DOES GEOGRAPHICAL PROXIMITY MATTER FOR INNOVATION? THE CASE OF EUROPEAN REGIONS

Francesco P. Appio[1], Antonella Martini[2], and Valentina Brescia[2]

[1] Pôle Universitaire Léonard de Vinci, France

[2]University of Pisa, Italy

francesco.appio@devinci.fr

ABSTRACT

The increasing globalization, challenges for the competitiveness, and resources prioritization are among the causes forcing the European (EU) regions to rethink their overall approach to regional economic development. To deal with such a complexity, EU policy makers deployed a program called Smart Specialisation Strategies (SSS) which aims at consolidating the sources of regional competitive advantage by making effective and efficient use of public investment in R&D. By promoting SSS, national and regional governments are attempting to enhance the competitiveness of firms and clusters. Then, the study of clusters along with their evolutionary and spatial dynamics is put on top of the agenda of EU policy makers. To better understand the determinants of clusters in Europe we first, investigate the role played by technological specialization and diversification; second, find empirical evidence to whether the link between geographical proximity and regional innovation activity exists; finally, explore the co-existence of cluster dynamics and the deployment of SSS.

Keywords*: regional innovation systems, geographical proximity, patent.*

1. INTRODUCTION AND MOTIVATION

The European countries in recent years are going through an era in which the globalization is transforming the relationships between states and markets, the dynamicity of the environment makes increasingly difficult to stay competitive, and economic resources (especially from public bodies) are shrinking and need both rationalization and prioritization. In this context, regions are forced to rethink their overall approach to regional economic development (McCann and Ortega-Argilés, 2015). As a consequence, topics like regional clusters and their evolutionary dynamics occupy a central place in the debate of policy makers (European Commission, 2013).

The present study meets the need to deepen and investigate the spatial structures of innovation, exploring the existing regional clusters in Europe and their dynamics. Results can be exploited to improve the model of 'Smart Specialization Strategies' (SSS) promoted by the European Commission to consolidate the sources of regional competitive advantage by making effective and efficient use of public investment in R&D (Foray, 2013).

To better understand the determinants of clusters in Europe, a systematic study is needed in order to: first, investigate the role played by technological specialization and diversification (Frenken et al., 2007); second, finding empirical evidence to whether the link between geographical proximity and regional innovation activity exists (Boschma, 2005; Delgado et al., 2010); finally, exploring the co-existence of cluster dynamics and the deployment of SSS strategies (European Commission, 2013).

2. BACKGROUND

2.1 THE ORIGIN OF THE SMART SPECIALISATION STRATEGY CONCEPT

The SSS concept has been formalized for the first time by a group of scholars named ‘Knowledge for Growth,’ that was investigating the productivity gap between USA and Europe. The results of their comparative analyses suggested that the main cause was a lack of prioritization in the innovation policies that was affecting, with different magnitudes, all European regions. They revealed the latter had the propensity of spreading the investments across several research fields, e.g. a bit of Biotechnology, a bit of ICT and a bit of Nanotechnology, without any form of prioritization and consequently with few chances to have a relevant impact in one of these. Every type of priority and specialization was largely rejected due to the strong conformity that has characterized innovation policy research over the last decade; pursuing an ‘horizontal’ and ‘neutral’ policy was considered the best strategy to avoid wrong choices or market distortions (Foray, 2013).

After the years of economic crisis and the resulting reduction of resources available for R&D investments, SSS has immediately gained momentum representing an important chance for a progressive economical restart. In order to develop a policy-prioritization logic to foster regional growth it is important to have a deep knowledge of the potential evolutionary pathways related with the existing dynamics and the structures at regional level (McCann and Ortega-Argilès, 2015). Accordingly, each region should start this process using as standpoints the knowledge-based sectors in which already presents a consistent ‘critical mass’ or, at least, capabilities that refer to a future potential exploitable with right and focused investments.

A decisive difference with previous conceptualizations of Regional Innovation Systems concerns the actual applicability of this approach to the less-developed regions as well; SSS cannot be prerogative for developed regions and technology leaders only. The foundation is that every region has chances to identify productive and potential beneficial activities.

Starting from this premise, Foray (2013) suggests that the less-developed regions could invest in the co-invention of applications (e.g., adopting some ICTs) aimed at improving the efficiency and productivity in one of the few sectors of their economies. This brings an immediate return and, at the same time, involves a great deal of R&D for understanding and embedding knowledge-driven activities. Advancing this idea, Foray (2013) underlines the need to overcome the principle of a sharp division of labour between ‘knowledge producers’ and ‘knowledge users’, building a process of knowledge exchange for creating and empowering a knowledge-based economy in all EU regions.

