional smart specialisation strategies. This large-scale European experience provides a unique case study of a new type of industrial policy particularly oriented towards the modernisation of industrial sectors.

While S3 does not focus only on the industrial and economic renewal of traditional sectors, many regions have seen it as an opportunity to support the modernisation of their traditional sectors. Indeed, a smart specialisation strategy identifies certain objectives regarding structural change, then determines the R&D and innovation activities that will enable these objectives to be achieved and finally supports and evaluates these so-called 'transformative' activities. In fact, in most cases, one or several structural change objectives identified by the regions were the modernisation of a particular traditional sector via innovation and the promotion of critical intangible assets (training, management, specialised services). This is why an analysis of this policy fits so well into the topic of this special issue.

The challenge of designing and implementing S3 was huge. It particularly concerned the fact of being able to reconcile a logic of strategic choice, selection and establishment of priorities for structural changes with a logic of decentralised and entrepreneurial information and initiatives. It is this conciliation between two logics, which in the past were too often seen as contradictory, that today forms the basis of what we can call the new industrial policies—of which S3 is one. Achieving this conciliation is however a delicate undertaking—entailing the invention of a policy design based on concepts such as level of granularity (at which priorities are established), entrepreneurial discovery or flexibility—and necessitates relatively new institutional and organisational forms (at least in the case of regional policies) to put this design into practice.

In our position of privileged observer-contributor,[2] and taking into account the fact that systematic evaluations of the effects of this policy will not be undertaken for several years, we think we are able to provide a collection of reflections offering a wealth of lessons and information regarding the capacity of regional governmental agencies and other actors involved in the innovation system to implement an industrial policy aiming at incentivising innovation and supporting modernisation of the mature and traditional sectors.

In the first section, we briefly review the fundamentals of the S3 approach. The following section highlights the main properties of S3 that make it particularly suited to the problem of sectoral modernisation in the context of a mature economy. The third section proposes an analytical framework based on a pragmatic use of the concept of market failures. This framework allows us to characterize the policy logic of the S3 approach—which implies certain principles of policy design that we consider as useful in minimizing the risks of such mode of intervention. The final section then describes the designing of this policy, which represents a crucial point in this paper: whilst the objective of modernising traditional sectors is not in itself anything new (see for example Sabel *et al.*, 1987; Dertouzos *et al.*, 1989; Kelley and Arora, 1996; or more recently

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[2] Dominique Foray was at the origin of the smart specialisation strategy concept, with Bart Van Ark, Paul A. David and Bronwyn Hall, then deeply involved in putting the recommendations resulting from this approach into practice. He also contributed to developing the design of this policy at a theoretical level and to its translation in terms of policy practices intended for regional agencies.

Andreoni and Chang, 2016), the way of proceeding within the S3 framework is relatively new and innovative.

2. S3 in a nutshell

2.1. Transformative activities as the main building block of S3

The concept of smart specialisation describes a process: a process aimed at transforming the economic structures of a region or any other geographical unit through the formation and development of new *transformative activities*.

Transformative activity is a key concept. It is neither an individual project nor a sector as a whole but rather a collection of innovation capacities and actions that have been 'extracted' as it were from an existing structure or several structures, to which can be added extra-regional capacities and which is oriented towards a certain structural change.

The following case will help readers to understand the notion of a transformative activity leading to structural change such as the modernisation of a traditional sector. This concerns the footwear industry in Northern Portugal, which has undergone profound renewal in a context of frantic global competition. The strategy implemented by the innovation public agency involved the formation of an activity aimed at the development of new forms of flexible automation in the footwear industry. The goal was to achieve the integration of engineering knowledge from the University of Porto (INESC), skills of companies specialised in industrial machinery, tools and software as well as the entrepreneurial vision of a few footwear-manufacturing firms which had a good understanding of the urgent need for revival via innovation. The integration of this knowledge facilitated the exploration of the potential for automation associated with advanced cutting tools to increase the flexibility and quality of production. Economic experimentation with these technological developments resulted in a new business model based on an increase in the variety of designs and the capacity to rapidly respond to small orders. This development has led one segment of the footwear industry in Northern Portugal to bypass global competition and become the second most important European producer in terms of exports and added value (ADI, 2012).

