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Exploring the role of industrial structure for regional economic resilience

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Abstract

The evolutionary approach of regional economic resilience suggests that an external shock can lead to a structural change and the development of new industrial specializations. Among its determinants, a role is played by the industrial structure where a certain degree of specialisation or diversification may influence the response of regions to shocks. The article aims at investigating the role of the relatedness of new specialisations to the existing industrial structure in favouring resilience of territories. Evaluating the resilience of Italian provinces in relation to the economic crisis of 2008, the analysis seeks to understand if provinces who resisted and recovered better, followed a 'related' or 'unrelated' diversification strategy. Conclusions discusses the implications for the policy debate on smart specialisation.

Introduction

A main point of the debate regarding the transformation of the industrial structure is how regions develop – or fail to develop – new sectorial specialisations. Evolutionary economic geography scholars have tackled the question through different theories and empirical applications, modelling the evolution of regional paths (Martin, 2010; Isaksen, 2015; Simmie, 2017) and arguing that new specialisations may emerge as related to close existing specialisations (Boschma, 2017; Balland et al., 2018; Xiao et al., 2018).

In a policy perspective, the problem of the evolution of the industrial structure and the creation of new industrial paths has been the central focus of a number of regional innovation policies led by concepts such as the Technology Plans or the Regional Innovation System (Cooke et al., 1997; Cooke, 2001) that have evolved recently into the idea of 'smart specialisation' (Foray et al., 2009; McCann and Ortega-Argilés, 2015).

This debate has assumed a central role after the occurrence of the economic and financial crisis of 2008, when both academics and politicians have tried to understand how and why some regions better resist and react to crisis and how innovation policies may influence responsiveness of regions in developing new industrial trajectories after crisis (Fingleton et al., 2012; Crescenzi et al., 2016; Bristow and Healy, 2018). These questions have led to rethinking the economic recovery as a path of industrial transformation through the lens of regional economic resilience. The latter acts as a dynamic and evolutive process that generate positive hysteretic outcomes of opportunities for the development of new sectors and new economic growth. *"Regional economic resilience in this framework could be viewed as having to do with the capacity of a regional economy to reconfigure, that is adapt, its structure (firms, industries, technologies and institutions) so as to maintain an acceptable growth path in output, employment and wealth over time."* (Martin, 2012, p.10).

Concerning the policy perspective, failures in the innovation systems have emerged due to the economic crisis, an example is the relative inability of regions' policies to promote solutions taking in consideration regional differences. This scenario has led to go beyond an innovation policy that supports neutrally technology, science and innovation, opening up to the renaissance of the industrial policy (Foray et al., 2011; Ortega-Argilés, 2012).

In this scenario, the theory of 'regional economic resilience' and the concept of 'smart specialisation' have become guiding principles for many policies. Despite the criticisms (Cooke, 2017; Marques and Morgan 2018), they have started to influence a large part of researches of regional economies. Both approaches recognise a significant role of the industrial structure in promoting new specialisations and contributing to the development of new industrial paths. This approach assumes that a new specialisation may be linked in some cases to the existing economic structure in which the region has a competitive advantage compared to other regions (Foray et al., 2011). Regional economic resilience, in its version of 'adaptive resilience', defines structural change as the output of a resilient regional economy (Martin, 2012). Based on concepts of adaptation and adaptability, response to exogenous shocks can lead towards the recombination of existing resources to create new knowledge or the development of new and unrelated trajectories (Grabher, 1993).

Building upon this framework, despite the emerging works in evolutionary economic geography (Balland et al., 2018; Xiao et al., 2017), more theoretical and empirical advancements are required to clarify the relationship between new industrial specialisations occurrence and regional economic resilience. The article aims to contribute to this debate by developing a conceptual approach capable of connecting the themes of smart specialisation and regional economic resilience. It wants to understand if new industrial specialisations and their relatedness to the already existing industrial structure may promote regional economic resilience in the face of shocks.

This conceptual approach is applied to the case of 103 Italian provinces (NUTS-3) in order to understand if provinces that were following a strategy of diversification into related industries before the crisis, resisted and recovered better to the Great Recession of 2008. In line with other researches concerning economic resilience in Italy (Cellini and Torrisi, 2014; Lagravinese, 2015; Faggian et. al., 2018), Italian provinces represent an interesting unit of analysis due to regional differences related to sectors specificities and productive structure. Moreover, the Italian economy is strongly signed by economic inequalities expressed by the divide between Northern and Southern regions. Such differences may contribute to the ability of Italian regions to respond and recover from crisis (Di Caro, 2015). Despite the results emphasized by previous studies of resilience in Italy, the development of new industrial specialisations and the relationship with the local industrial structure is an issue that requires to be further investigated.

The article is organized as follows. Section 2 discusses the industrial structure as a determinant for the resilience of regions in order to build the conceptual framework of our empirical analysis. Section 3 clarifies the data sources and the methodology applied. Section 4 introduces the results of the empirical research, while Section 5 underlines the conclusions and the implications for the policy and theoretical discussion of smart specialisation.