Concerning the relevance of the SSS concept, parallel to the aforementioned economic crisis, it is also noteworthy the strong influences of the globalized context on the trajectories of regional development. Indeed, the increasing competitiveness of international markets is pushing towards a progressive evolution of industrial organization paradigms with a shift from a ‘standardized’ production to a ‘flexible’ one, which is becoming a precondition for the firm’s survival. In this scenario the influence of Multinational Enterprise (MNEs) has risen. With their investments, they greatly influence the economic development at different levels. In particular, MNEs interface directly with the various realities at local level, bypassing the single nations. Cantwell and Vertova (2004) stress that MNEs tend to tap into regional profiles of specialization, which are the result of accumulated technological competence and expertise of the host country and by doing so, they tend to support the process of technological concentration.

Therefore, the importance of local specificities has increased rather than being marginalized in a globalized context and functional economic integration: development processes unfold at local level and globalization reinforce this pattern, stimulating the regional concentration. Thus, Globalization represents one of the drivers of the increased need to take into account the regional peculiarities; understanding the particular local dynamics is fundamental in order to develop the right policies for fostering growth and regional competitiveness.

Some scholars underline that in the recent past the traditional growth policies have paid little or no attention to forces and features such as agglomeration, physical distance, learning, innovation; also, institutions appear no longer adequate to respond to economic development needs of regions in an era of increasing globalization.

Frequently, R&D investments have been bestowed with a top-down procedure, copying the most common best practices and choosing a "standard technology mix", not focusing on those cores for the territory. This has been one of the main causes of failure and inefficiency for such types of policies (Toedtling et al., 2005).

Nowadays the formula 'one-size-fits-all' is no longer applicable. Innovation policies must be tailored at regional level and performing solutions need as a precondition a clear understanding of the regional knowledge base advantages in order to exploit the current and future potential. This last point is one of the main distinctions between the SSS approach and some older innovation policies that centralized all the decisions about priorities and investments without involving the leading actors at local level (i.e. experienced entrepreneurs, universities, research centers).

2.2 VARIETY VERSUS SPECIALISATION

The SSS guidelines use the term 'Specialized Diversification' for defining the process of knowledge-based growth through a technological diversification which starts from technologies and services embedded in the regions. This directs attention to the concept of 'technological relatedness' and the importance of links between sectors to foster innovation and growth (McCann and Ortega-Argilès, 2015).

Jacobs (1969, p.59) is considered as the forerunner of this idea, underlying the relevance of industrial 'diversity' within a region for boosting innovation and growth: "the greater the sheer number of and variety of division of labour, the greater the economy's inherent capacity for adding still more kinds of goods and services." Later on, other scholars have reinforced the concept of variety embedded in a region as crucial driving force of economic growth (e.g., Saviotti, 1996) and the necessity of overlapping areas in the knowledge base for facilitating knowledge transfer (e.g., Capello, 2009).

Closely with the aforementioned logics of spatial and cognitive proximity, the recent literature has gradually focused the attention on the importance of related variety which, accounting for cross-fertilization between sectors (knowledge spillovers), is one of the main strategies for fostering technological diversification (Asheim et al., 2011). Related variety is considered in juxtaposition with unrelated variety, which is defined as the diversity of sectors that do not complement each other. As such, it is expected to protect regions from external shocks (i.e. the crisis of a sector): it should work as risk-spreading effect (or portfolio effect), hampering regional unemployment. In this way, both types of variety are beneficial to regions in different ways.

Until a few years ago, the theoretical and empirical literature had paid extensive attention to firms' technological diversification, but the equivalent phenomenon was largely neglected at the regional level (Cantwell and Vertova, 2004). It is only in recent years that scholars started highlighting the importance of diversification in the knowledge base also from a regional perspective. In particular, empirical studies have

demonstrated that related variety is indeed a fundamental driver for promoting innovations and economic growth within regions. This body of literature has become complemented with studies which refer specifically to the SSS concept and that aim to suggest that, for a successfully integrated application of the SSS approach, the promotion of technological diversification amongst the most embedded sectors is necessary (McCann and Ortega-Argilès, 2015).
Still, strong empirical evidence is lacking to prove that creating regional advantage from a diversification perspective, grounding the policies on related variety approach, is highly relevant for regional economic performance. The aim of this study is to provide further evidence for validating the usefulness of the SSS concept, by relating technological diversification to regional performance. In particular, the objective is to prove that the process of related diversification may serve as an underpinning for a performing SSS policy.

