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Marco Di Cataldo, Vassilis Monastiriotis and Andrés Rodríguez-Pose

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WC2A 2AE

geog.comms@lse.ac.uk
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How 'smart' are Smart Specialisation strategies?

Marco Di Cataldo[a,b], **Vassilis Monastiriotis**[b,c], **Andrés Rodríguez-Pose**[b,d]

Abstract

The introduction of Smart Specialisation (S3) as a fundamental pillar of the 2014 reform of the European Union (EU) Cohesion Policy has represented a significant strategic shift in European development intervention. S3 strategies are aimed at mobilising the economic potential of each country and region of the EU, by allowing a more place-based and bottom-up approach to development. However, despite the salience that S3 has acquired in a short period of time, there has been no European-wide evaluation of the extent to which S3 strategies truly reflect the economic characteristics and potential of the territories where they are being implemented. This paper examines the characteristics of S3 strategies across Europe – by focusing on their development axes, economic/scientific domains, and policy priorities – to assess whether this is the case. The results show that S3 strategies display a proliferation of objectives, a problem which particularly affects those areas with weaker government quality. Moreover, strategies are generally loosely connected with the intrinsic conditions of each region and mostly mimic what neighbouring areas are doing. The lack of more concise and focused S3 strategies is likely to undermine the effectiveness of what is, otherwise, a very interesting and worthwhile policy experiment.

Keywords: Smart specialisation, EU policy, regions, Europe.

JEL codes: R58, O52.

a / Department of Economics, Ca' Foscari University of Venice;

b / Department of Geography and Environment, London School of Economics;

c / European Institute, London School of Economics.

d/ Cañada Blanch Centre, London School of Economics

Corresponding author: Vassilis Monastiriotis, European Institute, London School of Economics, Houghton Street, WC2A 2AE London, UK (v.monastiriotis@lse.ac.uk)

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Map disclaimer: The boundaries employed in the maps do not imply the expression of any opinion on the part of the authors concerning the legal status of any country.

1. Introduction

Smart specialisation (S3) occupies a special position in European policymaking. Analytically, the concept has its intellectual origins in the literature on innovation policy and on new forms of industrial policy. However, the concept is still far from being fully-articulated. This has not prevented it from gaining powerful track in the realm of policy, becoming, since the 2014 reform, one of the backbones of the European Union (EU) regional development policy, a fundamental constituent of the EU's Cohesion Policy. As noted by Foray et al (2011),

> *Elaborated by a group of academic "experts" in 2008, [smart specialisation] very quickly made a significant impact on the policy audience, particularly in Europe. […] Such a success story in such a short period of time is a perfect example of "policy running ahead of theory": while smart specialisation seems to be already a policy hit and policy makers show some frenetic engagements towards smart specialisation, the concept is not tight in particular as an academic concept.*
>
> (Foray et al., 2011: 3)

But what is smart specialisation? And why is it so important in the EU's Cohesion Policy? Following Midtkandal and Sörvik (2012: 1), smart specialisation is a process aiming to develop a vision in order to identify the areas of intervention of greatest strategic potential in every territory. As such, it represents a 'place-based' development strategy that includes not only identifying, through what is known as the entrepreneurial discovery process, where the potential of every territory lies, but also developing a system of governance involving multi-stakeholder mechanisms in order to set strategic priorities and systems of intervention (Midtkandal and Sörvik, 2012:1).

The adoption of smart specialisation is one of the key elements of European policy since 2014 and has represented a significant strategic shift in Cohesion Policy. The aim of the reform was not only to raise the effectiveness of the policy at large (e.g., by improving the sectoral targeting of funding and creating production synergies), but also to introduce a new way of thinking about local economic development: from a 'one-size-fits-all' to a more place-based intervention, from a top-down approach to a more bottom-up one, and from an objective of economic convergence among European regions, to a multitude of objectives more adapted to the conditions and potential of every region.

Smart specialisation has been designed as a policy mechanism that can support regions (and countries) to unleash their growth potential by helping them identify and harness their dynamic (and latent) comparative and competitive advantages.

As a new policy – and new concept – however, there is still limited knowledge about its effectiveness and impact. Because it has been implemented for the first time at a large scale during the programming period 2014-2020 – and despite some early attempts at assessing its impact (e.g. Iacobucci and Guzzini, 2016; McCann and Ortega-Argilés, 2016; Crescenzi et al., 2018; Gianelle et al., 2019) – it will take some time after the end of 2020 for a concrete picture of its effectiveness to emerge. What is more surprising, however, is that there are very limited accounts of how S3 strategies across Europe really reflect the endogenous potential of all regions for which an entrepreneurial discovery process was conducted and, subsequently, a smart specialisation strategy drafted. In other words, we lack a complete picture of how 'smart' smart specialisation truly is.

This is what this paper intends to do. We set out to offer a comprehensive analysis of the *population* of regional S3 strategies currently in operation in the EU with the aim of assessing how independent they are from one another and how they are influenced by differences in economic and institutional characteristics – quality of government, economic and technological capacities – across regions of Europe.

In order to do that, we first document and analyse some key features of the population of S3 strategies, focusing on the prevalence of different economic/scientific domains and policy objectives *within* and *across* regions (the breadth of specialisations per region and the coincidence of specialisations across regions). We then examine how groups of regions cluster together with regard to their economic priorities (domains) and through this identify five distinct clusters of (smart) sectoral specialisations across the EU. Last, we perform an exploratory analysis of key features of the S3 strategies across space, seeking to understand whether the policy approach as a whole contributes to a 'smarter' policy at an aggregate level – in other words, whether the 'smart' strategies adopted at the local level truly match the local economic context and can therefore be taken as a suitable approach for mobilising the economic potential of Europe as a whole. This is achieved by assessing, using regression analysis, the drivers of the observed heterogeneity in the key characteristics of regional strategies, offering a unique insight into how the policy creates or resolves spatial divisions in Europe.

2. Smart specialisation: concept and practice

2.1 What is smart specialisation?

The concept of smart specialisation is centred on the idea that each territory should concentrate development intervention in certain areas of specialisation where it holds significant potential and/or competitive advantage in order to sustain productivity growth (Foray et al., 2009; Asheim et al, 2017). This idea emerged following widespread criticism of ‘one-size-fits-all’ policy approaches and a vision according to which development intervention should be built around existing place-based capabilities and potential (Barca, 2009; Foray et al., 2009, 2011; Barca et al., 2012; McCann & Ortega-Argilés, 2015). Smart specialisation was conceived as an answer to questions about how to define targets for place-based policies (Balland et al., 2019). The answer proposed by the ‘Knowledge for Growth’ expert group (Foray et al., 2009) was that territories should develop their competitive advantage around sectors where they possess existing strengths, leveraging those capabilities.

According to this approach, context matters for the evolution of innovation and economic systems. The development pathway of territories is eminently driven by ongoing dynamics and inherited socio-economic/institutional structures. Hence, each place should design its development strategy with the aim of fostering the specialisation in knowledge-related sectors, depending on already existing assets (McCann & Ortega-Argilés, 2015) and within the principles of ‘diversified specialisation’ (Farhauer and Kröll, 2012). Consequently, policy-prioritisation within each S3 strategy should be done by looking for development opportunities in selected *domains* where a particular territory has advantages or a greater potential (Foray et al., 2009; 2011; David et al., 2009).

While, initially, the formulation of smart specialisation was that of a purely sectoral policy with no spatial dimension, its proponents later came to the conclusion that this approach had great potential for the promotion of economic growth at the *regional* level in particular (McCann & Ortega-Argilés, 2014; Foray, 2015). This conceptualisation of S3 recognises the uniqueness of local areas and their economic trajectories and assumes that each region should develop its own and unique place-specific development plan. This applies equally to economically strong regions as well as to weaker ones. For lagging territories, smart specialisation is seen as a way to concentrate resources in a few sectors with sufficient potential to achieve long-lasting economic impacts (Foray et al., 2009; Foray, 2015).

The entrepreneurial discovery process inherent to every S3 strategy implies identifying the economic and technological sectors on which to invest based on a number of guidelines. First, interventions should support 'regional embeddedness', by identifying activities with the greater possibility of achieving a critical mass to generate significant economic impacts (Fedeli et al., 2019). Second, they should enhance linkages across domains, prioritising sectors that would eventually lead to 'related diversification', i.e. the development of technological activities related to the existing knowledge bases (Balland et al., 2019), following fundamental aspects of evolutionary economic geography, such as path dependency and related variety (Frenken et al., 2007; Boschma & Iammarino, 2009; Asheim et al., 2011). Third, S3 requires experimentation and innovation in policy design, alongside a timely monitoring and evaluation, and constant involvement of local-level actors (Foray et al., 2011; Foray, 2015; McCann & Ortega-Argilés, 2015; Fedeli et al., 2019). As such, S3 strategies assign regional government authorities a central role. They are expected to perform a rigorous self-assessment of local potential, involving the key economic agents active in the territory (Boschma, 2014).

