Designing Smart Specialization Policy: relatedness, unrelatedness, or what?

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Abstract

A key objective of Smart Specialization Strategies (S3) is to stimulate related diversification in European regions, rather than unrelated diversification. This chapter will outline the pros and cons of S3 with a prime focus on either related or unrelated diversification. We argue it depends on the specific regional situation which type of S3 to pursue. While there are good reasons to promote related diversification in general, regions may become over-specialized or trapped in a low-complex economy that might warrant a S3 focus on unrelated diversification.

JEL codes: o25, o38, r11

Keywords: Smart specialization, related diversification, unrelated diversification, regional diversification, complexity

Introduction

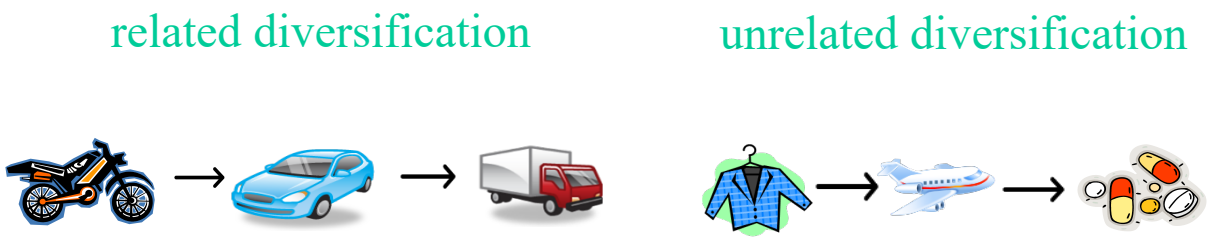
Form its very start, Smart Specialization policy aims to select and prioritize new domains in regions (Foray et al. 2009). Regions should focus on their own capabilities because they provide diversification opportunities but they also set limits to what can be achieved in this respect (Camagni and Capello 2013; Iacobucci 2014; Radosevic et al. 2017). S3 follows the basic principle that regions should not start from scratch when developing new domains (for example in AI) in which they have no relevant capabilities whatsoever. In particular, regions should target those domains in their S3 that could build on related variety (Frenken et al. 2007), as this would promote the cross-fertilization of knowledge and ideas across domains. In the EU guidelines for S3 design, explicit emphasis was put on relatedness as a key dimension to identify and choose future domains of specialization (Asheim et al. 2011; Foray et al. 2012; Boschma 2014; Valdaliso et al. 2014; Foray 2015; McCann and Ortega-Argilés 2015; Iacobucci and Guzzini 2016; D'Adda et al. 2019b; Santoalha 2019; Whittle 2020).

Scholars have also pleaded for S3 focusing on unrelated rather than related diversification, to avoid regional lock-in, and to promote radical change in regions (Frenken 2017; Grillitsch et al. 2018; Asheim 2019; Janssen and Frenken 2019). We outline and discuss the pros and cons of the two types of S3. We argue it depends on the specific regional situation whether S3 should purse related or unrelated diversification policy. While there are good reasons to promote related diversification in regions in general, regions may also become too specialized or trapped in a low-complex economy that might warrant a S3 focus on unrelated diversification. This will be further clarified by discussing S3 options of three stylized types of regions.

Related and unrelated diversification in regions

Broadly speaking, related diversification stands for a process of structural change in which a new activity (a technology, a job, an industry, a scientific field) draws on and combines capabilities that are related to existing local capabilities. A typical example is the rise of the car industry that built on relevant local capabilities in cycle making, coach making and engineering industries (Boschma and Wenting 2007). Region A in Figure 1 depicts a typical example of related diversification. This region is first specialized in motor bikes, moves into cars, and then diversifies into car trucks. Each time this region diversifies, it does not have to start from scratch but it can build on relevant local capabilities, engineering capabilities in this case. By contrast, unrelated diversification stands for a process of structural change in which a new activity builds on capabilities that are unrelated to existing capabilities. This would be the case when a textile region would diversify into aircraft making or pharmaceuticals, as illustrated by region B in Figure 1. Local capabilities in textiles are of no relevance whatsoever to build a new aircraft or pharmaceutical industry, so the required capabilities are unrelated to local capabilities in textiles. Each time region B diversifies, it has to create completely new capabilities and make new combinations that are unrelated to existing local capabilities.

Figure 1. Related and unrelated diversification in regions



Boschma et al. (2017) made a distinction between new activities that are new to the region and new to the world. New activities can be new to the region but not to the world. This may happen

either through related diversification (place dependence: replication) or unrelated diversification (no place dependence: transplantation). New activities can also be new to the world, either through related diversification (place dependence: exaptation) or unrelated diversification (no place dependence: saltation). The latter two involve activities that rely either on local capabilities that are related (in the case of exaptation), or they build on newly created capabilities and make new combinations that did not exist before (saltation).