In this case, the starting point is an existing structure, the transitional path is the formation and development of a transformative activity and the objective is a structural change (here the modernisation of a traditional sector). We also observe that the transformative activity does not necessarily concern the whole of the sector but a group of companies, suppliers and research partners that are prepared to embark upon certain forms of collective action in order to transform their capacities.

A transformative activity concentrates the necessary actions—R&D projects, partnerships, supply of new specific public goods—to explore the new area of opportunity and facilitate the implementation of collective actions between the different innovation actors concerned. The basic operational mode is not necessarily the collaborative project but the search for coordination and links between the entities and projects concerned, which will facilitate spillovers, economies of scope and scale and the supply of specific public goods and infrastructures to the domain in question. As such, a transformative activity can serve as a catalyst for collective action by firms, suppliers and research partners.

Based on this definition of the transformative activity, designing a smart specialisation strategy means identifying a small number of transformative activities, which will be developed and supported. This portfolio of activities is managed at the regional level and possibly modified as new opportunities for structural change arise.

2.2. Spontaneous process of smart specialisation

In some cases the development of a new transformative activity can occur in a spontaneous and decentralised way, with great success. It is triggered by entrepreneurial capabilities as well as the manager's understanding and vision that collective or coordinated actions can boost innovation and profitability (Ghemawat, 2017). Such development is likely to generate knowledge spillovers and stimulate the entry and agglomeration of firms around the new activity. There are many smart specialisation stories that were successful without any policy and which have been extensively studied in widely ranging literature including economics of innovation, business history and historical studies of technological change (although not under the heading of 'smart specialisation').

However, in many cases entrepreneurial and management capabilities are too weak, or perhaps the challenges of developing a new transformative activity to explore new combinations between capacities and opportunities through some kind of collective actions are too great, and the processes described above will not happen, at least not in a spontaneous way. A policy is needed to help identify a transformative activity that is needed to trigger a structural change and support the growth of such activity.

2.3. Smart specialisation policies: addressing specific capabilities and specific coordination problems

Such a policy is characterised by a key fact, which is that it has to address *specific* problems and needs, according to the technology or sector considered. Indeed, the construction or development of a transformative activity specific to a sector or technology entails the provision of innovation services and infrastructures that are themselves specific to this domain and the fulfilment of needs for coordination between actors that are also specific. *Each transformative activity thus in fact corresponds to a particular policy.*

Supporting biotechnology development for fisheries will require the provision of capabilities in terms of research, suppliers and services very different from those required to support the development of advanced manufacturing technologies for the footwear industry or to support the development of ICT for tourism. Such a policy has to deal with the complexity and specificity of each activity and this has a cost. But according to Hausmann and Rodrik (2006), it is unavoidable. Innovation policy cannot be limited to the provision of generic capabilities and infrastructures: '*the idea that a Government can disengage from specific policies and just focus on general framework conditions in a sector neutral way is an illusion based on the disregard for the specificity and complexity of the requisite publicly provided inputs and capabilities in specific domains*'.

2.4. Why 'specialisation'?

We have just highlighted that such policy involves addressing specific capabilities, infrastructures and coordination problems in terms of technologies and sectors. It then becomes clear that a regional government whose governance capacities are by

definition limited will not be able to achieve this for all sectors.[3] *Choices must be made.* Furthermore, essential determinants of the productivity of activities dedicated to innovation are scale, critical mass, and a sufficient agglomeration of actors. It is problems regarding the indivisibility of the R&D infrastructure and methods of circulating and recombining ideas and knowledge that give large-scale systems—for example urban centres—an indisputable comparative advantage when it comes to innovation. Thus each region will be well advised to possess some kind of critical masses of innovation actors, but here too a medium-sized region will be unable to obtain them everywhere.[4] Again *choices must be made*. There is therefore a double rationale—critical mass and political feasibility—to justify a specialisation strategy.

However, the logic of smart specialisation does not mean that 'all the rest' should be neglected. The most generic and horizontal policies naturally remain essential and smart specialisation becomes an additional option that regions are well advised to activate if they are capable of setting up an *intelligent process* of identification of priorities (i.e. transformative activities) and development of these activities.