The conceptual underpinnings of smart specialisation informed both the reform of the EU's Cohesion Policy for the 2014-2020 programming period and the Europe 2020 Agenda, implying that EU development policies require regions to adopt place-based policies tailored on their existing economic assets, through the collaborative involvement of local communities and institutions. Smart specialisation has become an *ex-ante* conditionality of Cohesion Policy (Charles et al., 2012), as every EU region had to submit S3 strategies in order to be eligible for EU funding (Iacobucci, 2014). To help regions develop their S3 strategies, the European Commission established a 'Platform', hosted by the EU Joint Research Centre in Seville, offering regions guidance and support in identifying the most promising areas in terms of economic opportunities (Fedeli et al., 2019).

2.2 Potential shortcomings of S3

One of the recurrent critiques of S3 is that it may promote a culture of 'picking winners', protecting already existing industrial champions (Fedeli et al, 2019). However, the smart specialisation concept prescribes a strategy of 'choosing races' (Hughes, 2012), which implies 'betting' on potentially successful domains. This is what makes S3 truly place-based and applicable to both more and less developed regions – the policy assumes that there is room for profitable investments also in areas where the ground for economic growth may initially seem less fertile. Yet, a number of pre-existing conditions which may be found in peripheral regions, such as limited entrepreneurial spirit, lack of industrial diversity, or inadequate market size, entail that identifying policy priorities in backward areas is more complicated (Iacobucci & Guzzini, 2016). This perceived lack of potential may lead backward regions to choose rather large areas of specialisation, selecting a high number of investment domains at the expense of existing sectors (Boschma, 2014; Capello & Kroll, 2016).

A similar issue may arise if resources are misallocated towards existing industrial targets for purely political interests and rent-seeking (Camagni et al., 2014). This would happen if policy priorities are not established on the basis of economic logic and are, therefore, disconnected from the needs of local communities. This is far more frequent if local governments are corrupt or lack the basic competences to produce effective policies. Hence, poor institutions and low local government quality represent substantial barriers for a successful design and implementation of S3 strategies (Rodríguez-Pose et al., 2014; McCann & Ortega-Argilés, 2015; Rodríguez-Pose & Di Cataldo, 2015; Capello & Kroll, 2016; Incaltarau et al., 2019; Rodríguez-Pose, 2020). The bottom-up nature of S3 implies that local actors – especially policy-makers – hold large responsibilities in the design and implementation phases, meaning that poor local government quality may jeopardise the capacity to select areas of intervention in a truly effective manner (Farole et al., 2011).

Another issue complicating the operationalisation of S3 strategies is that it has become an *ex-ante* conditionality for 2014-2020 Cohesion Policy. This fast conversion from theory to practice implies that policy intervention has taken place without a solid evidence-base and without adequate scrutiny of its strengths and weaknesses (Morgan, 2015). There has been limited exchange of experiences across jurisdictions that would provide indications on how to properly apply S3 in each context (Morgan, 2015). This fast adoption has been criticised – even by the creators of the S3 concept themselves (Foray et al., 2011).

2.3 Early evaluations

Given its novelty, there has been limited research of the effectiveness in the application of S3 strategies, but some analyses are starting to emerge. Iacobucci & Guzzini (2016), for example, consider the way in which S3 sectoral priorities have been defined by Italian regions, revealing that key concepts such as ‘relatedness’ and ‘connectivity’ of technological domains have been overlooked as guiding principles behind S3. Mostly, intervention has been defined on intuition and anecdotal evidence, and, in a majority of cases, without any clear justification. Furthermore, identifying areas of specialisation has been more complicated in weaker regions (Iacobucci & Guzzini, 2016). Poor institutions were at the root of these flaws, leading to what has been deemed as too broad, not sufficiently embedded, or not relevant S3 priorities in backward areas of Italy.

Gianelle et al. (2019) have examined how S3 priorities have been defined in Italian and Polish regions. They note that, while in some cases the chosen investment activities represent suitable S3 priorities, in at least 11 out of 39 regions the innovation areas prioritised in S3 strategies do not reflect the expected S3 criteria. They reveal that S3 in some regions, far from providing clear targets, identify a far too large number of priorities, covering basically all economic areas, thus contradicting the basic S3 principle of selective intervention.

Finally, while a full impact analysis of S3 cannot be conducted yet, because of the newness of the strategies, Crescenzi et al. (2018) provide evidence on the effectiveness of a precursor of S3 interventions: the requirement for local businesses in the South of Italy to submit project applications based on the identification of their own priorities and collaboration strategies with other firms and other research-active local stakeholders in order to secure R&D funding during the programming period 2007-2013. The authors report that the project had limited impact on additional investments, value added, and employment, because of ‘overshooting’ – selecting technological domains that were too advanced with the aim of maximising the chances of receiving funding, but that failed to create synergies with the local production structure (Crescenzi et al., 2018).

However, and to the extent of our knowledge, no research has so far conducted an analysis of how focused S3 strategies are and how this may relate to the local economic context of each region. From related literature, we know that the design, deployment, and overall effectiveness of regional development policies are influenced by the characteristics – institutional, economic, or other – of the regions. For example, Crescenzi (2005) has shown for EU regions that the effectiveness of local innovation policy is conditioned by local characteristics, such as geographical accessibility and levels of human capital. For the case of the Common Agricultural Policy, Henke et al (2018) indicated that the effectiveness of policy implementation is influenced by national norms and institutional path dependencies. A more extensive literature exists on what determines the success and failure of Cohesion Policy

(Crescenzi et al, 2018) with a range of factors identified, including the type of prioritised expenditures (Rodríguez-Pose and Fratesi, 2004), the coordination of expenditures with other policies (Crescenzi et al, 2015), and, more recently, the targeting of expenditures on regional needs (Di Cataldo and Monastiriotis, 2020) or on existing regional strengths (Sotiriou and Tsiapa, 2015). Informed by this literature, our analysis of the features of smart specialisation strategies constitutes a unique attempt to assess aspects of policy design in this new policy area.

3. Descriptive features of smart specialisation strategies

The analysis uses the information concerning the S3 strategies adopted by European regions, as recorded in the Smart Specialisation JRC Platform.[1] This database collects all the S3 strategies from every territory (country or NUTS1/NUTS2/NUTS3 region), including the date (from 2014 onwards) in which the strategy was submitted to the platform. For each territory, the Platform reports the full set of sub-strategies[2] adopted under the S3 framework. For each of these it lists the sectors of economic activity (labelled *economic domains* according to Eurostat's NACE2 sectoral classification) on which investment efforts will focus, as well as the *scientific domains* associated to these, defined along the Nomenclature for the Analysis and Comparison of Scientific Programmes and Budgets (NABS 2007). Finally, each axis lists its *policy objectives*, i.e. the broad areas of intervention to which it will contribute. These are related to the 'Societal Grand Challenges' identified in Horizon 2020 and the headline policies in the Innovation Union Flagship Initiative. They include, among others, Nature & biodiversity, Sustainable innovation, Creative and Cultural Industries, Key Enabling Technologies (KETs), Social Innovation, and the Digital Agenda.

The coding of the strategies along the key dimensions (economic and scientific domains and policy objectives) is conducted by policy experts at the Joint Research Centre of the European Commission in Seville. Although any coding involves potential problems of misclassification, the fact that the task is concentrated on one team ensures consistency in the classifications produced. In our analysis, we present the examination of the S3 strategies assuming that the official information about them is not systematically inaccurate in any of the dimensions that we discuss here.

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[1] Retrieved from https://s3platform.jrc.ec.europa.eu/map.

[2] Henceforth, we refer to these as *axes*, to avoid conflation with the overall S3 strategies of regional/territories.