2.3 REGIONAL CLUSTERS AND SSS

Recently, the importance of clusters has been mixed with the SSS concept, as a territorial development model seeking to increase the efficiency and effectiveness of economic systems with the aim of contributing to sustainable development. Since both cluster policies and SSS are policy approaches with a place-based dimension aiming at regional economic growth and competitiveness, the question of the differences, similarities, and contribution of one approach to the other is highly relevant (European Commission, 2013).
To define a cluster scholars report words of the father of the concept (Porter, 1998): a cluster is a "geographic concentration of interconnected companies, specialized suppliers, service providers, firms in related sectors and related institutions (e.g., universities, R&D institutions, trade associations etc.) in fields that compete but also cooperate."
Instead, the SSS concept can be defined as "the establishment of priorities that at a regional-level take place in a series of activities and/or technology domains, and that are potentially competitive and able to generate new business in a global context faced competition from other places" (Del Castillo et al., 2012).
Authors agree to retain that the theory of the cluster can be understood as a specification within the theory of SSS (European Commission, 2013). Del Castillo and co-authors (2013) highlight the following elements from both concepts:

- Global context: Smart Specialization reaches competitive advantage through the specialisation starting from the possibilities that the actual reality offer (comparative advantages). And this is in line with the priorities of other regions in the context of globalization. Clusters instead are good channels for both the internationalization of enterprises (especially SMEs) and identification of global trends;
- Specialisation patterns: Smart Specialization achieves competitive advantages prioritizing choices of specialisation based on key enabling technologies. Clusters are an indicative reflection of the current and potential regional specialisation pattern and in addition, cluster initiatives are channels to reach the critical mass they represent;
- Related variety: Smart Specialization exploits the potential of specialized diversification from the relation between different but related activities/technologies. Cluster initiatives facilitate relationships in the quadruple helix, as well as they contribute to technological hybridization through inter-

cluster processes and identifying and seeking support for entrepreneurial discovery initiatives.

In line with this, Aranguren and co-authors (2013) suggest that both cluster policies and SSS seek to facilitate forms of cooperation among firms and a range of other agents that are developing related/complementary economic activities. Both policies are fundamentally place-specific and therefore rely on constructing strategies and activities that build from available place-based assets and capabilities, both policies seek to be transformative in the sense of strengthening existing and building new competitive advantages, something that requires processes of prioritization and selection and fourthly, they are both characterized by significant challenges in evaluating their effectiveness.

Anyway, there are also important differences that have to be considered: SSS focuses on specific innovation-intensive sectors while clusters apply to a broader set of sectors in the economy. Furthermore, the explicit goal of SSS is the transformation of regional economies around new knowledge-based activity domains, while the goal of cluster policies is often to enhance the performance of the companies that are member of the cluster (European Commission, 2013). Aranguren et al. (2013) argue similarly that among difference there is the focus of concern of the policy but also the scale at which the policy is articulated and the policy tools employed.

3. METHODOLOGY

3.1 TECHNIQUES

The work required a review of the literature on the topic of regional clusters, as well as econometric analysis and spatial autocorrelation. We performed them by means of patent data (EPO), socio-economic data (GDP per capita) and spatial data (longitude and latitude) concerning 203 EU-27 Regions, over 35 technological domains in the 1997-2012 time window.

To address the first research question we relied on Moran's global and local indices (Getis and Ord, 1992), looking for negative, positive or null spatial autocorrelation. Concerning the second research question, we used the GeoDa methodology (Anselin et al., 2006) in order to work out the weight matrices using the three criteria of regions' contiguity. Analyses concerning the third research question were a fixed-effects regression analysis using spatial lag information was performed by detecting both spatial direct and indirect effects (Elhorst, 2003). The econometric analysis involved also and indicators signalling technological specialization and related/unrelated diversification (Frenken et al., 2007).