There is consensus that related diversification is much more common than unrelated diversification (Boschma 2017). Theoretically speaking, this makes sense, as it is relatively easier and less costly to diversify into new activities that can leverage relevant regional assets (Balland et al. 2019). The evolutionary literature in economic geography has provided a solid theoretical framework that builds on concepts like bounded rationality, local search, branching, proximities, path dependence and institutions to understand the diversification process and the development of new growth paths in regions (Boschma and Frenken 2006; Martin and Sunley 2006; Frenken and Boschma 2007; MacKinnon et al. 2009; Pyke et al. 2009; Martin 2010).

Empirical studies have shown that regional diversification is driven by the principle of relatedness, using a range of (quantitative and qualitative) methods and relatedness measures, and applying it to different spatial scales, time periods and spatial contexts (Boschma 2017; Hidalgo et al. 2018). Most studies have focused on the Global North but to an increasing extent also on the Global South (Guo and He 2017; Zhu et al. 2017; He et al. 2018; Alonso and Martín 2019; He and Zhu 2019). This principle of related diversification has been demonstrated for the entry of new industries (Neffke et al. 2011; Essletzbichler 2015; Xiao et al. 2018), jobs (Muneepeerakul et al. 2013; Farinha et al. 2019), export products (Guo and He 2017; Alonso and Martín 2019), scientific fields (Boschma et al. 2014; Guevara et al. 2016) and technologies

(Kogler et al. 2013; Boschma et al. 2015; Rigby 2015), including nano-technologies (Colombelli et al. 2014), bio-technologies (Boschma et al. 2014), green technologies (Montresor and Quatraro 2019; Corradini 2019), renewable energy technologies (Li 2020) and fuel cell technologies (Tanner 2016).

There seems to be consensus in the scientific literature on these findings on related diversification in regions (Boschma 2017). Cases of unrelated diversification have also been reported in studies using both quantitative methods and qualitative case studies, though they occur less frequently (Coniglio et al. 2021; Pinheiro et al. 2021a).

Related diversification and S3 policy?

Where opinions tend to diverge to some extent is what kind of policy implications could be derived from this empirical body of literature on related regional diversification. From the very beginning, the EU guidelines for S3 design prescribed that relatedness should be a key criterion when regions select and target new domains (Foray et al. 2012; Boschma and Gianelle 2014; Foray 2015; McCann and Ortega-Argilés 2015; Iacobucci and Guzzini 2016; Balland et al. 2019; D'Adda et al. 2019a; Marrocu et al. 2020; Kramer et al. 2021). However, some scholars have also pleaded for a S3 policy focusing on unrelated diversification (Morgan 2017; Grillitsch et al. 2018; Asheim 2019; Janssen and Frenken 2019), while Balland et al. (2019) proposed a S3 framework differentiating between 4 types of policy based on the concepts of relatedness and complexity, of which two policies focused on related diversification and the other two focused on unrelated diversification. Below, we compare and discuss the pros and cons of S3 with a prime focus on either related or unrelated diversification respectively.

S3 policy based on related diversification

A related diversification strategy aims to identify and target new activities in regions that show a high degree of relatedness with existing local activities. This identification process can be done using a combination of quantitative and qualitative approaches. Quantitative approaches have, for example, identified diversification opportunities of regions by making use of relatedness metrics (e.g. Balland et al. 2019). Qualitative analyses have been inspired by the entrepreneurial self-discovery process (Rodrik 2004; Foray et al. 2011) in which diversification opportunities of regions are identified by a wide range of local stakeholders while accounting for local strengths (Boschma and Gianelle 2014)[1].

Proponents would argue such S3 policy is likely to be effective, as it builds on and exploits existing capabilities the region is already familiar with. When new activities are embedded in and related to local capabilities, they have a higher survival rate, for which there is strong evidence, but empirical evaluations of related diversification policies do not yet exist. Balland et al. (2019) also showed it may be an effective way to enhance the complexity of activities in a region. They demonstrated that diversification in complex technologies is generally very hard for regions to accomplish, unless regions build on local related technologies. Rigby et al. (2021) showed that this may also pay off economically. They found that European regions that diversified into related and more complex activities in the period 1981 to 2015 showed on average higher economic growth in terms of GRP and employment growth.

This all requires a S3 policy that facilitate this process of related diversification. Conventional market and system failures may prevent related diversification to take place (Hausmann and Rodrik 2003; Rodrik 2004; Frenken 2017). This would imply that policy should aim to take away bottlenecks that impede related diversification to occur. This policy could focus on

[1] Foray (2019) claimed that the entrepreneurial discovery process is not needed in the selection of priorities.

entrepreneurship, education, research, institutions et cetera to ensure the new capabilities required are created, and the available (related) diversification opportunities are exploited. This requires a serious policy effort. A classic example is the rise of the car industry in the late nineteenth/early twentieth industry that emerged out of related industries like bicycle making, coach making, and engineering (Boschma and Wenting 2007). These related industries provided capabilities on which the car industry could build, but equally important were the many institutional changes and policy efforts needed in order to build up new infrastructure and legitimation, like road infrastructure, traffic laws and regulations, new social norms and habits, new media, trade regulations, et cetera (Hannan et al. 1995; Boschma 1997).