3.1 Mapping S3 strategies

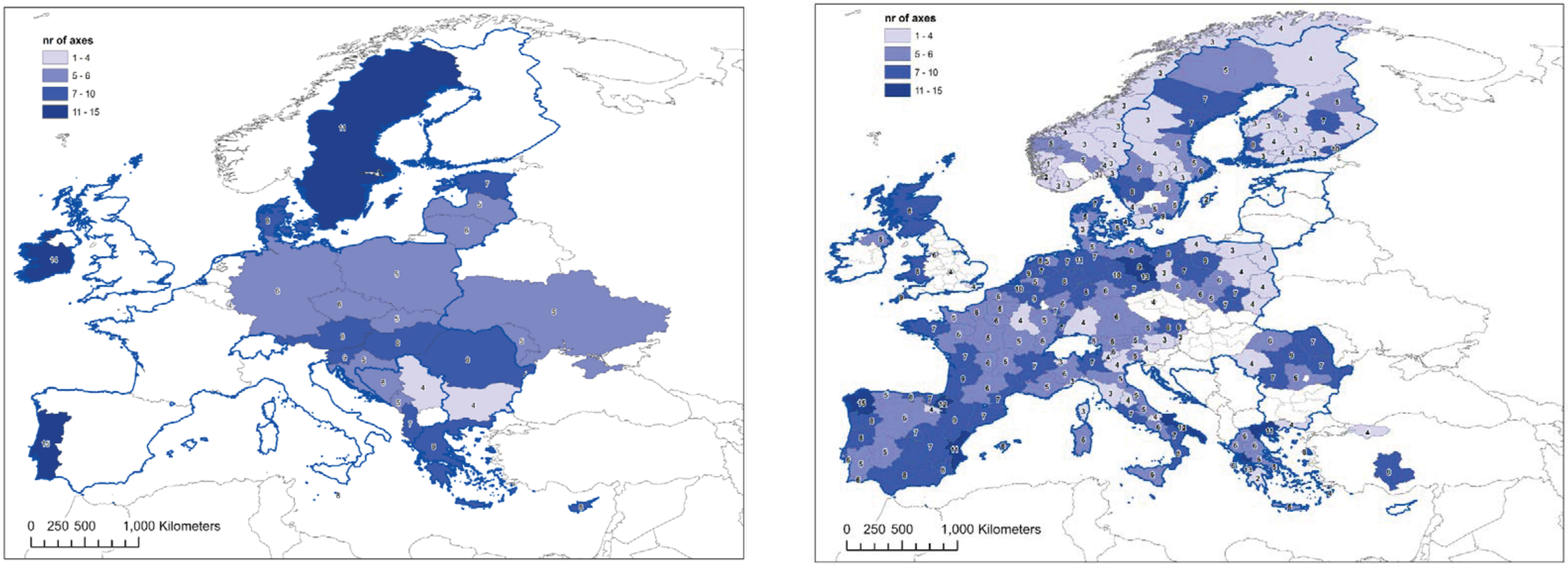
Our starting point is a visual representation of S3 strategies across Europe for all countries and regions that submitted S3 strategies to the European Commission for the 2014-2020 period. Figure 1 depicts the number of axes within each S3 strategy, providing a descriptive picture of regions and countries with ongoing S3 strategies, separately for national-level strategies (panel (a)) and for sub-national ones (panel (b)). As can be seen, despite S3 being conceived as part of EU Regional Policy, it has been adopted also by a substantial number of countries at the national level; while in a number of EU countries – Portugal, Germany, Greece, Austria, Denmark, Poland, Romania, and Sweden – both regional and nationwide S3 strategies have been adopted. In the remaining EU member-states, S3 is conducted either at the national (i.e. Latvia or Slovakia) or regional (i.e. Belgium, France, Italy) level. Some non-EU countries have also been lured by the glow of S3, either at national – Ukraine, Bosnia-Herzegovina, Serbia, Montenegro, Moldova, and Albania – or regional – Norway and two Turkish regions – level.[3] Finally, panel (b) reveals that the NUTS level at which regional S3 strategies have been designed and implemented varies across European countries. In Germany, smart specialisation strategies are being conducted at NUTS1 (*Länder*) level. In most other countries the level chosen is NUTS2. In Scandinavian countries the level is NUTS3. A peculiar case is that of the United Kingdom, where all NUTS1 Home Countries – England (not shown in the map), Wales, Scotland, and Northern Ireland – have submitted a strategy, while a small number of NUTS2 regions in England also have one.

Figure 1 also displays that the number of *axes* within each S3 strategy differ widely across Europe. The country with the largest number of axes is Portugal, with 15, while Bulgaria has only 4 (Figure 1, Panel (a)). At the regional level the difference is even sharper. Galicia in Spain has 15, while Peloponnese in Greece is limited to 2 and Hordaland in Norway to only 1 (panel (b)).

[3] EU's neighbouring countries and Candidate Member States were given the opportunity to participate in the S3 programme (https://s3platform.jrc.ec.europa.eu/eu-neighbourhood).

Figure 1. Number of axes within each S3 strategy (countries and regions)

(a) National axes *(b) Regional axes*



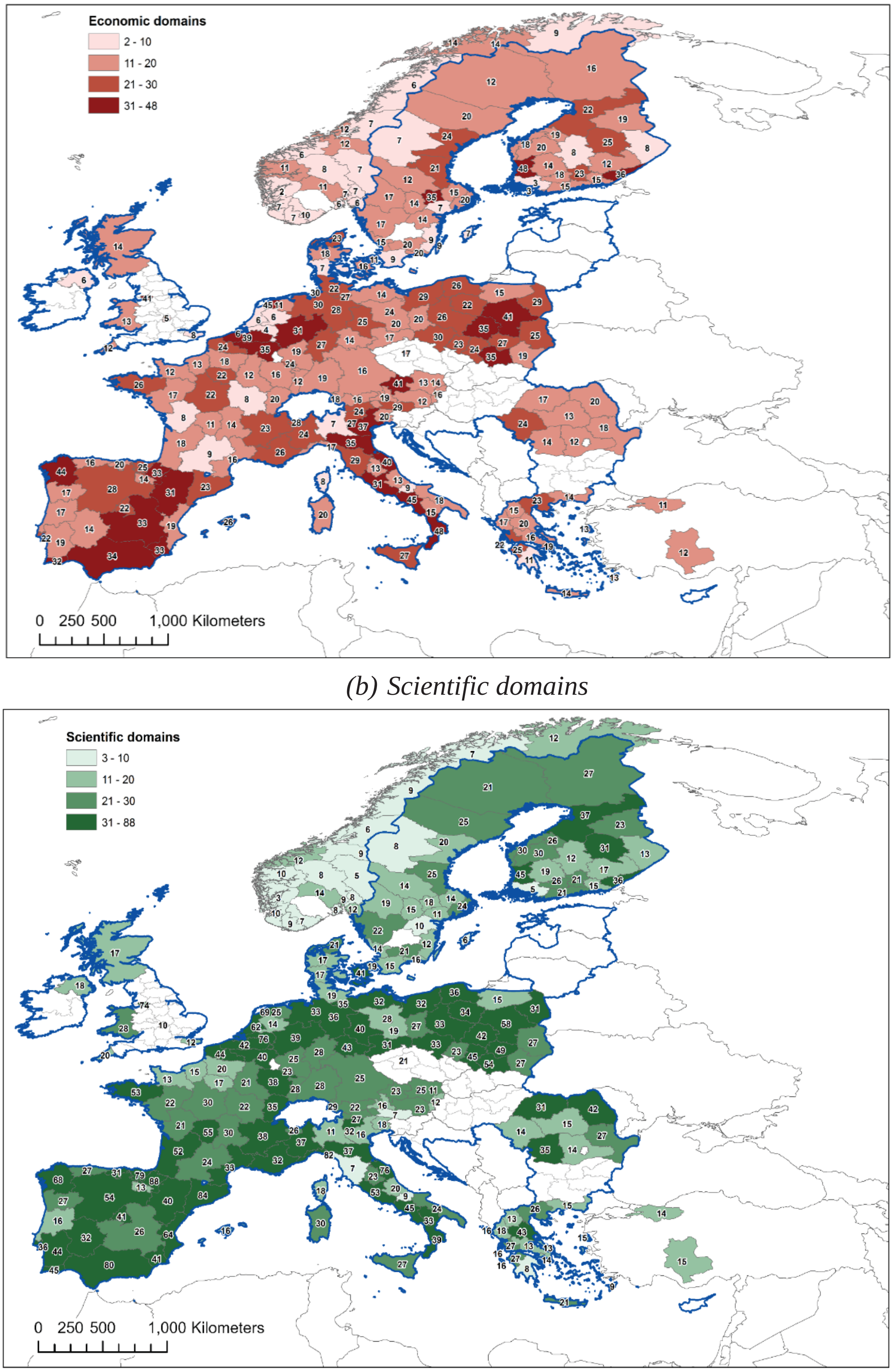
Note: panel (a) reports the number of axes in European countrywide S3 strategies; panel (b) reports the number of axes in regional S3 strategies; EU borders at the beginning of the 2014-2020 period in blue bold.