According to an evolutionary perspective, the analysis can provide useful insights in order to explain how regions transform and evolve in response to shocks. Moreover, such analysis can be useful to understand if the smart specialisation strategy can be an instrument to foster resilience leading towards a more comprehensive and sustainable growth.

Resilience, industrial structure and the role of policy
The economic resilience of regions is a theoretical framework widely explored in studies of regional growth (Christopherson et al., 2010; Simmie and Martin, 2010; Hervas-Oliver et al., 2011; Bristow and Healy, 2015; Bailey and Turok, 2016; Fröhlich and Hassink, 2018). It discusses the capacity of a region to recover, reorganize and reorient its structure and functions in order to respond to external pressure (Martin, 2012).

Within this theory, the possibility for a structural change of the region is the guiding principle of the evolutionary approach (Boschma, 2015). However, it is not still clear which determinants influence resilience and the structural change (Martin and Sunley, 2015) nor how adaptation processes occur, both on spatial base and on temporal perspective (Evenhuis, 2017). A consequence is that the role of a number of place-based attributes of regional economies in fostering transformation and adjustment in response to shocks should be deeper investigated.

A large debate concerns the most suitable form of industrial structure that may favour resilience. A regional economy specialized in activities that involve intensive knowledge and information capital can easily adapt to changing circumstances and being more resilient (Martin et al., 2016). By contrast, high diversity hardly impacts the sustainability of the growth rate (Eraydin, 2016). Moreover, sector-specific shocks may likely hit diversified regions than regions with a specialized economy, but the damage will be less dangerous for the whole local economy because variety spreads risks among different sectors (Boschma, 2015).

The discussion concerning the role played by the industrial structure on the capacity to resist and recover from a shock is highly intriguing and the issue of the form of industrial structure that is more likely to favour resilience is far from its conclusion. As argued by Martin et al. (2016), a number of explanations underline the role of specialization (Storper et al., 2015), complexity (Hausmann et al., 2013) or related-variety (Frenken et al., 2007) of the existing industries.

Within this debate, literature of path dependence recognises that exogenous shocks can lead towards the recombination of existing resources in order to create new knowledge or the development of new and unrelated trajectories (Grabher, 1993). According to this view, resilience refers to the adaptive ability of regions to change structure and functions to deal with external pressures (Martin, 2012). This adaptive process may be discussed in terms of 'adaptation' and 'adaptability' (Grabher and Stark, 1997; Pike et al., 2010). Adaptation represents a path-dependent process that involves a non-radical transformation of the regional path based on the existing structure. Adaptability deals with a long-term change within the regional economy that may occur through a shifting in the industrial path. Such processes coexist and interact as old and new industries coexist and interact within the region (Hu and Hassink, 2017; Simmie, 2017). When resilience is conceived as a long-term transformation, a synergic action of adaptation and adaptability should be considered. A reciprocity between adaptation and adaptability may involve the needs for a degree of relatedness between existing industries and new emerging trajectories (Boschma, 2017).

Another approach addresses the issue through the idea of related diversification where the degree of 'related' and 'unrelated' variety of regions (Frenken et al., 2007) matters for their resilience. This approach stresses the role of diversification as an output of the structural change where the capacity of regions to diversify is strongly dependent on the existing activities. These are the bases of knowledge from which new activities are developed and more related are new activities to the existing ones, less cost and less risky is the regional diversification strategy (Boschma, 2018). Some recent studies tackle if 'related variety' or 'unrelated variety' influence regional resilience (Balland et al., 2015; Xiao et al., 2017). The evidence shown by these researches is that related variety is an important factor in influencing resilience to shock having a positive impact on regional ability to absorb disturbance and develop new activities.

What emerges from literature both of path dependence and related variety is a prominent role of the existing industrial structure in favouring the emerging of new path and, consequently, resilience. Then, the structural change may be fostered by a regional strategy inclined to related diversification that sees the coexistence of adaptation and adaptability processes.

This debate suggests that theory of resilience should give further explanations of why regions choose a specialisation or diversification strategy and how this strategy develop and adapt over time (Martin et al., 2016). The configuration of the industrial structure can be influenced by different regional variables and, among these, a decisive role can be taken by the policies. Literature of resilience downplays the role of government and policy as determinants of regional growth or decline in consequence of a shock (Hassink, 2010; Arbolino et al., 2016).

Regional innovation policy has moved recently to the idea of developing an innovative strategy based on a 'smart specialisation'. This strategy should help regions to develop new economic activities with a specific policy based on innovation, investments in R&D and information and communication technology (ICT) that stresses the industrial strength of regions. The strategy promotes the idea that a coordinated process between government and private sector should lead toward the discovery of the regional domain on which prioritizing investments to generate a long-term economic transformation (Foray et al., 2018). This is what the smart specialisation framework identifies as the entrepreneurial discovery process (EDP) and represents the main difference between smart specialisation and other innovation strategies (Pinto et al., 2019). New technologies and new sectors do not develop from random events but encompasses the capabilities of regional agents that shape the distinctive technological and industrial characteristics of the regions (Boschma and Gianelle, 2014; Balland et al., 2018).