However, one may criticize such a S3 focus on related diversification for a number of reasons. First, such policy has been described as essentially conservative, focusing on less radical change and not moving the technological frontier, and merely serving vested interests and big players (Janssen and Frenken 2019). Second, related diversification has a tendency to make regions more specialized which could increase the risk of running out of diversification opportunities and ending up in a lock-in state (Neffke et al. 2011; Frenken 2017). This lack of diversity would also make regions less resilient over time (Boschma 2015). This can be further illustrated by region A in Figure 1 where the related diversification process has made this region depend on engineering capabilities to an increasing extent. These are rooted in rather outdated technologies which makes the region vulnerable to radical changes, such as new technologies in computing and electronics that are transforming the car industry (electric cars, self-driving cars). Related diversification policy is likely to reinforce this lock-in process, making it even worse. Third, there is an implicit assumption that related diversification happens almost automatically because it is easier to achieve. In that context, there is no strong rationale for a related diversification policy. Fourth, S3 policy on related diversification might not be an

option for regions trapped in low complex activities. This is the case when opportunities for related diversification are restricted to low complex activities (Pinheiro et al. 2021b), as is the case in some old industrial regions like Detroit. Such policy focusing on related diversification in low complex activities might not be sustainable in the long run, and has therefore been dubbed as 'low road' policy by Balland et al. (2019).

S3 policy based on unrelated diversification

Some scholars have proposed a kind of S3 that promotes unrelated diversification (Grillitsch et al. 2018; Asheim 2019; Janssen and Frenken 2019). It is crucial to note this policy does not completely start from scratch, as it still takes local capabilities as point of departure. If not, it would violate the core principle of S3 that departs from local capabilities as key input. This type of S3 aims to develop new growth paths by combining local capabilities that are unrelated. For Grillitsch et al. (2018), unrelated knowledge combinations provide a potential source of new path creation that is embedded in local resources and competences. Janssen and Frenken (2019) focus on creating linkages between unrelated industries that are strongholds (i.e. specializations) in a region. Although local players build on existing capabilities to make such new combinations, there is no previous experience in making these combinations, and the unrelated industries do not share similar capabilities (e.g. high cognitive distance).

Various reasons may be put forward to justify such a focus of S3 on unrelated diversification. First, risks of lock-in might favor a type of policy intervention that aims to prevent or to overcome such a state of regional lock-in (Hassink and Gong 2019). For the economic development of regions in the longer run, unrelated diversification might therefore be needed (Coniglio et al. 2021). This has led to calls for policy support for radical change and the development of completely new trajectories in regions. This also resonates to some extent the

literature on middle-income traps that advocates an active role of public policy to support countries to make jumps to escape such a trap (Alshamsi et al. 2018; Hartmann et al. 2020). Second, related diversification is often thought to take place anyway because it is very common. This is unlike unrelated diversification which happens only now and then. Apparently, unrelated diversification is not easy to accomplish in practice, and this may justify government support. Third, unrelated diversification requires the build-up of completely new capabilities in terms of knowledge, skills and instititions (Neffke et al. 2018). This requires collective action and experimentation in which policy is bound to play a major role, due to fundamental uncertainty (Hausmann and Rodrik 2003). One example is policy interventions that aim to bridge the cognitive distance inherent in unrelated combinations which would remain unexploited otherwise (Janssen and Frenken 2019).

However, one could also mention a few cons attached to such a policy focus on unrelated diversification. First, there is a high risk of policy failure (also attached to the need for policy experimentation) when regions have to start almost from scratch, and when there is little experience to build on. Second, there is a serious information problem, as there will be long lists of unrelated diversification opportunities in regions from which it is hard to choose. It might be close to impossible to assess and compare the economic potential of each of those (Janssen and Frenken 2019). Third, unrelated diversification policy may run the risk of creating cathedrals in the desert that are not embedded in the region. The latter has often been mentioned as a typical policy failure in the past when industries were encouraged to locate in peripheral regions where they had little connections with the surrounding local economy, and with no significant spillovers as a result. Such unrelated diversification policy turned out not to be very effective especially in lagging regions where local firms lack absorptive capacity, local people have simple skills, and local institutions are considered to be rather weak (Karo and Kattel