Figure 2 presents the number of *Economic* and *Scientific domains* identified by each S3 regional strategy, while Figure 3 displays the number of *Policy objectives*. Economic and scientific domains represent the key investment targets of S3 strategies and are intended to indicate the sectors in which the region aims to ‘specialise’. It becomes evident from Figure 2 that some S3 strategies have disproportionally high numbers of economic and scientific domains. Hence, the main takeaway is that in many EU regions there has been a ‘proliferation’ of both economic and scientific domains of S3 strategies (Figure 2). Such ‘proliferation’ is prevalent across Spanish regions. Navarra, Aragón, Castilla-La Mancha, Murcia, and Andalucía identify over 30 economic domains, while Valencia, Cataluña, Andalucía, Galicia, the Basque County, and Navarra list more than 60 scientific domains among their priorities. Navarra tops the S3 ranking with 88 scientific targets.

Many Belgian, Dutch, French, Italian, and Polish regions are similarly ambitious in terms of economic and scientific domains. The region of Calabria lists 48 economic domains, Groningen and Campania 45, Mazovia 41, Marche 40, and Flanders 39. The Italian regions of Calabria, Campania, Marche, Emilia-Romagna, Lazio all have over 30 scientific domains in their S3 strategy (76 in Marche alone). Of the 16 Voivodships in Poland, all but 5 have strategies with over 30 scientific domains. Internal contrasts in the number of scientific domains within countries are also flagrant. Whereas Tuscany lists only 7 scientific domains and Lombardy – the largest region in Italy – 11, Marche has a total of 76. In France, Limousin boasts 55, while Île-de-France included only 17. And in Greece, the starkest contrast is between 43 in Thessaly, on the one hand, and 14 in Attica or 8 in the Peloponnese, on the other.

Figure 2. Number of economic and scientific domains of S3 strategies by region.

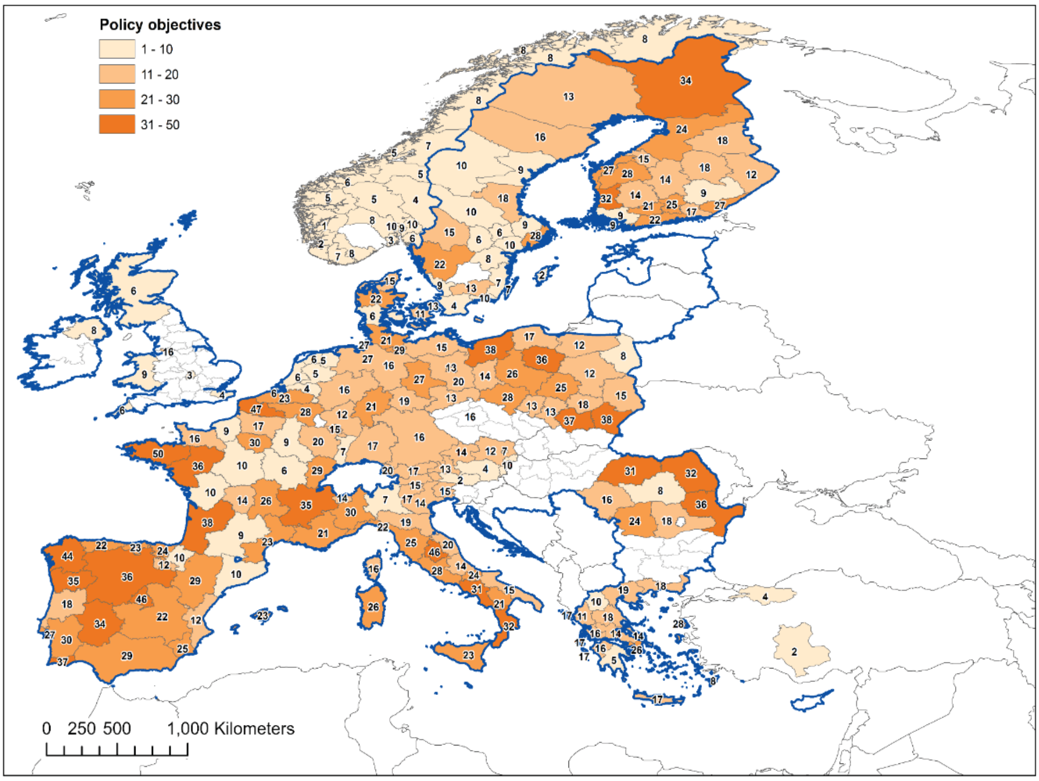
(a) Economic domains



(b) Scientific domains

The number of policy objectives also varies sharply, ranging from the single-digit figure of almost all Norwegian regions to the very high figures in many Spanish, Romanian, Italian, Polish, and French regions. Bretagne, in France, is the region with the highest number of policy targets in its S3 strategy, with 50 identified objectives.

Figure 3. Number of policy objectives of S3 strategies by region.



It should be noted that the presence of a large number of areas of specialisation does not necessarily reflect lack of ‘smartness’ in any particular strategy. Indeed, S3 strategies are not about selecting sectors per se – but rather about identifying “missions” (Mazzucato, 2018), i.e., sets of activities across sectors, which contribute to a particular specialisation (see also Rodrik, 2004). In this sense, it should not be of surprise if some regions’ S3 strategies list an unusually large number of domains. However, given that the majority of regional S3 strategies list 18 economic domains or fewer, our sense is that strategies which list economic domains well above this number – perhaps half or more of the entire set of sectors in the economy – are perhaps not sufficiently fine-tuned. To a sceptic, given that listed sectors within S3 strategies are de facto potential beneficiaries of Cohesion Policy funds, the implied proliferation of specialisations in some S3 strategies may even be a signal that some strategies are driven by a “something for everybody” logic. In this regard – and to the extent that this may be true – there is scope for improvement in the logic, focus, and precision of the regional specialisations pursued under the S3 framework.

3.2 Are S3 strategies truly distinctive?

Besides the point raised above, the widespread proliferation of economic and scientific domains and policy objectives questions additionally, and to a considerable extent, how 'smart' S3 strategies truly are. Many European regions seem incapable of truly identifying a narrow list of priorities – and the EU of curtailing the multiplication of policy objectives. The proliferation of domains may also signal an inability to present distinctive regional strategies that would reflect the conditions and potential of each individual region. In order to assess whether S3 strategies across Europe are sufficiently distinctive or if, inversely, they overlap significantly in their priorities, thus reproduce the same economic and innovation domains and the same policy priorities over and over again, we proceed as follows. First, we examine the frequency of different domains across regional strategies – looking at the sectoral, scientific and policy content of each strategy. Second, we perform a cluster analysis, this time only for the economic domains, aiming at classifying regions into groups of specialisations.[4]

Table 1 list the 20 most frequent economic domains, scientific domains, and policy objectives in the 244 S3 national and regional S3 strategies analysed. A number of domains occur across a high share of S3 strategies, indicating either that many territories have overlapping specialisations or that there is a tendency to repeat strategies among countries and regions. 169 territories (or 69% of the total) identify 'Information service activities' as one of their specialisations. 'Computer programming' appears as a priority in 68% of strategies. 'Health promotion' is the most common scientific domain, covered by 67% of strategies, and an implausible 157 (64%) specialise in 'Medical sciences'. A similar example for the policy objectives is the case of 'Advanced materials', which forms part of the specialisation strategies of 131 regions/countries in the EU.

These frequencies indicate the presence of very similar priorities across many S3 strategies, raising the important question of the extent to which the S3 framework is producing strategies that both adequately identify the characteristics of each territory and, at the same time, are collectively rational, or appropriate, at the EU-wide level.

[4] Our analysis was conducted at the regional level, but including the S3 strategies of countries where no sub-national S3 strategies exist.