3. From S3 to structural changes

What are the properties that make S3 seem well adapted to the objectives of modernising traditional sectors? These properties concern the way in which a transformative activity is constructed, based on the following four arguments:

- a broad conception of innovation, which is not reduced to high tech and scientific invention,
- a central role played by general purpose technologies, which attach great importance to the processes of the adoption and co-invention of new technologies,
- particular attention paid to the complementarity between the subsidised R&D and innovation projects and the training of the specialised human capital necessary for conducting these projects,
- the possibility of linking innovation objectives and diffusion objectives within the framework of the transformative activity.

3.1. What sort of innovation and capabilities are to be promoted through the development of a transformative activity?

Structural changes might follow different logics—we talk of modernisation, transition, diversification and radical foundation (Foray, 2015). As far as modernisation

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[3] This point was made very well by Matsuyama (1997): ' *Understanding the basic principles of coordination problems does not take one very far in the direction of useful, practical conclusions about how to construct technology policy. Understanding the basic problems, one is led to a new but not simpler set of questions: what activities in what firms are complementary and need to be coordinated and in what way? An appropriate choice of policy tools requires a detailed understanding of the externalities and the innovative complementarities involved.*' This is obviously a relevant comment but it should be not taken as an argument to stop any policy intervention aimed at addressing specific capabilities and specific infrastructures to support the formation of a specific transformative activity (Aghion *et al.*, 2009).

[4] Critical mass is a relative measure. The absolute amount of resources that need to be invested to boost innovation depends upon many factors that are specific to the technological field or industry involved (Trajtenberg, 2002). In some cases, the amount of resources is likely to be huge (and thus not attainable by any medium-sized region). In other cases, this amount of resources is not 'big', as for instance in regions specialising in the co-invention of ICT applications for a specific sector (see next section on the role of general purpose technologies).

of a traditional sector is concerned, this implies that the reality of innovation is not reduced to high-tech and cutting-edge research. In the realm of innovation, there is not only one game in town, in the sense of fundamental invention in a few key enabling technologies. Innovation is widely distributed over the whole spectrum of sectors (not just high tech) and invention processes (not only formal R&D). For many regions, the point is not inventing at the frontier but rather generating innovation complementarities in existing sectors. These types of complementarities are perhaps less exciting and flamboyant, but they ultimately represent the key to economy-wide growth in regional economies (Trajtenberg, 2010). This means that a transformative activity, depending on what the objective of transformation is, can involve actions like training programmes, the formation of new managerial and engineering skills, quality control and certification processes as well as technology adoption—all these actions are perhaps less ostentatious than supporting high-tech start-ups but are the components of a coherent and full-fledged transformative activity aimed at profoundly transforming the structures of traditional industries.

3.2. The centrality of general purpose technologies

The specific properties of general purpose technologies (GPTs) complete this broadened vision of innovation (above) in a coherent fashion and therefore play an important role in helping secondary regions to combine their existing capacities with new opportunities (Bresnahan, 2010). Central features of a GPT are horizontal propagation throughout the economy and complementarity between the invention of the GPT and the development of applications that are related to specific sectors. Most often, GPTs do not offer the complete innovative outcome, but the recombination of GPTs with complementary technologies enables the creation of new innovative solutions. Expressed in economists' language, the invention of a GPT extends the frontier of invention possibilities for the whole economy, while application development changes the production function of one particular sector. Myriad economically important innovations result, therefore, from the 'co-invention' of applications. Moreover, the dynamics of a GPT may be spatially distributed between regions specialised in basic inventions and regions investing in specific application domains that are related to existing structures. While a few leading regions can invest in the invention of a GPT or the combination of different GPTs (such as bioinformatics), *follower regions and laggards* are often better advised to invest in the '*co-invention of applications*', i.e. the development of the applications of a GPT in one or several important domains of the regional economy.

There is, therefore, an important theoretical relationship between smart specialisation as a process of diversification and modernisation of economic structures and the potential of opportunities offered by such GPTs in *any* region.