3.2 INDICATORS

A list of indicators is provided in Table 1 in order to measure Specialization, Diversification, and socio-economic variables:

Variable	**Formula**	**Description**
	Specialization indicators	
Herfindahl index (H)	$H = \sum_{i=1}^{N} {S_i}^2$	Where S_i is the share of the technology domain i (where i=1…35) in the regional technology portfolio. It indicates the level of technological concentration in a Region.
#Spec Fields	Number of Fraunhofer	Where $\mathrm{RTA_{ij}} = \frac{\mathrm{P_{ij}}}{\sum_i \mathrm{P_{ij}}} \Big/ \frac{\sum_j \mathrm{P_{ij}}}{\sum_{ij} \mathrm{P_{ij}}}$ with P the number of EPO

	domains in which RTA_{ij} >2	applications, i = Fraunhofer domain and j = Region grouping variable. It indicates the number of Fraunhofer domains in which a Region has an outspoken technological strength.
Diversification indicators		
Unrelated Variety (UV)	$\text{UV} = \sum_{g=1}^{G} S_g log_2\left(\frac{1}{S_g}\right)$	Where S_g is the main class share obtained summing up the Fraunhofer shares S_i for all domains belonging to it ($S_g = \sum_{i \in T_g} S_i$ where T_g with g = 1,…,5 denotes the main class). It indicates the extent of diversification <u>between</u> the main classes.
Related Variety (RV)	$\text{RV} = \sum_{g=1}^{G} S_g H_g$	Where $H_g = \sum_{i \in T_g} \frac{S_i}{S_g} log_2\left(\frac{1}{S_i/S_g}\right)$ Related variety is indicated by the weighted sum of the entropy at the Fraunhofer level within each main class. It indicates the extent of diversification <u>within</u> the main classes.
Socio-economic variables		
GDP per capita		The Gross domestic product -at current market prices - indicates the result of the production activity of resident producer units.

Table 1. Indicators and variables for diversification and specialisation

While important considerations can be made by looking at results from a temporal stance, a more nuanced overview emerges by analysing the effects of diversification and specialization from a spatial perspective. As many OECD countries and regions are combining clusters policies and SSS, it seems relevant to provide further insights on how – and to what extent – spatial dynamics impact the regional economic growth. This can be done through a spatial analysis. The essence of spatial analysis is that "space matters", i.e. what happens in one region is related to what happens in neighbouring regions. This has been made more precise in the First Law of Geography: "Everything is related to everything else, but closer things more so". One way to approach this is via the notion of spatial autocorrelation. This "law" defines the statistical concept of (positive) spatial autocorrelation, according to which two or more objects that are spatially close tend to be more similar to each other with respect to a given attribute Y - than are spatially distant objects.

A global index of spatial autocorrelation expresses the overall degree of similarity between spatially close regions observed in a given study area A with respect to a numeric variable Y (Pfeiffer et al., 2008). Since global indices of spatial autocorrelation summarize the phenomenon of interest in a single value, they are intended not so much for identifying specific spatial clusters, as for detecting the presence of a general tendency to clustering within the study area. We will use Moran's I Test. A local index of spatial autocorrelation expresses, for each region r_i of a given study area A, the degree of similarity between that region and its neighbouring regions with respect to a numeric variable Y (Pfeiffer et al., 2008). The local indices of spatial autocorrelation are derived from the corresponding global indices and share their fundamental properties (Table 2).

Research question	**Methodological steps**	**Description**
Does geographical proximity matter for regional innovation	Computation of Moran's Global Indices for RV, UV and #Spec fields indicators (for every year in 1997-2012 period) and execution of z-test	Following formulas used to compute indices (where X was substituted with values of RV, UV and #Spec fields).