2015; Rodríguez-Pose and Wilkie 2015). Fourth, there might be a serious risk of duplication in unrelated diversification policy, because it is not unlikely that regions go for the same when priorities are not fully embedded in the region-specific context. This tendency may be reinforced in a context when 'missions' and 'grand societal challenges' are popular drivers of regional policy. Fifth, empirical research has shown it is easier for regions to increase the level of complexity of their economies through related rather than unrelated diversification (Balland et al. 2019). Moreover, Rigby et al. (2021) has shown that regions in Europe show higher economic growth when diversifing into related and complex activities, as compared to regions that diversify into unrelated and complex activities. Sixth, in principle, one can diversify in unrelated activities through smaller steps based on related diversification. In other words, a region could diversify gradually from bananas to computers through a product space or tech space through many small steps, each time building on local capabilities. So in principle there is no radical transformation needed to move into something completely different, as this can be achieved by related diversification in smaller steps. There is no *apriori* reason why related diversification cannot avoid regions to get caught in one specialization or to end up in a lock-in (Hidalgo et al. 2018). Seventh, there is increasing evidence that new path creation is not necessarily associated with unrelated diversification (Van den Berge et al. 2020; Santoalha and Boschma 2021). These papers show that green diversification in regions is enhanced by related capabilities, even from local capabilities related to existing dirty activities. In other words, it is possible to move into a completely new regional path (in this case from dirty to green) through related diversification. This is further confirmed by Boschma et al. (2021) who showed that technological breakthroughs (so the most radical ones) primarily make related combinations, besides unrelated combinations. So, radical change often turns out to rely on relatedness to a considerable degree. And nineth, there is a strong assumption implicit in unrelated diversification policy that related diversification would happen anyhow (Frenken 2017).

Although research points out that related diversification is more common, in practice, by far, most diversification potentials in regions are not realized. What studies on regional diversification tend to share is the general outcome that the number of actual entries in related activities is far lower than the level of potential entries in related activities in regions. Moreover, there also exists no empirical study to date that has identified how many times related diversification has failed in practice. But we can think of many plausible reasons why regions might fail to diversify into related activities, such as lack of supportive laws and regulations, a poor entrepreneurial culture, restrictive social norms, weak university-industry linkages, a lack of (risk) capital investment, limited labour mobility, et cetera.

S3 policy: relatedness, unrelatedness, or what?

The foregoing has outlined pros and cons attached to both types of policies. So what to conclude, what makes more sense: S3 with a prime focus on related or unrelated diversifcation? There is no easy answer here. For sure, a full answer is impossible to give with the current state of knowledge: systematic evidence at the sub-national scale is simply missing. To start with, there is no strong evidence yet which type of policy works better. There is little systematic information whether related or unrelated diversification in regions has been enhanced by systematic policy action. There are no studies on regional diversification to date that have controlled for all kinds of policy actions. Moreover, as the key objective of S3 is unleashing structural change in regions, and structural change takes long to unfold, it is just too early to tell, as S3 began to be implemented only from 2014 onwards (Foray 2019).

Nevertheless there are studies that have made the first empirical assessments. On the one hand, studies have focused on the question whether local institutional governance structures have improved (Capello and Kroll 2016; Kroll 2015, 2017; Moodysson et al. 2016; McCann et al.

2017; Sotarauta 2018; Aranguren et al. 2019; Gianelle et al 2019; Trippl et al. 2020; Fratesi et al. 2021). Kroll (2017), for instance, identified different planning and governance cultures in different parts of Europe that had consequences for the rate and nature of S3 implementation. On the other hand, scholars have examined whether the priorities set in each S3 reflect or mirror the profiles or potentials of regions (McCann and Ortega-Argilés 2016; D'Adda et al. 2019a,b; Di Cataldo et al. 2020; Marrocu et al. 2020; Pagliacci et al. 2020; Deegan et al. 2021; Pavone et al. 2021). The latter type of studies have done so very differently. McCann and Ortega-Argilés (2016) found that selected priorities by countries and regions in Europe varied considerably, in line with the basic principle that S3 should be region-specific. D'Adda et al. (2019b) concluded that technological priorities set by Italian regions fulfilled the basic requirement of S3 to a considerable degree, in the sense that they had chosen a narrow set of activities which also reflected more or less their technological capabilities. Di Cataldo et al. (2021) were less optimistic, finding that S3 are often detached from the economic conditions of regions, and that regions are inclined to copy S3 of their neighbours. Trippl et al. (2020) also found that the types of priority setting differed between types of regions. They found that less developed regions had a tendency to set a large number of broad priorities that are also likely to strengthen well established local activities. Other studies looked at the extent to which relatedness has been accounted for in S3. Iacobucci and Guzzini (2016) found Italian regions did not consider relatedness of technological domains in their S3 documents. Still, D'Adda et al. (2019b) found that the choices made by Italian regions more or less showed a significant level of relatedness. In a study of European regions by Marrocu et al. (2020), this was true to a lesser extent: "overall, regions have not selected sectors highly associated with their current specialization or closely related to it, indicating a limited potential for S3 to activate successful growth trajectories that leverage existing capabilities" (p. 1). Deegan et al. (2021) used the S3 framework of Balland et al. (2019) to examine whether the S3 of regions mainly in Southern