3.3. Securing human capital supply as demand for R&D increases

The construction of the transformative activity needs to take into account Romer's well-known argument regarding the correct sequencing of policy programmes: it is not enough to increase spending on R&D, but what needs to be supported is the total quantity of inputs that go into R&D: '*In fact, any generous subsidies will fail in adding more R&D if the supply curve of human capital is fixed and was not adjusted through early*

training programmes. In such case the increase of demand for R&D induced by policy will translate into a proportional increase in wages for R&D scientists with no increase in the level of R&D activities' (Romer, 2000). Romer rightly emphasises here the importance of a correct sequencing of policy programmes. The consideration of the complementarities between human capital and demand for R&D should help to focus on the correct sequencing of the policy: the formation of specialised human capital and capabilities should precede, or at least occur at the same time as, the programmes aimed at increasing the demand for R&D in the specialised domain in question.

3.4. Coupling innovation (vitality) and diffusion (inclusion)

As the objective of a transformative activity is the modernisation of a traditional sector, the construction of the transformative activity should avoid a systematic allocative bias in favour of high-tech innovations, even if these high-tech innovations are related to the traditional sector. Policies aimed at promoting rocket science and high-tech entrepreneurship will hardly have an impact on the traditional sector unless another complementary, say 'adoption-oriented', policy is designed and implemented. Based on a high-tech policy *only*, entrepreneurial activities are going to be stimulated and this will be beneficial to a small part of the regional economy—a few indicators will improve, and not the least important ones (patent, VC attractions, highly skilled jobs)—but the modernisation/inclusion effect will be negligible and the gap between the dynamic part and the non-dynamic part of the economy will increase.

The point is therefore to develop an integrated vision of the transformative activity that must not focus only on the *high-tech* dimension of the structural change sought. The activity must also integrate actions that allow the adoption of high tech by the sector that will be a potential user. Thus, for example, a transformative activity that concerns a certain number of scientific innovation projects for agriculture must also include the actions (adoptions, training, management) that will facilitate the adoption of high tech by the traditional sector. The point here is to involve the agri-food sector as a huge reservoir of potential adopters of these new technologies. The goal is therefore twofold: encourage young innovative firms by equipping their ecosystem with all the necessary capabilities AND address the innovational complementarities between the high-tech and traditional sectors. The latter goal involves addressing human capital and capability problems, fixing the adoption externalities, addressing coordination failures and providing some specific public goods; in other words, it will address many barriers and obstacles to innovation diffusion in a traditional sector. If this is not done, the activity will remain limited to start-ups and will lose its truly transformative nature.

The development of an integrated vision of a transformative activity—not just reduced to high tech—reminds us of Phelps's argument about dynamism and inclusion (Phelps, 2006): a policy to promote both dynamism and inclusion is not a policy that would support *pushing* more resources into the economy (more research infrastructure, more human capital), because these resources will ultimately be largely captured by the top science/high-tech ecosystem, but instead it aims at *pulling* some existing resources (of the traditional sectors) into innovation activities. This is exactly what is happening in the agri-food case described above: the transformative activity is a mechanism to pull economic agents from the traditional sector into the innovative part of the economy through various programmes and actions involving training, management skills and adoption of new technologies. In this sense S3 is an inclusive

policy because the strategic domains and transformative activities that are identified and selected are not limited *a priori* to a certain part of the economy.

4. Framework: from 'standard' market failures to coordination and directionality failures

Certain innovation policy goals—such as accelerating innovation to modernize a traditional sector—imply a change in the degree and nature of innovation and research policies that have dominated the policy landscape in the past thirty years. These policies have been characterized by a moderate degree of interventions and *neutral* logics of resource allocation—in other words, such policies have deployed programs and instruments to support innovation without any pre-determination of the domains, sectors or technologies where these instruments should be used. Our assumption is that such types of innovation policy are insufficient in supporting more radical transformations—such as the modernization of an old industry. It is thus necessary for policy to shift to a higher level of intervention, characterized by a higher degree of intentionality and prioritization.

This shift can be conceptually explained by using an extended market failure framework: while moderate interventions are used to fix what we can define as 'standard market failures', stronger, *non-neutral* interventions are needed to address both coordination failures as well as directionality failures which are mostly sector- or technology-specific.

4.1. Market failure as a starting point

We interpret market failure pragmatically. At a theoretical level, the concept of market failure is linked to the formal theory of general competitive equilibrium; it comprises the framework of optimising actors, competition, general equilibrium and its counterpart, the theory of market failure.