activities?	(*H0 = "There is not spatial autocorrelation and values are distributed randomly "*) with these indices. Realization of Moran scatters plot for each indicator; Computation of Moran's Local indices for RV, UV and #Spec field indicators and execution of z-test. Realization of choropleth maps for Europe for each indicator in order to visualise the principal geographical clusters; Chronological examination of maps.	**For global analysis:** $I = \frac{N}{\sum_i \sum_j w_{ij}} \frac{\sum_i \sum_j w_{ij} (X_i - \bar{X})(X_j - \bar{X})}{\sum_i (X_i - \bar{X})^2}$ Where N= total of Regions, i and j refer to two neighbouring Regions and w_{ij} is a standardized weight calculated as the inverse of the distance between these two Regions. **For local analysis:** $I_i = \frac{(X_i - \bar{X})}{S_X{}^2} \sum_{j=1}^{N} (w_{ij}(X_j - \bar{X}))$ Where $S_X{}^2$ is the variance of all Regions.
Up to what order of contiguity extends the influence of neighbouring Regions?	Division of temporal windows in two periods (1997-2004 and 2005-2012) and computation for each period of variables RV, UV and #Spec fields; Computation of three weights matrixes, which respectively consider neighbouring of 1st, 2nd and 3rd order; Realization of Local Moran's I maps using 1st, 2nd and 3rd order matrixes; Examination of maps chronologically and for order of contiguity	- RV, UV and #Spec fields for every period have computed as the arithmetical mean of data for the period - For the weights matrixes was used the queen contiguity criterion, which defines a location's neighbours as those with either a shared border or vertex - The analysis for order of contiguity was executed observing maps realized from the 1st to the 3rd order. Temporal analysis was executed comparing maps for the two periods (1997-2004 and 2005-2012).
What is the impact of related/unrelated diversification and specialization on regional economic performance when are considered also the proximity effects?	Elimination from dataset of data for 8 of 203 EU-27 Regions and data for year 2012 (to avoid problems of missing data with the software) Execution of correlation analysis in order to choice models to be applied in the regression analysis. Execution of regression analysis Evaluation of direct, indirect and total effects	- For the regression analysis it was used the Spatial Autoregressive Model (SAR) with this formula: $y = \rho W y + X\beta + \varepsilon$ where ρ is the coefficient estimated for the spatial lag and W denotes the NxN spatial weights matrix calculated as for the question 1.a. **Direct effect**: change on the dependent variable's value of one Region due to change of its independent variable's value; **Indirect effect**: change on the dependent variable's value of one Region due to change of independent variable's values from its neighbouring ; **Total effect**= direct effect + indirect effect.

Table 2. Indicators and variables for spatial analyses

4. RESULTS

The global analysis performed shows significant p-values for the Moran Global index denoting the existence of spatial autocorrelation for related/unrelated diversification and specialization (Table 3).

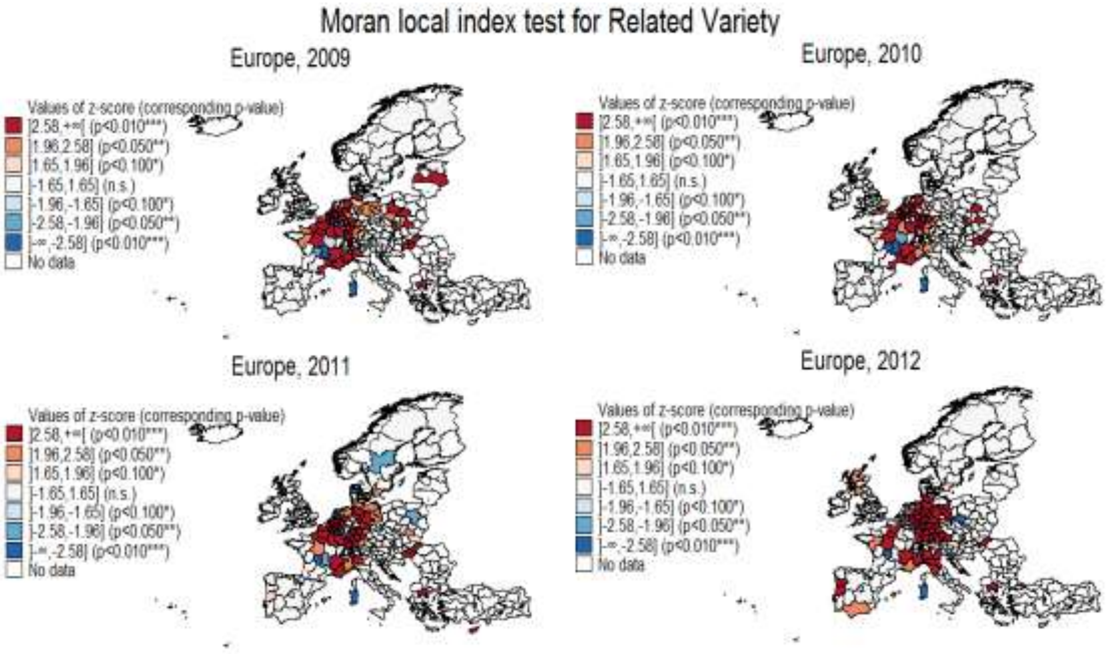
	GDP per capita	GDP per capita
	(A)	**(B)**
Specialization (1)	-61,664** (30,752)	-63,685** (30,058)
Specialization (2)	-556,663 (1024,694)	
Related diversification		365,407** (181,397)
Unrelated diversification		93,985 (228,885)
Rho (ρ)	0,952*** (0,009)	0,950*** (0,091)
Fixed effect included	Yes	Yes
R^2	0,205	0,319
Number of observations	2925	2925
	Direct effects	
Specialization (1)	-69,102** (29,058)	-70,865** (28,154)
Specialization (2)	-534,135 (1224,952)	
Related diversification		419,068* (222,229)
Unrelated diversification		114,101 (270,22)
	Indirect effects	
Specialization (1)	-1305,177** (637,679)	-1256,316** (549,412)
Specialization (2)	-9346,654 (23736,43)	
Related diversification		7414,913* (4143,077)
Unrelated diversification		1820,585 (5004,438)
	Total effects	
Specialization (1)	-1374,279** (663,705)	-1327,181** (575,348)
Specialization (2)	-9880,789 (24941,29)	
Related diversification		7833,981* (4352,801)
Unrelated diversification		1934,486 (5270,979)