Table 1. Top-20 domains and policy objectives across S3 strategies in the EU

Economic domains			Scientific domains			Policy objectives		
Name	Strategies	Share	Name	Strategies	Share	Name	Strategies	Share
Information service activities	169	0.69	Health promotion	164	0.67	Public health & wellbeing	176	0.72
Computer programming, consultancy and related activities	167	0.68	Medical sciences	157	0.64	Sustainable energy & renewables	156	0.64
Human health activities	164	0.67	Renewable energy sources	149	0.61	Advanced manufacturing systems	138	0.57
Electricity, gas, steam and air conditioning supply	155	0.64	Mathematics, computer and information sciences	148	0.61	Advanced materials	131	0.54
Scientific research and development	137	0.56	Energy production and distribution efficiency	147	0.60	Development of regional cultural & creative industries	116	0.48
Crop and animal production, hunting and related service activities	132	0.54	Food productivity and technology	145	0.59	e-Health (e.g. healthy ageing)	113	0.46
Food products	129	0.53	Improving industrial production and technology	143	0.59	Resource efficiency	107	0.44
Machinery and equipment	127	0.52	Public health services	140	0.57	Industrial biotechnology	107	0.44
Other professional, scientific and technical activities	126	0.52	Energy efficiency - consumption	137	0.56	Eco-innovations	106	0.43
Telecommunications	116	0.48	Engineering Sciences	136	0.56	Sustainable agriculture	101	0.41
Creative, arts and entertainment activities	113	0.46	Cultural services	135	0.55	Cleaner environment & efficient energy networks and low energy computing	95	0.39
Other transport equipment	101	0.41	Monitoring the health situation	135	0.55	Support to link cultural & creative industries with traditional industries	93	0.38
Computer, electronic and optical products	99	0.41	Agriculture, animal and dairy sciences	125	0.51	Food security & safety	92	0.38
Motor vehicles, trailers and semitrailers	98	0.40	Agriculture forestry fishery	123	0.50	Intelligent inter-modal & sustainable urban areas (e.g. smart cities)	92	0.38
Beverages	91	0.37	Manufacture of food products	123	0.50	New or improved service processes	91	0.37
Sports activities and amusement and recreation activities	85	0.35	Telecommunication systems	118	0.48	Sustainable production & consumption	91	0.37
Basic pharmaceutical products and pharmaceutical preparations	84	0.34	Recreational and sporting services	115	0.47	Smart green & integrated transport systems	87	0.36
Other manufacturing	83	0.34	Manufacture of machinery and equipment	115	0.47	e-Commerce & SMEs online	86	0.35
Electrical equipment	83	0.34	Transport systems	113	0.46	Ageing societies	86	0.35
Libraries, archives, museums and other cultural activities	79	0.32	Public health management	112	0.46	Digitising Industry (Industry 4.0 smart and additive manufacturing)	86	0.35

The evidence from our cluster analysis[5] is partly reassuring in this regard. S3 strategies in Europe cluster into five distinctive groups, each with a reasonable geographical spread (Table A1 in appendix). Based on their prevalent specialisations,[6] the groups can be labelled as follows: (1) Food and Metal Manufacture; (2) Agrifood and Hospitality; (3) ICT and Health; (4) Creative and Leisure; (5) Energy and Resources. This clustering covers a reasonably wide range of economic domains, with meaningful sectoral linkages (e.g., agrifood is connected to hospitality). Moreover, the membership of territories in these clusters also appears to relate reasonably well to the existing specialisations of the territories (for example, the Creative and Leisure cluster – cluster 4 in Table A.1 – includes mainly touristic areas; while the Agrifood and Hospitality cluster – cluster 3 in Table 1 – includes most of the regions with existing specialisations in Agriculture, Food processing and Food services) – while the clusters themselves are not spatially fragmented (reproducing, for example, a north-south division).

Thus, on the whole, our statistical review of the S3 strategies reveals two patterns: on the one hand, regions do appear to specialise in economic domains that are relevant, in the sense that they relate to existing strengths/specialisations of the regions; on the other hand, across the EU space we observe a relative proliferation of specialisations (too many regions specialising in too many economic domains), which produces significant overlaps in specialisations across territories. This leads to an important first conclusion for our analysis: S3 strategies may be individually 'smart', but collectively sub-optimal. Our analysis in the next section moves beyond this observation, focusing on examining the local economic and institutional factors that possibly account for the observed variation in the degree of specialisation of S3 strategies across territories.

4. Drivers of regional S3 strategies

In this section we perform an econometric analysis that examines how particular regional characteristics relate with some of the features of S3 strategies discussed above – namely the

[5] We performed a partition (non-hierarchical) clustering using the – cluster k-means – command in Stata. The number of clusters was decided based on the Calinski/Harabasz pseudo-F.

[6] We define domains as prevalent if they appear in the strategies of at least 70% of territories in any particular group.

numbers of axes, economic domains, scientific domains and policy objectives appearing in the S3 strategy of each territory.

Our goal is to verify whether these aspects link with the structural conditions of EU regions. In the absence of prior theoretical knowledge about the drivers of key aspects of S3 strategies, the analysis includes a broad range of explanatory variables covering various economic, labour market, geographical, socio-demographic, and institutional regional characteristics.[7] The rationale for including these variables, and our expectations with regard to the types of effects that they may relate to, are as follows.

To examine whether the economic capacity of regions exerts an influence on the characteristics of S3 strategies, we include alternatively two measures of agglomeration: population density and log-population. As is widely discussed in the new economic geography and urban economics literature (e.g. Combes et al., 2008), agglomeration is a key factor linked to productivity and consumption externalities and, by implication, to greater degrees of diversification. Thus, we expect that higher degrees of agglomeration will also create potential for regions to plan strategically their 'diversified specialisations' (Farhauer and Kröll, 2012). We also include two measures of economic performance, reflecting each region's position in the economic cycle: GDP per capita growth and unemployment. The former captures the economic dynamism of each territory: with higher rates of growth, a region can presumably afford to be more strategic in its S3 strategies for the future, thus deciding to specialise in fewer domains; or instead it could feel empowered to experiment more, thus potentially opting for more – or at least more 'risky' – specialisations. The latter captures instead the extent of slack in the economy and thus possibly more immediate pressures to policy (including for electoral reasons – Mechtel and Potrafke, 2013), leading regional policy-makers to 'spread their bets', thus producing more 'profligate' strategies. Our model also includes proxies for the technological capabilities and available set of skills of places, measured by the log of patent applications per million inhabitants[8] and the share of adult population with higher education,

[7] All variables are measured as averages for the 4 years prior to the beginning of the 2014-2020 period (mean values for 2011-2014). This ensures that variables are measured in the period prior to the implementation of S3 strategies and hence cannot be affected by it, thus minimising any endogeneity concerns.

[8] Patents are an imperfect proxy for innovation, but, for lack of a better alternative at a regional level, they have been frequently used in the literature looking at regional-level EU innovation capacity (e.g. Bottazzi & Peri 2003). A potential alternative would be to use data from the EU Regional Innovation Scoreboard. However, as this is available only for few of the regions having ongoing S3 strategies, using this variable – which correlates 90% with log patents for the available data – would have implied losing many observations in the analysis.

respectively. As S3 strategies are expected to leverage on existing knowledge and innovation strengths, we expect that regions with higher technological capabilities will be able to support a broader number of economic/scientific domains in their strategies.[9] Last, we expect that the quality and characteristics of S3 strategies will depend heavily on the administrative capacities of the regions and on their overall quality of government (Rodríguez-Pose and Di Cataldo, 2015). We thus introduce a measure of regional government quality in our analysis, adopting the widely-employed Quality of Government EU regional indicators developed by the University of Gothenburg (Charron et al., 2014).

Formally, we estimate the following model with ordinary least squares (OLS):

$$S3_r = \alpha + \beta X_r + \varepsilon_r \qquad (1)$$

where $S3_r$ is one of the four characteristics (number of axes; number of economic domains; number of scientific domains; and number of policy objectives) of S3 strategy in region r;[10] X_r represents the vector of regional-level explanatory variables; ε_r is the error term.

As the definition of S3 goals and priorities in every single strategy may not follow exclusively an identification of local potential, other elements may shape S3 strategic choices at a regional level. One important factor potentially shaping the strategy is what neighbouring regions are doing. Regional decision-makers and officials when designing their own S3 strategies may be concerned with/guided by neighbours' strategies for a number of reasons. First, they may consider that replicating what is done elsewhere is the best way to secure funds (a form of mimicking – Revelli, 2002). Second, they may not want to be outdone by their competitors in numbers of goals and priorities, due to territorial/yardstick competition considerations (Rodríguez-Pose & Arbix, 2001; Gordon, 2010). Third, the rapid enactment of S3 at a European level may have led to copycat strategies. Finally, the economic returns of European

[9] An alternative specification of the model also tests whether more diversified economies would be able – or, find it necessary – to leverage on more economic sectors. To account for this, we include a measure of sectoral specialisation (Herfindahl index) based on the share of regional employment in the primary, secondary, and tertiary sector. A higher value of the index corresponds to a stronger specialisation. The results of the model estimated with the inclusion of this control are reported in Table A3 in the Appendix.