Our point here is not theoretical; rather, it follows a recent argument made by Winter, which recognises that the language and theory of market failure is a valuable resource for building a strong case for innovation policy. The goal is then to impart a balanced perspective of market failure and to use it for cases that can satisfy three criteria (Winter, 2017):

- The mechanism generating the core market failure problem is relatively simple and transparent;
- The nature of the harm is fairly clear; and
- There is relevant experience using non-market organisational arrangements to address the problem.

4.2. From standard market failures to coordination and directionality failures

In the domain of innovation, it is obvious that knowledge spillovers, as well as acute risk and moral hazard in financing R&D, are cases of market failure that satisfy the three criteria. For instance, the whole geographically mediated patent citation literature has built an extensive base of evidence regarding the existence of knowledge

spillovers (see, for instance, and among many, Jaffe, 1989; Jaffe *et al.*, 1993; Audretsch and Feldman, 1996); the mechanism and effect of this market failure are clear. This creates a gap between private and social returns, resulting in systematic underinvestment in R&D, which is likely to be detrimental to innovation and productivity growth. Additionally, there is relevant experience in non-market organisational arrangements to address such a problem. This experience involves, for instance, the creation of private institutions by the economic agents themselves to capture the externalities and reduce the gap between social and private returns.

Similar to these 'standard' market failures, one can identify coordination and collective action failures. Here again, a pragmatic approach invites us to search for cases where the sources of failure are clear. They can come from the complementarity of investments (each needs the other to be profitable) or from the difficulty of small entities to join forces in order to collectively produce some industry-specific public goods. The negative effects of these failures are also easily identifiable. In many ecosystems of innovation and entrepreneurship, one important gap to be addressed by policies is the provision of complementary capabilities (or specific public inputs) upon which most small and medium companies can draw, even if they have not contributed to their production (Berger, 2013). The same kind of non-market organisational arrangement, as in the knowledge spillover case, can apply here to address coordination problems. They again involve the creation of private institutions by the economic agents themselves in order to solve collective action problems resulting from the provision of specific public goods. Weder and Grubel (1993) identify the importance of such a mechanism in the innovation systems of two countries (Japan and Switzerland). In a similar vein, Romer (1993) builds a model of specific public goods provision, based on a hybrid institutional arrangement that combines public intervention and a decentralized market process.

The final type of failure that is important to consider could be called 'directionality failure', a new term to describe an old and well-recognised problem (Chataway, *et al.*, 2017): innovation does not necessarily happen where it is socially desirable. While a certain rate of innovation might be found to be sufficient in sustaining productivity growth in the economy in general, it can appear to be insufficient in some domains in which accelerating innovation is an imperative for certain reasons (such as in the case of modernisation of an old industry, etc.). The policy goal then is not merely to address market failure and incentivise innovation in the general economy, but to do it in a specific way within certain domains or directions. Some policies can address the rate of innovation within the entire economy, while others need to address both the rate and direction—or, more precisely, the rate in a certain direction of invention and innovation.

We began this section by offering a pragmatic vision of market failure because such a categorization forms the basis of two policy logics. The first category of 'standard market failures' (including essentially knowledge-positive externalities and risk and moral hazard in financing innovation) provides policymakers with the possibility to limit their actions to *neutral* interventions. Indeed, these market failures are generic and apply to any firm in an undifferentiated way. There are of course sectoral variations in the potential importance of these standard market failures across sectors, but economists recognize (in principle) the generality of these market failures in the economy—which opens the possibility of generalising the application of policy instruments within the

entire economy (R&D tax credits, R&D subsidies, patents). This has positive implications in terms of administration and monitoring costs, as well as in terms of evaluating the effects of such a neutral treatment.

Conversely, coordination and directionality failures are sector- or technology-specific by nature, and therefore imply non-neutral policies involving targeted interventions to fix these coordination or direction problems in certain ways. This is the logic of an S3 approach.[5] However, such a logic is full of risks. Adopting *non-neutral* logics of resource allocation, which implies preferential intervention, would result in much higher responsibilities for the government. Moreover, such a shift would open a Pandora's box, with all of the ensuing problems that economists fear. As such, S3 as well as other policies involving choices and preferential interventions have been seriously criticised (by Schultze [1983] and Krueger [2011], for example, as well as heated discussions among economists in *The Economist* [2010]). Responses to these sceptical arguments involve the elaboration of a new policy design to which we turn now.