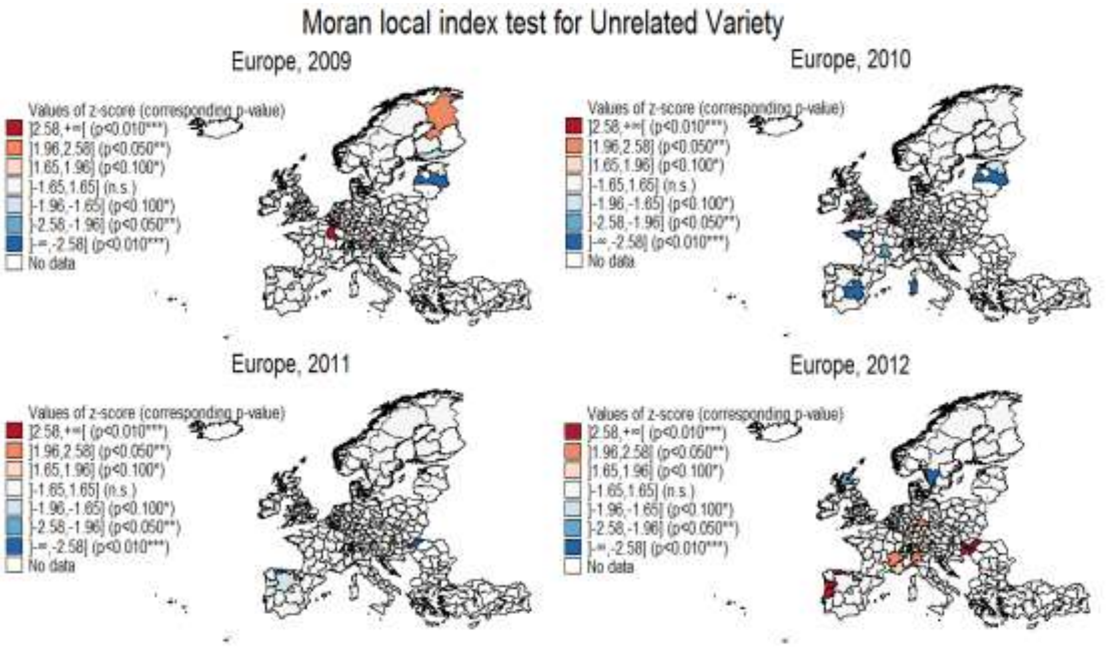
*p<0.10, **p<0.05, ***p<0.01 (Standard errors in brackets)

Table 3. Regression results

The indirect effects of specialization on neighbour regions are negative and higher than the direct one suggesting that increasing specialisation in neighbour regions has a significant negative impact on the regional GDP per capita. Related diversification has a both significant direct and indirect positive effect on regional performance suggesting that we would see increasing the GDP in regions experiencing related diversification surrounded by regions following the same strategy.

Chronological examination of choropleth maps (Figure 1) carried out for the local analysis shows that: concerning related diversification, maps appear in large part significant to the test over the years; regions in the middle of Europe tend to rely on knowledge spillovers giving origins to clusters. concerning unrelated diversification, the results of the global analysis are not supported and maps reveal absence of clusters. For specialization, maps show a patchy distribution, rather uneven over time, making the possibility to improve connections between regions unlikely.