[10] Following the S3 Platform classification of 3-digit sectors in each S3 strategy, the dependent variables reflect the 'count' of targeted S3 sectors by each region at 3-digit level. As a robustness test, we have aggregated targeted sectors at 1-digit. The results of the analysis are broadly unaffected by this change.

policies are highly influenced by whatever strategies neighbours are pursuing (Breidenbach, 2019). We test for this hypothesis by augmenting model (1) with the spatial lag of the dependent variable, capturing the number of axes, economic/scientific domains, and policy objectives of regional neighbours. Formally, we estimate the following spatial autoregressive (SAR) model with a maximum-likelihood estimation (MLE):

$$S3_r = \alpha + \beta\, X_r + \gamma\, W\, S3_r + \varepsilon_r \qquad (2)$$

where $W\ S3_r$ is the spatial lag of the dependent variable, and the row-normalised spatial weight matrix W defines regional neighbours through rook contiguity.[11]

The sample is composed of EU NUTS regions and some small EU countries. This means that we exclude country-level observations from all countries that have both national and regional strategies (i.e. Portugal, Germany, Greece, Austria, Denmark, Poland, Romania, and Sweden) and consider only their regional S3 strategies. Furthermore, the X_r vector of explanatory variables is only available for NUTS1 and NUTS2 regions, thus all NUTS3 Scandinavian regions are not considered when X_r variables are included. These variables are also not available for non-EU countries, forcing us to exclude Ukraine, Bosnia-Herzegovina, Montenegro, Serbia, Albania, Moldova, and Turkish regions.

We present the results from the econometric exploration in Table 2. For all four dependent variables, we report the results of the OLS and SAR models in consecutive columns.[12] When the dependent variable is the number of economic/scientific domains or of policy objectives (columns (3)-(8)), we also control for the number of regional axes of S3 strategies. As such, our explanatory variables in columns (3)-(8) describe the relationship between a given regional socio-economic factor and the number of domains/objectives per axis.

[11] We have experimented with alternative definitions of the W matrix. Results (available upon request) are consistent across specifications.

[12] Given the descriptive nature of our analysis, we do not concern ourselves with issues of endogeneity or inverse causality. In the SAR model(s) the reported coefficients represent the sum of the direct and indirect effects of the explanatory variables (LeSage and Domínguez 2012).

Table 2. Characteristics of S3 strategies and their determinants

Dependent variable:	Axes		Economic domains		Scientific domains		Policy objectives	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Population density	-0.000227	-0.000393	9.48e-06	-9.39e-05	-0.00131	-0.00106	0.000470	0.000546
	(0.000286)	(0.000255)	(0.000586)	(0.000823)	(0.00146)	(0.00142)	(0.00119)	(0.000946)
GDP pc growth	-0.0900	-0.195*	-0.346	-0.403	-0.0156	-0.0860	-0.506	-0.555
	(0.141)	(0.112)	(0.391)	(0.360)	(0.630)	(0.621)	(0.398)	(0.414)
Unemployment rate	0.182***	0.0776	0.181	0.0865	0.647*	0.489	0.202	0.0957
	(0.0630)	(0.0539)	(0.164)	(0.175)	(0.346)	(0.304)	(0.192)	(0.202)
Log patents pc	0.607**	0.0986	1.738*	1.194	2.836	2.316	-0.826	-1.193
	(0.283)	(0.291)	(1.028)	(0.937)	(1.922)	(1.598)	(0.999)	(1.064)
Share of tertiary educated	-0.0265	0.00924	-0.105	-0.0489	0.254	0.265	-0.0824	-0.0373
	(0.0386)	(0.0310)	(0.103)	(0.101)	(0.179)	(0.171)	(0.117)	(0.116)
Quality of Government	0.00408	-0.0680	-3.208**	-3.053***	-3.509	-3.555*	-1.037	-0.916
	(0.343)	(0.349)	(1.468)	(1.133)	(2.428)	(1.954)	(1.303)	(1.302)
W axes		0.451***						
		(0.0700)						
W economic domains				0.198***				
				(0.0703)				
W scientific domains						0.173**		
						(0.0758)		
W policy objectives								0.197**
								(0.0815)
Axes			2.461***	2.234***	3.951***	3.597***	2.437***	2.201***
			(0.225)	(0.235)	(0.404)	(0.410)	(0.275)	(0.271)
Constant	2.266	2.409	1.809	1.214	-14.91	-14.34*	9.387	8.784
	(1.641)	(1.511)	(5.039)	(4.929)	(9.734)	(8.504)	(5.840)	(5.665)
Observations	168	168	168	168	168	168	168	168
R-squared	0.117		0.488		0.471		0.415	

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Dependent variables: number of S3 *axes* per region (columns (1), (2)); number of S3 *economic domains* per region (columns (3), (4)); number of S3 *scientific domains* per region (columns (5), (6)); number of S3 *policy objective* per region (columns (7), (8)). Models in columns (1), (3), (5), (7) are estimated with OLS, while SAR models in columns (2), (4), (6), (8) are estimated with MLE. Spatial weight obtained with row-standardised rook contiguity matrix.

The results show that, on the whole, economic concentrations exert little influence on S3 strategic choices. Population density is never significantly related with S3 strategy characteristics;[13] while GDP per capita growth and the unemployment rate are only statistically significant in a sub-set of the regressions (in the SAR model for the number of axes and in the OLS estimates for the number of axes and the number of scientific domains, respectively). Still, the signs of the obtained coefficients are in line with expectations – with fast growth being associated with more focused strategies and higher unemployment being associated with more diffuse strategies, at least in terms of number of axes and scientific domains.

The results for the technological capacity measures are equally weak. The log of patents displays a positive coefficient in most specifications, indicating perhaps that more innovative regions tend to develop more axes and identify more investment domains, but the estimates are only statistically significant in two cases – concerning the numbers of axes and of economic domains (columns (1) and (3)). Instead, the human capital variable is never statistically significant and enters with different signs across specifications. It thus appears that, like the economic variables, technological capacity plays only a limited role in the design of S3 strategies. As these strategies are supposed to be devised exactly with the technological/innovation capacity of regions in mind, this finding is somewhat perplexing.

The last regional factor considered in the analysis is the quality of regional governments. In this case, the results are stronger across specifications, with the quality of government not correlating significantly with the number of axes but returning a strong and consistent negative coefficient on the number of economic domains per axis. This result confirms the idea that the proliferation of investment targets in S3 strategies is a sub-optimal policy choice often conducted by regions with weaker governance structures. Regions with better institutional capacity tend to be much more selective when it comes to identifying the areas in which to invest.

In addition to the relatively poor performance of the variables representing various regional characteristics, the inclusion of spatial lags of the dependent variables leads to important findings. Across all regressions, the coefficients of the spatial lags (columns (2), (4), (6), and (8)), are always positive and statistically significant. Such finding suggests that the

[13] As an alternative specification, we have estimated our regression substituting population density with log population. The results are shown in Table A2 in the Appendix. The coefficient of log population is only mildly significant in the first estimation (column (1), Table A2), while it is insignificant in all other specifications. All other coefficient are unchanged from our main model.

characteristics of S3 strategies of neighbouring areas represent strong predictors of how a given region develops its own strategy. While this may be due to neighbouring regions having similar needs,[14] it can also signal that these regions struggle to find their S3 priorities and thus set these up by observing what their neighbours do. In other words, they may be simply replicating their approach. Hence, rather than trying to address their main bottlenecks, by prioritising exclusively areas in which strength or potential has been identified, many EU regions mostly seem to be replicating the strategic choices of their neighbours. This would seem to cast doubts on whether S3 priorities are truly set in order to foster the selected competitive advantages of places and could raise legitimate concerns as to whether the specialisations proposed and pursued by individual regions are consistent with the macro-objectives of the S3 policy framework.

We test the robustness of our findings in a number of ways. First, we replace population density with log population as control and add a variable accounting for the sectoral composition of the regions (Herfindahl index). Second, we also ran a simple SAR-lag model without additional controls for regional characteristics using alternatively a spatial weights matrix (W) based on inverse distance. This allows us also to include in the sample the full set of countries and regions with S3 strategies (again excluding higher-level strategies when lower-level ones are available). The results (see Tables A2, A3, A4 in the Appendix), are highly consistent, confirming the spatial lag-dependence of S3 strategies and the limited role played by region-specific economic and technological characteristics.

These results also highlight that the tendency of regions to 'imitate' the S3 strategies of neighbouring areas decreases with institutional quality. Table A5, reproducing the estimates with no controls and splitting the sample by different quartiles of government quality, suggests this is the case. Regions with higher quality institutions are less likely to be replicating the S3 policy choices of their neighbours (insignificant spatial lag). In contrast, regions in the two lowest quartiles of government quality do so in a systematic way (positive and significant spatial lag for regions with QoG < 0) (Table A5).

[14] Given the performance of the substantive variables in the regressions, however, such needs would not seem to be related to the economic and technological capacities of regions.

5. Conclusions

The 2014 reform of the EU's Cohesion Policy brought about a significant strategic shift in development intervention across countries and regions in Europe. Despite some initial misgivings by the academics behind the concept – who described its rapid policy adoption by the EU as "policy running ahead of theory" (Foray et al., 2001:1) – S3 was widely implemented even in countries outside the EU. S3 has represented a substantial shift from previous policy. It marked the transition to a more place-based, bottom-up Cohesion Policy intended on identifying the strategic potential of each and every territory in the EU (Midtkandal and Sörvik, 2012). By using an individual entrepreneurial discovery process the aim was to adapt development intervention to the varying conditions and potential of each region and country while, simultaneously, raising the overall effectiveness of cohesion intervention.