and Eastern Europe accounted for complexity besides relatedness when looking at their priorities. They found that "while regions are more likely to select complex economic domains related to their current economic domain portfolio, complexity and relatedness figure independently, rather in combination, in choosing priorities" (p. 1). Interestingly, Kramer et al. (2021) also looked at the extent to which expenditures in ERDF funded R&I projects reflected the selected priorities in S3. Other studies looked at the possible impact of R&D subsidies on technological diversification in regions. Uhlbach et al. (2017) examined the EU Framework Programmes and concluded that R&D subsidies had the highest impact when relatedness with the new technology was not too high nor too low. Mewes and Broekel (2020) found that joint R&D subsidies enhance related technological diversification in regions in Germany, and sometimes facilitate unrelated diversification.

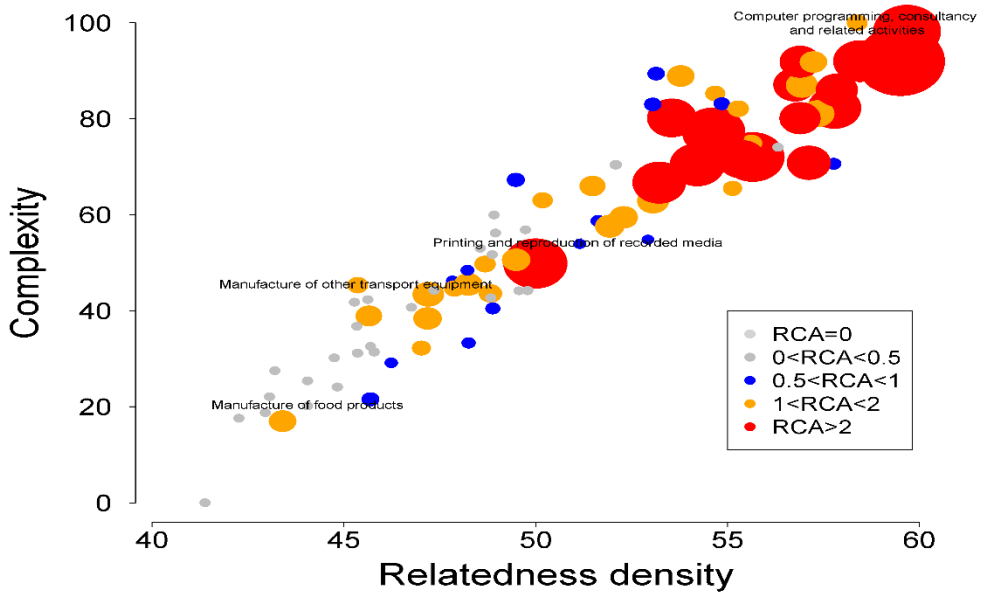
Not a question of either or

In the remainder, I will argue it is not a matter of S3 focus either on related or unrelated diversification, but that this choice depends on the region-specific context. I will clarify this by discussing S3 options for three stylized types of regions, following the typology proposed by the seminal work of Tödtling and Trippl (2005): major urban regions, old industrial regions, and peripheral regions. Peripheral regions are a key category to focus on in particular, as scholars have raised serious concerns whether S3 might be effective in such regional setting (McCann and Ortega-Argilés 2013, 2015; Morgan 2015; Sörvik et al. 2019). I tend to deviate from Foray (2019, p. 2075) who argued it makes sense to implement S3 in 'intermediate regions', but not in the 'less advanced regions' (lacking entrepreneurial and institutional capacities) and also not in the 'most advanced regions' (having many opportunities). When discussing the three types, one has to remind these are presented as ideal types for heuristic

reasons, while in practice, there might be huge variations within each type, like a peripheral region in Norway is very different from a peripheral region in Bulgaria in many respects.

S3 based on related diversification seems to be preferable for the many reasons mentioned previously. Major urban regions tend to have many opportunities to move into more complex activities (Balland and Boschma 2020). This is illustrated for the case of the Paris region in Figure 2. The figure shows potential entries of industries which are all industries represented by the grey and blue dots in which the Paris region has no Relative Comparative Advantage (i.e. RCA<1). Each of these potential entries score high or low on relatedness density (high relatedness with local activities) and complexity (high potential economic returns). The figure shows that potential entries are clearly in more complex industries, rather than less complex industries. The Paris region is blessed with a positive relationship between relatedness density and complexity. The same story holds for potential entries in new technologies (Balland et al. 2019) and new professions (Balland and Boschma 2020). Apparently, Paris has high potentials to diversify into complex activities, no matter whether these concern industries, technologies or occupations. Pinheiro et al. (2021b) showed that high-income regions like Paris not only have the highest levels of potential entries but also the highest levels of actual entries in more complex activities, because they can build on related activities (relevant capabilities) to do so.