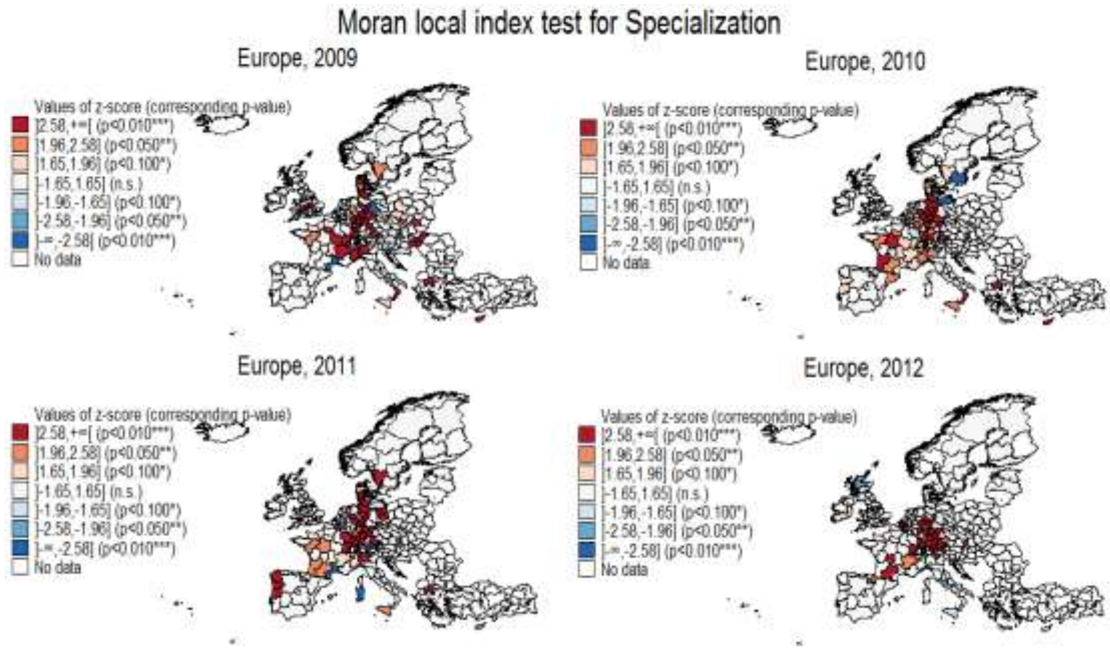


Figure 1. Moran's Local test and cluster detection on RV, UV and Specialization indicators

We further investigated related diversification ad specialization using different contiguity matrices. Clusters emerging as the results of related diversification strategies show higher innovative potential; specialization, instead, is not a good driver of innovative activities. By looking at the spatial dimension, regions relying on related diversification are influenced by 3rd order neighbours; those relying on specialization do not have a wide-radius vision in that they are influenced by their 1st order neighbours. The temporal analysis shows an increase in the size of the clusters only for relatedly diversified regions.

5. Conclusions and Implications

The main results show the importance of geographical proximity to innovation activity. We also detected that technological diversification exists through complementary sectors and is a fundamental driver to promote economic growth within the EU Region. Concerning the first question, innovating in technological domains related to regional assets is in line with the Smart Specialization Strategies. Indeed, EU regions, especially those in central Europe, tend to take advantage from knowledge spillovers; then; they aggregate in clusters in order to improve connections with neighbouring regions. This means that they innovate considering not only their regional context but also the larger European framework. Then, innovating leveraging on related diversification offers a more concrete possibility to apply the SSS program fostered by the European Commission.

Results emerged for the unrelated diversification indicator suggest that this type of technological diversification strategy of the regional assets is not in line with strategies that want to improve internal but also external connections and support exchange and interaction between regions. SSS strategies imply that regions also need to be outward looking, positioning themselves in European value chains and improving their connections and cooperation with other regions. This is important when it comes to consider the internationalization of their companies, achieve a critical potential of