5. S3 policy design: the centrality of the process of identification of priorities and of learning from transformative activities

The way in which the process of choice and selection of priorities is conducted, as well as the way in which information concerning the successes and failures of the transformative activities is exploited, are essential challenges for the success of S3. These are questions of policy design. Our contribution on the search for an appropriate policy design for S3 is original even if significantly inspired by the works of Rodrik. It identifies the three major problems that any targeting and strategic policy prioritisation is likely to encounter and that are the source of the different kinds of scepticism mentioned above:

- how to go about establishing priorities,
- how to develop transformative activity within the framework of the established priority,
- what the implications of a policy that is by its very nature experimental are

and suggests solutions, principles of policy design—based on the literature on technology policy and the detailed and meticulous observation of the trials and errors experienced in the context of the setting up of S3.

5.1. Establishing priorities

Designing an S3 involves establishing priorities to support preferential interventions. This is the rule for a non-neutral policy! How can this process be made as innocuous as possible, which means in particular minimising distortions and avoiding policy capture problems and the monopolisation of resources by a small number of motivated actors? There are two principles that seem to us to be important.

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[5] The regional innovation system approach was of course a valuable development, recognising the need to build an institutional framework for innovation at the regional level, but this approach remains largely neutral and undifferentiated regarding regions' specificities. There were exceptions of course, but horizontal policy (or sector-neutral policy) was the main logic underlying resource allocation in the framework of regional and cohesion policy.

5.1.1. Level of granularity. The selection of priorities must be carried out not at the sector level but at the level of activities that transform these sectors or establish new ones. This level—known as transformative activities—is thus one of intermediate granularity, finer grained than sectors but coarser grained than individual entities. For example a 'correct' priority should not be the footwear industry as a sector but rather the development of flexible manufacturing technologies for the footwear industry, as in the case mentioned in Section 1. This is the level that best reveals the domains in which a region should position itself. This intermediate level of aggregation also allows the defining of priority domains (transformative activities) that are not too extensive. In an activity that is too broad—one designated 'energy', for example—the 12 or 15 projects that are selected and supported are scattered and dispersed. Connections, synergies and spillovers will hardly happen and critical mass will not emerge. In a narrower priority area, the same number of projects will be more connected, providing potential scale, scope and spillover effects. Some platforms will be 'general-purpose', and the markets for specialised inputs (skills and services) will become thick. There is, of course, a political rationale underlying the need for broad areas (the so-called 'coffee for all'), but this is not the right way to proceed because, at the end of the day, the region will not get what an S3 is supposed to deliver.

5.1.2. Public-private interactions. The identification of transformative activities is based on a process of interactions and dialogue between the government, public sector and private sector, backed up by evidence concerning the regional economy and knowledge concerning the region's entrepreneurial activities and capacities. There is no magic solution to avoid problems of policy capture by 'regulars' and those with the most influence. In the context of S3, it is a question of establishing a decentralised and transparent process in order to identify the desired structural changes, the transformative activities that could lead to them and the capacities and potentials that enable the selected activities to be initiated in a credible manner. All of this contributes to the selection of a small number of unique combinations between existing capacities and new opportunities for transforming regional structures.

5.1.3. A central process. John Enos wrote very pertinently—long before the era of smart specialisation—that it is useful and productive for regions to put more effort into discovering and choosing, in detail and for the future, priority areas for R&D and innovation (Enos, 1995). The reason is that the knowledge and experience acquired from discovering and choosing the right directions for R&D and innovation can be valuable in carrying out the subsequent stages of product/process/market design, production and distribution.

   The idea is therefore that the process by which priorities and transformative activities can be identified is not a process on which resources must be economised or that should be speeded up at all costs. Neither is it a process that should be 'confiscated' by the government. But it is a process of learning about the capacities and opportunities specific to the region's economy that is useful and productive. And as such, it lies at the very heart of S3.