Figure 2. Diversification opportunities in new industries in major urban region of Île-de-France

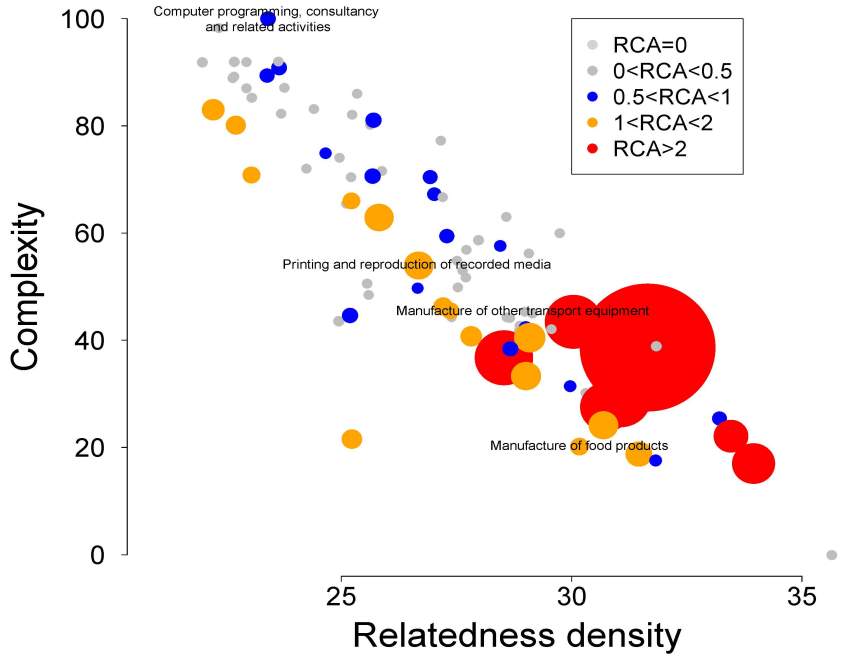


Source: Balland and Boschma 2020, p. 14

The case of old industrial regions is a very different story. These concern a large group of regions in the Rustbelts of the US and Europe that used to belong to the most prosperous regions but have fallen behind in the last decades due to decline of their main specializations. A key problem of many old industrial regons is that the best diversification opportunities are often found in low, not in high complex industries (Balland and Boschma 2020). This can be illustrated in Figure 3 where the diversification opportunities of the Polish region of Silesia are defined in terms of relatedness and complexity. For this type of regions, Balland and Boschma (2020) often found a negative relationship between relatedness and complexity such as the one shown in Figure 3. The highest diversification potentials are in low, not in high complex industries. The same story holds for potential entries in new technologies (Balland et al. 2019) and new professions (Balland and Boschma 2020). While this might reflect a general pattern, related diversification might still be a realistic option for old industrial regions. There may be opportunities to break out of lock-in or to leave behind old specializations through related diversification. Old industrial regions might even have the opportunity to break out of their

low-complexity trap, and diversify into related activities that make their economies more complex. It is up to systematic empirical research to identify those.

Figure 3. Diversification opportunities in new industries in the old industrial region of Silesia