cluster activities and generate knowledge inflows relevant to the region's existing knowledge base.
Finally, technological specialization would not seem to offer a concrete possibility to apply the SSS because regions do not tend to take advantage of knowledge spillovers in a continuous way over time. Clusters tend to change continuously not allowing regions to exploit the economic advantages due to their geographical proximity.
Concerning the second and third research questions, the effects of related technological diversification expands well beyond the close neighbours. Over time, clusters building upon these kinds of innovative practices are larger and take the advantages of geographical interactions. On the contrary, specialization does not echo by forcing regions to innovate in a very local way. In the light of these results it is possible to highlight that technological specialization has a negative effect on both the economic and spatial dimensions and as such it does not provide a model on which the SSS strategies can be grounded program. The positive contribution given by related technological diversification on regional performance supports the idea that there is also a considerable positive effect on one region's performance, which is strongly related to the average performances from neighbouring regions. This implies that the regional GDP improves as soon as the specific region echoes in the space surrounding it and stimulates an improvement for the neighbours too. Therefore, the fact that indirect impact is larger than the direct effect leads us to reflect on the possibility of exploiting this multiplier effect, placing regions in conditions to cooperate. In this sense, the SSS program has to continue to encourage the development of infrastructures and platforms fostering collaboration, as well as breaking down as much as possible the still high coordination costs.

6. Limitations and Future Research

This research does not come without limitations. First, our level of analysis is the region at NUTS 2 level: a more fine grained study would require NUTS 3 level insights.
Second, we do not delve into the evolution and structure of industrial clusters: it would be interesting to overlap the maps of the geographical clusters with those concerning the industrial clusters in order to see whether interactions emerge.

References

Aranguren, M.J., and Wilson, J.R., (2013), What can experience with clusters te3ch us about fostering regional smart specialisation?, Ekonomiaz, Vol. 83, No. 2, pp. 126-145.

Asheim, B.T., Boschma, R. and Cooke, P., (2011), Constructing regional advantage: platform policies based on related variety and differentiated knowledge bases, Regional Studies, Vol. 45, No. 7, pp. 893-904.

Boschma, R., (2005), Proximity and innovation: a critical assessment, Regional Studies, Vol. 39, No. 1, pp. 61-74.

Cantwell, J., and G Vertova, G., (2004), Historical evolution of technological diversification, Research Policy, Vol. 33, No. 3, pp. 511-529.

Capello, R., (2009), Spatial spillovers and regional growth: a cognitive approach, European Planning Studies, Vol. 17, No. 5, pp. 639-658.

Del Castillo, J., Barroeta, B.Y., and Paton, J., (2012), Smart Specialisation Strategies RIS3: A quick guide, INFYDE Working Papers, Year 2, Vol. 1.

Del Castillo, J., Barroeta, B.Y., and Paton, J., (2013), RIS3 policy instruments: clusters, INFYDE Working Paper, Year 3, Vol. 1.

Delgado, M., Porter M.E., and Stern S., (2010), Clusters and entrepreneurship, Vol. 10, No. 4, pp. 495-518.

Elhorst, J.P., (2003), Specification and estimation of spatial panel data models, International Regional Science Review, Vol. 26, No. 3, pp. 244-268.

European Commission, (2013), The role of clusters in smart specialisation strategies. Online: https://ec.europa.eu/research/evaluations/pdf/archive/other_reports_studies_and_documents/clusters_smart_spec2013.pdf

Foray, D., (2013), The economic fundamentals of smart specialisation, Ekonomiaz, Vol. 83, No. 02, pp. 55-82.

Frenken, K., Van Oort, F., and Verburg, T., (2007), Related diversification, unrelated diversification and regional economic growth, Regional Studies, Vol. 41, No. 5, pp. 685-697.

Getis, A. and Ord, J.K., (1992), The analysis of spatial association by use of distance statistics, Geographical Analysis, Vol. 24, No. 3, pp. 189-206.

Jacobs, J., (1969), The Economies of Cities, New York, NY: Random House.

McCann, P. and Ortega-Argilés R., (2015), Smart Specialization, regional growth and applications to European Union cohesion policy, Regional Studies, Vol. 49, No. 8, pp. 1291-1302.

Pfeiffer, D.U., Robinson, T.P., Stevenson, M., Stevens, K.B., Rogers, D.J., and Clements. A.C.A., (2008), Spatial Analysis in Epidemiology, Oxford, UK: Oxford University Press.

Porter, M.E., (1998), On Competition, Cambridge, MA: Harvard Business School Press.

Saviotti, P.P., (1996), Technological evolution, variety and the economy, Cheltenham: Edward Elgar.

Tödtling, F., and Trippl, M., (2005), One size fits all?: Towards a differentiated regional innovation policy approach, Research Policy, Vol. 34, No. 8, pp. 1203-1219.