5.2. Developing a transformative activity

Once a priority (a transformative activity) has been identified, the standard *modus operandi* for policy is to deploy all sorts of policy instruments in order to support the

exploration of the new area of opportunities, provide the specific public goods that are needed (training, basic research, services) as well as coordination devices to assist the formation of networks and partnerships. There is nothing new here: R&D and human capital policy tools as well as cluster policy tools can be deployed, but there is an important qualification: these tools address the specific development of a quite narrowly defined activity aimed at a particular structural transformation. We have already mentioned, in the previous section, some of the important conditions allowing a transformative activity to play its role of structural change to the full. We must also mention the design principle, which can guide policymakers in the deployment of the different instruments and programmes to support the emergence and development of a transformative activity.

5.2.1. Tinbergen assignment theorem. How can we be sure that supporting the development of transformative activity will not result in a piling up of useless instruments that are poorly coordinated and ultimately costly? Respecting the previously mentioned design principles—for example the integrated vision of a priority that involves supporting not only breakthrough innovations but also the management and absorption capacities of sectors that are potential users—is likely to produce an over-elaborate policy. A design principle is essential here. It is the one known as the *Tinbergen assignment theorem* that provides at least first-order guidance on the 'number' of instruments or programmes that need to be deployed according to the goals or targets. The number of externalities or market failures should determine the number of instruments (Jaffe *et al.*, 2004). If we again take the transformation of the agri-food sector, there is a need for instruments to support research and start-ups (because of knowledge externalities as well as capital market imperfections) and instruments to support adoption in the traditional sector (because of adoption and network externalities as well as training externalities). Finally, coordination failures can happen at the interface between the high-tech and traditional sectors and this would also need to be fixed through other instruments (for example a platform of specialised services to support transfer of technologies). All in all the support of the transformative activity in this special S3 case should therefore involve about five instruments to be implemented in a coordinated way. And it is because some sceptical economists will ask—how can the government manage such complexity? (see footnote 3)—that the latter must choose and determine a small number of transformative activities that must be supported. 'Doomed to choose', Hausmann and Rodrik (2006) tell us!

5.3. Experimental policy

We know from history that any pretext given to the government for setting priorities and establishing strategic targets increases the risk that the whole policy will become a central planning exercise based on a principal-agent governance and resulting in very poor information flows from the bottom. Rodrik (2013) puts the argument very well: '*the agency framework assumes that the principals already have a very good idea of what needs to be done to achieve public goals, and all that needs to be done is to provide the agents (firms) with the right incentives to carry out the requisite investments*'.

It is therefore crucial to recognise the experimental nature of any S3. The objectives targeted represent by definition experiments; some will work and some won't. Each one of the transformative activities initiated is a gamble! These risks imply certain design principles.

5.3.1. Entrepreneurial discovery. The application of the entrepreneurial discovery principle fundamentally reflects the experimental nature of each transformative activity. As concrete exploration and coordination actions advance (projects, partnership, platform, training), entrepreneurial discovery operates at two levels—projects (success, failure) and the transformative activity in its entirety—is it growing, will it lead to the hoped-for structural change? The centrality of entrepreneurial discovery in the development of a transformative activity stems from the fact that initially there is no complete knowledge regarding the way in which the process of the emergence and development of this activity is going to unfold. It is as R&D investments, projects and coordination actions develop that the potential of the transformative activity, the probabilities of success of the different projects and actions, will be revealed. Unlike in the case of a neutral policy, one cannot apply here the standard *principal-agent* logic that supposes that the government has sufficient information to construct a plan and provide the incentives necessary for firms to carry it out (Sabel, 2004, p. 3). We talk of entrepreneurial discovery (Kirzner, 1997), as this term comprises a crucial learning dimension regarding the real possibilities of development and structural effect offered by the transformative activities. There are successes, failures and surprises. Integration of the entrepreneurial discovery concept in an industrial policy design was first achieved by Haussmann and Rodrik (2002). This represents an essential step forward in enabling industrial policies to avoid the tragedy of centralised planning, in other words reconciling a logic of vertical choice and priorities with a logic of decentralised and entrepreneurial information and initiatives.