This implied a thorough transformation of the old Cohesion Policy extending the shift of the 'place based' approach towards a 'territorialised' industrial policy, by introducing a new way of thinking about territorial development in the EU. EU countries and regions have been required in S3 strategies to identify and harness their dynamic advantages, so as to unleash their growth potential. The idea has been to create a more efficient and 'smarter' policy, more capable of improving the development prospects of territories and the well-being of citizens wherever they live in Europe.

Yet, despite the importance of the reform, to date there has been virtually no evaluation of the extent to which the S3 strategies designed and implemented by countries and regions truly reflect the economic characteristics of each territory. This has been the goal of this paper. We have found that S3 strategies are, by and large, very loosely connected with the characteristics of the region. With the exception of local government quality, the economic and scientific domains as well as the policy objectives included in the strategies are not reflective of the intrinsic conditions of each region. Only territories with better governance structures and government quality have strategies that are more concise and focused, meaning that these territories are pursuing clearer and less complex strategies with a more realistic and manageable number of priorities.

Rather than reflecting the intrinsic characteristics of each territory, S3 strategies, to a large extent, mimic what neighbouring areas are doing. A sort of copycat system – which is far more prevalent among regions with a low government quality – dominates by which countries and regions define their number of economic and scientific domains and their policy priorities by what their neighbours do, rather than by their own needs and perceived potential. This accounts, to a large extent, for the proliferation of priorities and lack of distinctiveness of strategies observed in our descriptive analysis.

Hence, the question that remains is whether ‘smart’ specialisation is really smart. Given the results of the analysis, it can be said that in the way it has been applied S3 is not yet ‘smart’ enough. Most S3 strategies include far too many axes of intervention; and a limited coincidence with the strengths and specialisation of the territories for which the strategies develop remains the norm. Further research will be required in order to assess the efficiency of the massive S3 experiment once the payments linked to the 2014-2020 programming period are wrapped up. However, the tendency, especially by regions with a low government quality, to mostly imitate what the neighbours are doing and have a ‘token compliance’ with EU requirements is likely to lead to inefficient strategies that fail to deliver on their promise of mobilising the local economic potential and improving development levels and quality of life across the whole of Europe.

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Appendix

Table A1. Clusters of territories/strategies on the basis of economic domains

Cluster	No of territories / strategies	Specialisations	Name of cluster	Territories
1	49	Food products, Fabricated metal products, Computers and electronics, Machinery and equipment n.e.c.	Food and Metal Manufacture	Kärnten, Oberösterreich (AT); Kentriki Makedonia (EL); Galicia, Principado de Asturias, La Rioja (ES); Satakunta, Kanta-Häme, Pohjois-Pohjanmaa (FI); Champagne-Ardenne, Picardie, Haute-Normandie, Bourgogne, Lorraine, Aquitaine, Midi-Pyrénées (FR); Piemonte, Valle d'Aosta, Campania, Calabria, Veneto, Friuli-Venezia Giulia, Toscana, Marche (IT); Eastern Netherlands (NL); Rogaland, Møre og Romsdal (NO); Lódzkie, Lubelskie, Wielkopolskie, Zachodniopomorskie, Opolskie (PL); Nord-Vest, Centru, Sud-Est, Sud-Muntenia, Vest (RO); Södermanlands, Östergötlands, Västmanlands, Västra Götalands (SE); Kocaeli, Konya (TR); Greater Manchester (UK); Estonia; Lithuania; Latvia; Moldova; Slovenia
2	37	Agriculture, Food processing, Accommodation, Food services; Computer programming, Information services	Agrifood and Hospitality	Burgenland (AT); Nordrhein-Westfalen (DE); Anatoliki Makedonia & Thraki, Dytiki Makedonia, Thessalia, Ionia Nisia, Dytiki Ellada, Sterea Ellada, Attiki, Voreio Aigaio (EL); Castilla-La Mancha, Extremadura, Comunidad Valenciana, Andalucía, Canarias (ES); Päijät-Häme, Kymenlaakso, Etelä-Karjala, Pohjois-Savo (FI); Provence-Alpes-Côte d'Azur, Martinique (FR); Puglia (IT); Sogn og Fjordane (NO); Malopolskie, Swietokrzyskie, Lubuskie (PL); Norte, Algarve, Centro, Região Autónoma dos Açores, Região Autónoma da Madeira (PT); Vojvodina (RS); Kronobergs, Kalmar, Dalarnas, Västernorrlands (SE); Montenegro
3	73	Telecoms, Computer programming, Information services, Scientific R&D; Human health	ICT and Health	Niederösterreich, Wien, Steiermark, Salzburg, Tirol, Vorarlberg (AT); Republika Srpska (BA); Flemish Region, Région Wallonne (BE); Praha (CZ); Baden-Württemberg, Bayern, Berlin, Brandenburg, Hamburg, Mecklenburg-Vorpommern, Rheinland-Pfalz, Saarland, Sachsen, Sachsen-Anhalt, Thüringen (DE); Cantabria (ES); Keski-Suomi, Etelä-Savo, Pohjois-Karjala, Kainuu, Keski-Pohjanmaa, Lappi (FI); Île de France, Centre, Basse-Normandie, Nord - Pas-de-Calais, Franche-Comté, Pays de la Loire, Bretagne, Auvergne, Languedoc-Roussillon, Guadeloupe, Guyane (FR); Liguria, Abruzzo, Molise, Sicilia, Sardegna, Provincia Autonoma di Bolzano/Bozen, Provincia Autonoma di Trento, Emilia-Romagna, Umbria, Lazio (IT); Southern Netherlands (NL); Oslo, Akershus, Hordaland (NO); Mazowieckie, Slaskie, Podkarpackie, Dolnoslaskie, Kujawsko-Pomorskie (PL); Stockholms, Uppsala, Blekinge, Skåne, Hallands, Västerbottens (SE); Kharkiv (UA); Cornwall and Isles of Scilly, Wales, Northern Ireland, England (UK); Bulgaria; Ireland; Malta; Slovakia
4	35	Creative and entertainment activities, Libraries and cultural activities, and Sports and recreation activities	Creative and Leisure	Syddanmark, Midtjylland, Nordjylland (DK); Ipeiros, Peloponnisos, Notio Aigaio, Kriti (EL); Illes Balears (ES); Limousin, Corse, Réunion (FR); Lombardia, Basilicata (IT); Western Netherlands (NL); Hedmark, Oppland, Buskerud, Vestfold, Aust-Agder, Vest-Agder, Sør-Trøndelag, Nord-Trøndelag, Nordland, Troms, Finnmark (NO); Warminsko-Mazurskie (PL); Lisboa, Alentejo (PT); Örebro, Gotlands, Värmlands, Jämtlands, Norrbottens (SE); Kent, Scotland (UK)
5	35	Electricity, gas and steam; Water collection and treatment; Waste collection and treatment; and Other waste management services	Energy and Resources	Brussels-Capital Region (BE); Bremen, Hessen, Niedersachsen, Schleswig-Holstein (DE); Hovedstaden, Sjælland (DK); País Vasco, Comunidad Foral de Navarra, Aragón, Comunidad de Madrid, Castilla y León, Cataluña, Región de Murcia (ES); Etelä-Pohjanmaa, Pohjanmaa, Pirkanmaa, Helsinki-Uusimaa, Varsinais-Suomi (FI); Alsace, Poitou-Charentes, Rhône-Alpes (FR); Northern Netherlands (NL); Østfold (NO); Podlaskie, Pomorskie (PL); Nord-Est, Sud-Vest Oltenia (RO); Gävleborgs (SE); Cherkasy (UA); Northamptonshire (UK); Cyprus; Croatia; Hungary; Luxembourg