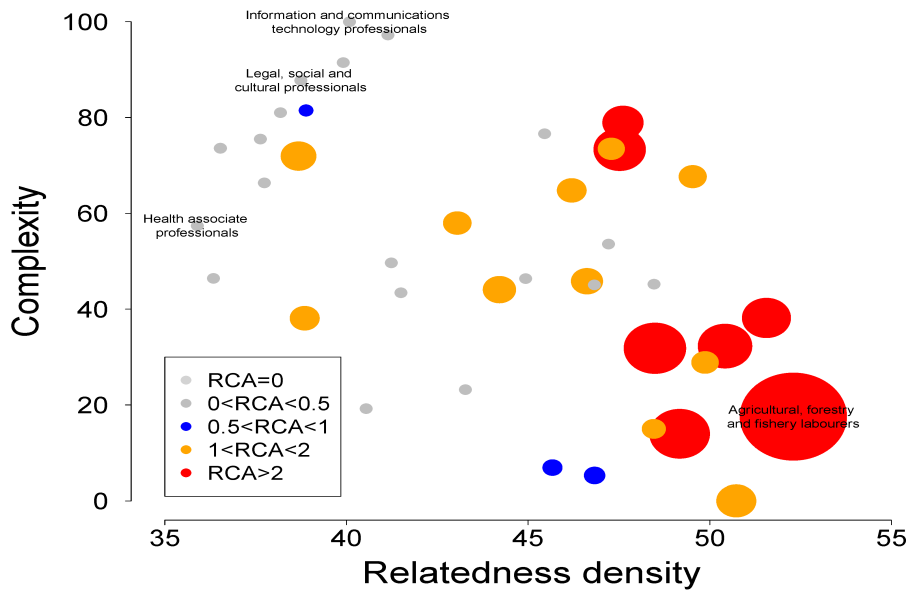


Source: Balland and Boschma 2020, p. 14

The case of peripheral regions is yet another one. Studies have shown these lower-income regions have a tendency to diversify in activities related to their own activities to a greater extent than higher-income regions (Boschma and Capone 2016; Petralia et al. 2017; Xiao et al. 2018). At the same time, many of these regions (like in Southern and Eastern Europe) have a general low average score on relatedness density as far as technologies are concerned, which means there are not too many opportunities of related technological diversification (Balland et al. 2019; Kramer et al. 2021). And although related diversification might still offer some opportunities to develop new activities, it is also quite likely that lagging regions run the risk of being trapped in a low-complexity state. For sure, these low-complex regions will have a hard time to diversify into high-complex activities. This is clearly demonstrated by Pinheiro et

al. (2021b) who observed that low-income regions have diversification potentials primarily in low-complex activities. The potential of peripheral regions to diversify is often quite limited (Balland and Boschma 2021). This tends to be more true for technologies than occupations. Indeed, Figure 4 shows the peripheral region of Extremadura shows some diversification potentials in new occupations (with RCA lower than 1), and sometimes even in complex ones.

Figure 4. Diversification opportunities in new occupations in peripheral region of Extremadura



Source: Balland and Boschma 2020, p. 13

So, while S3 based on related diversification seems to be preferable, this is not to say that S3 based on unrelated diversification is not needed now and then. I will argue there are indeed cases where such S3 policy will make absolutely sense. First of all, if countries would like to develop more radical breakthroughs and unrelated diversification, empirical studies tend to show that major urban regions are the places to be (Mewes 2019; Boschma et al. 2021). Local conditions that favour unrelated diversification are found primarily in major urban regions, such as related and unrelated variety (Castaldi et al. 2015), the best research and innovation

infrastructure (Xiao et al. 2018) and inter-urban connectivity (Balland and Boschma 2021)[2]. Second, as demonstrated before, old industrial regions are often trapped into a trajectory from which it was hard to get out (Grabher 1993; Hassink 2005). Boschma and Balland (2020) have shown that old industrial regions tend to show a negative relationship between relatedness and complexity as far as potential entries are concerned. Thus, their highest diversification potentials are in simple, not complex activities, as the example of Silesia in Figure 3 illustrated. If the objective of S3 is to make such regions more complex, the only way out of such a trap could be through strong policy intervention enhancing unrelated diversification. Third, peripheral regions may find themselves trapped in 'low complexity' economies as well. This is the case when their diversification opportunity space is only in low, rather than high complex activities. In those circumstances, the only way out of such trap is to make a sort of jump which is unlikely to happen as existing local capabilities are not of immediate relevance, and other factors enabling unrelated diversification are not in place (Boschma 2017). To escape from this low complexity trap in these circumstances requires a serious and concerted policy effort.

This emphasis on complexity traps is related to a much wider literature that focuses either on middle-income traps or lock-in processes. The literature on middle-income trap is big (Gill and Kharas, 2007; Kharas and Kohli, 2011; Lee 2013; Doner and Schneider 2016; Glawe and Wagner 2016; Vivarelli 2016; Agénor 2017; Bresser-Pereira et al. 2020). It describes the situation of emerging countries that managed to develop and grow rapidly till some point but are unable to grow any further and compete with high-income countries. Due to the rise of labor and other costs, it becomes hard for them to retain their competitiveness in labour-intensive industries in mature technologies and compete with low-income countries on the one

[2] This is not to say that breakthroughs and unrelated diversification do not happen outside major urban regions. Fritsch and Wyrwich (2021) show that major innovations also occur outside major urban agglomerations, challenging the 'urban bias' on innovation (Shearmur 2012; Shearmur and Doloreux 2016).

hand, while they lack strong capabilities to enter new knowledge-intensive industries and compete with the most advanced regions on the other hand (Kharas and Kohli 2011). The reason why middle-income traps happen at the country-level has been attributed low human capital accumulation, an inadequate advanced infrastructure, limited access to finance, weak institutions, among other factors (Lee 2013; Agénor 2017). Doner and Schneider (2016) argue it is difficult to escape a middle-income trap because of the poor ability of countries to promote effective public intervention and implement required institutional change. Aghion and Bircan (2017) provided a Schumpeterian perspective of the middle-income traps by focusing on institutional structures that support or inhibit a country to move into a new growth paths. These latter views adopted evolutionary approaches in which the middle-income trap is more strongly associated with institutional factors and path dependencies of trajectories.