5.3.2. Flexibility. The transformative activities thus identified must not be seen as unalterable structures but rather as pioneering ventures and experiments. *The flexibility of the strategy* is therefore a requirement. What is learned thanks to the entrepreneurial discovery must exert a retroactive effect on the characteristics of the programmes within each transformative activity and also on the activities themselves to modify or possibly discontinue them. Moreover, new combinations can emerge at any time and must be integrated in the form of new priorities. The flexibility of the strategy imposes *control and evaluation* mechanisms that are essential for the conducting of the strategy. Monitoring is a key element and any transformative activity needs to be measured in order to understand performance, the degree of progress, the direction and magnitude of changes as well as potential failures and structural deficiencies and to indicate that some issues warrant further investigation. One key feature of such indicators is to provide an up-to-the-minute barometer of the activity that can be used for immediate feedback and adjustment of the policy (Feldman *et al.*, 2014).[6]

5.3.3. Spillovers. The social value of a process of entrepreneurial discovery is that it informs the whole system about new opportunities, potential success and failures; i.e. what are the directions of R&D and innovation that are likely to generate the desirable

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[6] Rammer's recent works provide a good basis for the development of subsidy mechanisms for R&D projects allowing a certain flexibility in the allocation of resources: instead of one single financing decision, made at the start of the project, Rammer elaborates a multiple and sequential decision model that allows projects that are not working to be interrupted sooner and the volume of financing allocated to those that are progressing to be increased (Rammer and Klingebiel, 2012).

structural changes? The maximisation of *informational spillovers* created by the discovery phase is a key design principle that distinguishes entrepreneurial discoveries supported by a public policy, as is the case here, from those made privately within firms that will tend not to diffuse this information. Companies—usually large ones—are looking for new strategic domains and ways to explore them concretely. However, the difference between a process of entrepreneurial discovery internalised in a company and a process of entrepreneurial discovery embedded in a public policy is obvious. In the former case, the social value of the process will be lower than in the latter.

When the entrepreneurial discovery process is supported by a public policy, it is critical that the informational value of the process be maximised. The companies that are supported in joining the entrepreneurial discovery process must accept and conform to these rules of information and audit. This creates a design issue: the reward for the entrepreneurial discovery should be structured in a way that maximises the spillovers to the other participants and potential entrants in the transformative activity (Rodrik, 2004).

5.4. The general nature of the policy design

The various policy design elements described above are helpful in order to set up a transparent, robust and flexible process for the establishment of priorities, construction of the transformative activities and promotion of decentralised information and entrepreneurial initiatives. This policy based on such design principles is neither purely bottom-up (because at some points priorities are chosen by the government) nor totally top-down (because a few design principles—entrepreneurial discovery process, public-private interactions—introduce a strong bottom-up component). It is rather an intermediate process aiming to enhance entrepreneurial coordination within a framework (a small number of priority areas and transformative activities) structured by the government that pursues an objective of industrial modernisation.

6. Conclusion

This article has developed the case of S3, recently adopted and implemented in Europe as part of the EU's cohesion policies, to examine how this type of policy constitutes an appropriate solution to problems posed by the modernisation of the traditional sectors of mature economies.

We have seen that the concept of transformative activity is central in this respect. The morphology of a transformative activity is neither that of a sector nor that of an individual project but rather corresponds to a collection of innovation capacities and actions, which have been 'extracted' as it were from an existing structure or several structures, and which are oriented towards a certain process of modernisation.

We have also observed that the development of a transformative activity must comply with certain principles for its structural impact to be fully achieved: broadened vision of innovation, centrality of GPTs, correct sequence of actions regarding the training of human capital and R&D incentives, transformative activity that cannot be reduced to high tech but that also includes the actions of diffusion of innovation and improvement of skills and management in sectors that are potential users of high tech.

We have finally insisted on other policy design principles that are important for the establishment of priorities (to minimise distortions and increase transparency in the

prioritisation process) and with regard to the experimental dimension of this policy (entrepreneurial discovery, flexibility and monitoring, spillovers).

All these design principles represent challenges that must encourage public agencies to invent new structures and change their political practices and culture.

Numerous cases of regional S3s show that the interim assessment is not negative (Morgan, 2016; Navarro *et al.*, 2011). Many regions have been able to adapt or transform their policy process to respond to some of these challenges. A new policy mindset is slowly being instilled into policymakers—comprising prioritisation and vertical choice instead of neutral and horizontal programmes; decentralisation, self-discovery and flexibility rather than central planning; transformative activities rather than sectoral priorities. It seems to us that this is an important message in view of the resurgence of these new industrial policies oriented towards the modernisation of traditional sectors in mature economies.

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