Table A2. Log population as control

Dependent variable:	Axes		Economic domains		Scientific domains		Policy objectives	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log population	0.473*	0.562**	-0.770	-0.400	-0.236	0.139	-0.800	-0.500
	(0.283)	(0.254)	(0.813)	(0.847)	(1.405)	(1.454)	(1.035)	(0.970)
GDP pc growth	-0.0701	-0.164	-0.355	-0.400	0.0637	-0.0211	-0.544	-0.592
	(0.138)	(0.110)	(0.396)	(0.356)	(0.635)	(0.616)	(0.386)	(0.410)
Unemployment rate	0.183***	0.0817	0.178	0.0892	0.661*	0.497	0.194	0.0919
	(0.0650)	(0.0533)	(0.166)	(0.174)	(0.348)	(0.304)	(0.189)	(0.202)
Log patents pc	0.479	-0.0590	1.912*	1.293	2.805	2.202	-0.616	-1.032
	(0.325)	(0.296)	(1.004)	(0.961)	(1.887)	(1.635)	(1.002)	(1.089)
Share of tertiary educated	-0.0526	-0.0275	-0.0774	-0.0408	0.203	0.213	-0.0336	0.00282
	(0.0366)	(0.0296)	(0.0976)	(0.0974)	(0.175)	(0.167)	(0.115)	(0.112)
Quality of Government	0.302	0.324	-3.582**	-3.222***	-3.218	-3.164	-1.568	-1.330
	(0.371)	(0.359)	(1.431)	(1.182)	(2.454)	(2.030)	(1.426)	(1.355)
W axes		0.450***						
		(0.0694)						
W economic domains				0.192***				
				(0.0712)				
W scientific domains						0.178**		
						(0.0761)		
W policy objectives								0.190**
								(0.0823)
Axes			2.486***	2.255***	3.980***	3.599***	2.456***	2.218***
			(0.218)	(0.237)	(0.403)	(0.416)	(0.279)	(0.275)
Constant	-3.715	-4.628	11.69	6.407	-11.18	-15.55	19.40	14.93
	(3.231)	(3.606)	(12.76)	(11.95)	(21.79)	(20.47)	(14.95)	(13.70)
Observations	168	168	168	168	168	168	168	168
R-squared	0.138		0.495		0.475		0.415	

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Dependent variables: number of S3 *axes* per region (columns (1), (2)); number of S3 *economic domains* per region (columns (3), (4)); number of S3 *scientific domains* per region (columns (5), (6)); number of S3 *policy objective* per region (columns (7), (8)). Models in columns (1), (3), (5), (7) are estimated with OLS, while SAR models in columns (2), (4), (6), (8) are estimated with MLE. Spatial weight obtained with row-standardised rook contiguity matrix.

Table A3. Control for sectoral specialisation

Dependent variable:	Axes		Economic domains		Scientific domains		Policy objectives	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Population density	-5.22e-05	-0.000317	0.000407	0.000131	-0.000817	-0.000793	0.000392	0.000337
	(0.000324)	(0.000268)	(0.000598)	(0.000866)	(0.00143)	(0.00148)	(0.00125)	(0.000986)
GDP pc growth	-0.200	-0.237*	-0.608	-0.541	-0.343	-0.268	-0.454	-0.416
	(0.146)	(0.121)	(0.414)	(0.396)	(0.685)	(0.683)	(0.453)	(0.454)
Unemployment rate	0.182***	0.0806	0.190	0.1000	0.659*	0.506*	0.200	0.0843
	(0.0611)	(0.0540)	(0.162)	(0.175)	(0.348)	(0.305)	(0.194)	(0.202)
Log patents pc	0.612**	0.115	1.782*	1.264	2.890	2.381	-0.834	-1.237
	(0.281)	(0.291)	(1.027)	(0.940)	(1.936)	(1.600)	(1.003)	(1.063)
Share of tertiary educated	0.00799	0.0221	-0.0255	-0.0108	0.352	0.320*	-0.0980	-0.0773
	(0.0407)	(0.0343)	(0.116)	(0.111)	(0.219)	(0.192)	(0.133)	(0.127)
Quality of Government	0.00109	-0.0671	-3.214**	-3.070***	-3.518	-3.557*	-1.035	-0.905
	(0.333)	(0.349)	(1.482)	(1.132)	(2.437)	(1.953)	(1.307)	(1.299)
Sectoral composition (Herfindhal Index)	-5.558**	-2.240	-12.99	-7.055	-16.20	-9.252	2.564	6.996
	(2.266)	(2.544)	(8.383)	(8.495)	(15.67)	(14.46)	(10.07)	(9.515)
W axes		0.438***						
		(0.0719)						
W economic domains				0.181**				
				(0.0734)				
W scientific domains						0.162**		
						(0.0780)		
W policy objectives								0.209**
								(0.0826)
Axes			2.407***	2.224***	3.884***	3.582***	2.448***	2.217***
			(0.226)	(0.235)	(0.401)	(0.411)	(0.275)	(0.271)
Constant	5.228***	3.599*	8.853	5.091	-6.132	-9.358	7.996	4.956
	(1.968)	(2.026)	(6.483)	(6.785)	(11.93)	(11.52)	(7.523)	(7.685)
Observations	168	168	168	168	168	168	168	168
R-squared	0.138		0.495		0.475		0.415	

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Dependent variables: number of S3 *axes* per region (columns (1), (2)); number of S3 *economic domains* per region (columns (3), (4)); number of S3 *scientific domains* per region (columns (5), (6)); number of S3 *policy objective* per region (columns (7), (8)). Models in columns (1), (3), (5), (7) are estimated with OLS, while SAR models in columns (2), (4), (6), (8) are estimated with MLE. Spatial weight obtained with row-standardised rook contiguity matrix.

Table A4. Robustness test – SAR model, all regions and countries in sample

Dependent variable:	Axes		Economic domains		Scientific domains		Policy objectives	
W:	Contiguity	Inv. dist.	Contiguity	Inv. dist.	Contiguity	Inv. dist.	Contiguity	Inv. dist.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
W axes	0.346*** (0.0575)	0.413*** (0.124)						
W economic domains			0.352*** (0.0609)	0.484*** (0.164)				
W scientific domains					0.472*** (0.0579)	0.616*** (0.184)		
W policy objectives							0.451*** (0.0610)	0.284 (0.214)
Constant	3.363*** (0.313)	3.596*** (0.443)	11.27*** (1.159)	11.39*** (1.966)	13.50*** (1.658)	14.33*** (3.138)	9.184*** (1.095)	12.76*** (2.277)
Observations	243	243	243	243	243	243	243	243

Standard errors in parenthesis. *** p<0.01, ** p<0.05, * p<0.1. Dependent variables: number of S3 *axes* per region (columns (1), (2)); number of S3 *economic domains* per region (columns (3), (4)); number of S3 *scientific domains* per region (columns (5), (6)); number of S3 *policy objective* per region (columns (7), (8)). Models are estimated with MLE. Spatial weight obtained with row-standardised rook contiguity matrix in columns ((1), (3), (5), (7)) and with inverse distance in columns ((2), (4), (6), (8)). The sample consists of the territories included in Table 2, plus all Scandinavian regions and non-EU territories with S3 strategies. In countries where only some regions have submitted a regional strategy, all regions that did not submit a strategy have been assigned the value of zero to axes and domains. For example, in the Czech Republic, where only Prague has submitted a regional strategy, all regions except Prague have been assigned the value of zero to axes and domain.

Table A5. SAR models by quartile of quality of government

Dependent variable:	Axes				Economic domains				Scientific domains				Policy objectives			
QoG quartile:	First	Second	Third	Fourth	First	Second	Third	Fourth	First	Second	Third	Fourth	First	Second	Third	Fourth
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
W axes	0.243**	0.312**	0.235	0.105												
	(0.115)	(0.143)	(0.183)	(0.128)												
W economic domains					0.336***	0.312***	0.207	-0.168								
					(0.120)	(0.121)	(0.183)	(0.163)								
W scientific domains									0.222*	0.343***	0.332***	0.0286				
									(0.132)	(0.123)	(0.124)	(0.168)				
W policy objectives													0.218*	0.339**	0.0948	-0.140
													(0.130)	(0.136)	(0.185)	(0.216)
Constant	4.656***	4.308***	5.037***	5.225***	14.56***	16.09***	14.57***	20.46***	22.33***	23.05***	18.52***	29.08***	17.01***	16.13***	15.56***	15.95***
	(0.522)	(0.605)	(0.733)	(0.582)	(2.516)	(2.502)	(2.120)	(2.489)	(3.975)	(4.215)	(3.870)	(4.119)	(2.648)	(2.719)	(2.346)	(2.349)
Observations	43	43	42	42	43	43	42	42	43	43	42	42	43	43	42	42

Standard errors in parenthesis. *** p<0.01, ** p<0.05, * p<0.1. Dependent variables: number of S3 *axes* per region (columns (1)-(4)); number of S3 *economic domains* per region (columns (5)-(8)); number of S3 *scientific domains* per region (columns (9)-(12)); number of S3 *policy objective* per region (columns (13)-(16)). Models are estimated with MLE. Spatial weight obtained with row-standardised rook contiguity matrix. The sample consists of the EU regions developing S3 strategies for which information on Quality of Government is available. First quartile of QoG: average QoG of -1.02; Second quartile of QoG: average QoG of -0.08; Third quartile of QoG: average QoG of 0.63; Fourth quartile of QoG: average QoG of 1.13.