At the sub-national level, there are only few studies inspired by the middle-income trap literature. Iammarino et al. (2020) introduced the notion of development traps to identify two types of regions in Europe that are facing hard economic times, or run the risk of ending up in such trap, as shown by prolonged low growth rates in GRP per capita, productivity and employment. The first type of regions concern low-income regions that experienced sustained growth but got stuck at some point of time. The second type of regions concern old industrial regions that once belonged to the wealthiest regions in Europe but have been losing manufacturing activities for decades. In both cases, the determinants of the trap are associated with low quality of production factors (Iammarino et al. 2020).

Another branch of literature on traps is the regional lock-in literature linked to path dependency developed in the 1980s and 1990s (Arthur 1989, 1994). In economic geography, it has been applied almost exclusively to describe the lack of adaptability of old industrial regions (Grabher

1993; Boschma and Lambooy 1999; Hassink 2005, 2010; Martin and Sunley 2006; Pyke et al. 2009; Martin 2010; Evenhuis 2016). Following Grabher (1993), this literature drew inspiration from evolutionary, institutional and network science, and identified different dimensions of lock-in, such as cognitive, economic and institutional lock-in. Many case studies have described how these lock-in mechanisms make that old industrial regions are trapped in a long-term process of structural economic decline (Hassink 2007; Evenhuis 2016).

Recently, the EEG literature has put a new dimension to this literature on traps making use of the notions of relatedness and complexity to argue that countries and regions may get stuck into a low complexity trap (Pinheiro et al. 2021b). Only few countries have managed to overcome that, like Ireland and Taiwan (Hartmann et al. 2021). Adopting a capability approach and using the relatedness framework, an effort is made to identify what are diversification opportunities of regions, given the capabilities regions have accumulated in the past. Pinheiro et al. (2021b) looked at that at the regional scale and identified diversification potentials of regions with varying income levels (low, middle, high). What they found is that many low-income regions have diversification potentials primarily in low-complex activities, while high-income regions have diversification potentials primarily in high-complex activities. This implies that two types of regions are trapped: (1) low-complex regions have a hard time to diversify into high-complex activities (with higher economic returns). They are trapped in 'low complexity' economies: the only way out is to make a sort of jump which is unlikely to happen as local capabilities are not of immediate relevance. This refers to the category of peripheral regions discussed before. (2) medium-complex regions are nor close to complex nor to simple activities. This means that to some extent they are out of the low-complexity trap (their opportunity space is not anymore in simple activities only) but they still have to make jumps to move in complex activities, as relevant capabilities are not present. This group may come

closest to middle-income trap regions, with similar challenges. The only category of regions not trapped are high-income regions: they can diversify more easily in complex activities, building on existing capabilities. The latter corresponds to our category of major urban regions.

Some concluding remarks

What can we conclude? The main take-away message is that S3 should take as point of departure the region-specific situation before setting priorities.

First, we suggested S3 should promote related diversification in regions where such opportunities have been identified. Both quantitative and qualitative research tools have been developed to make feasible this identification process. Second, we argued that some sort of S3 with a focus on unrelated diversification might be needed in situations when regions appear to be locked in or trapped. This requires a thorough study of any possible traps that might warrant such S3. Despite many publications on regional lock-ins and traps, we feel appropriate tools are still missing to identify systematically the presence of lock-ins and traps at the sub-national scale. What do we mean by a trap, and how can we identify it systematically? Third, we argued it would be quite misleading to present related and unrelated diversification as opposites and mutually exclusive categories. In practice, regional diversification will be more a matter of degree (Boschma 2017). The overwhelming majority of combinations breakthrough inventions make are between related technologies, and radical breakthroughs rely in practice on both related and unrelated combinations (Boschma et al. 2021). This should not be ignored in the implementation of S3. Fourth, we argued it is still too early to tell which type of policy would work better. We have little information whether related or unrelated diversification in regions has been enhanced by policy action. Furthermore, studies on S3 have investigated whether the priorities set in S3 in regions reflect their opportunities to grow and diversify. What is still

missing is empirical evidence showing which type of S3 is more successful. Moreover, the actual implementation of S3 has remained a kind of blind spot (Matti et al. 2017; Marques and Morgan 2018; Gianelle et al. 2019). Finally, the discussion on S3 focusing either on related or unrelated diversification should also take on board the role of inter-regional linkages (Radosevic and Stancova 2018; Boschma and Balland 2021). This is considered to be an essential part of S3 and should therefore be given full consideration when designing an effective smart specialization policy (Iacobucci and Guzzini 2016; Uyarra et al. 2018) that promotes either related or unrelated diversification in regions (Boschma and Balland 2021).

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