A goal of the policy is to enhance competitiveness and foster the resilience of regions (European Commission, 2010; 2012; 2017). However, the frameworks of regional resilience and smart specialisation have not been frequently combined. The following analysis wants to connect such approaches and understand if new industrial specialisations and their relatedness to the already existing industrial structure may promote regional economic resilience in the face of shocks.

The starting point of the analysis is that a degree of diversification – based on the existing range of capabilities - may influence the response of regions to shocks and favour structural change. We use the concept of relatedness to measure the distance between industrial sectors (Neffke et al., 2011) and then to approximate the degree of similarities between activities in terms of capabilities (Boschma, 2017). Relatedness may offer a measure of how new domains – identified with the new industrial specialisations - are related to the existing industrial structure.

Based on this measure of industrial relatedness, the analysis wants to understand if new industrial specialisations emerged in the post-shock scenario are related to those already existing. Through the analysis of dimensions of resistance and recovery of regional economic resilience, the sensitivity of regions to the economic shock and their ability to recover are measured.

Data and methodology

In this article we analyse how the diversification paths of regions before and after the advent of the great recession affect their capacity to resist and to react to the crisis. The main arguments of the work are that the regions that follow a more related diversification path before the crisis are better suited to resist to the shock than those that follow a more unrelated diversification in new industries and ultimately perform higher growth rate in a medium long run.

The study concerns the totality of Italian provinces (103) corresponding to the NUTS-3 classification of the European Union, existing before the changes occurred from the 2007.

The paper builds on data drawn from the firm-level AMADEUS database of Bureau Van Dijk, referred to the number of employees subdivided by the NACE code, up to the four-digit level of detail (560 industrial categories) for the period 2006-2015.

Using these data, following the methodology developed from Hidalgo et al. (2007), a relatedness index is calculated for every pair of industrial categories. Then we control the rise of new specialisations in sectors more or less related to those already present in the province. This analysis is useful to understand if there is a relation between the related diversification of a province and the capacity to resist and react to the economic crisis. It allows also to understand how the provinces 'diversification/specialisation' strategy have changed after the economic crisis in 2008 and if this has affected their recovery process.

New specialisations and Relatedness
To understand this relation, we firstly compute a Location Quotient (LQ) for every industrial category of each province for the whole period, this is aimed to understand which new industrial specialisations occurred during the period 2006-2014.

$$LQ_{pi} = \left(\frac{E_{pi}/E_P}{E_I/E} \right) \qquad (1)$$

To avoid the occurrence of new specialisations that are not structural for the area but tend to appear and disappear frequently, a new specialisation here is defined as follow:

- The LQ is higher than 1, meaning that the specific industry has a concentration in that province higher than the national average.
- The LQ was lower than 1 since the 2006, this is aimed to avoid the consideration of those industrial specialisations that appear and disappear frequently, concentrating the analysis only on those that are more stable.
- At least the 0.5% of the workers of the province are employed in that sector. This point is aimed to exclude those micro-sectors where a change in few employees may determine the appearance of the specialisation.
- There has been an increase in the employment in that sector compared to the previous year, this last point is aimed at the exclusion of those specialisations that appear in connection to a decrease of the employment in the area, rather than to an increase in the specific industry.

Following this analysis, 9684 new specialisations were identified during the nine years period considered. Figure 1 presents the number of new specialisations occurred in each Italian province during the period 2007-2014, this shows clearly how the occurrence of new specialisations is largely concentrated in the south of Italy. This may seem an unexpected result at a first sight, however, the changes that occurred in the south of the Italian peninsula, were much larger than those occurring on the north since the beginning of the 2000 (Barca, 2006). This is then confirmed by the fact that, the productivity growth and the diversification of the industrial structure of the south were largely higher than the national average since

the mid of the '90 (Boschma and Iammarino, 2009). Of course, this did not allow to cover the gap between north and south, and this is probably connected by the diversification strategy followed that will be considered here.

Figure 1. *New specialisations in Italian provinces 2007-2014*
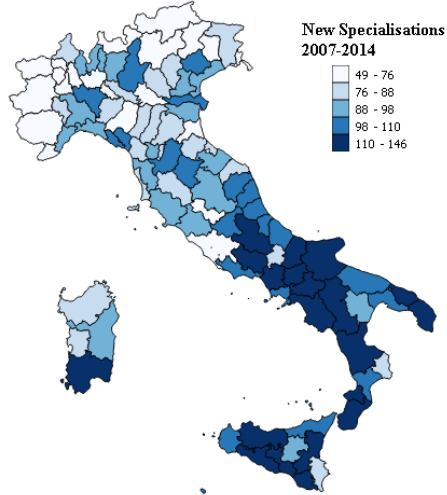
Source: Authors' elaboration using QGis software.

The following step aims at understanding if the new specialisations that occurred in each province are related or unrelated to the specialisations already present. Here for every new specialisation we have computed an index based on the relatedness measure between each pair of industrial categories.

Firstly, it is necessary to compute the relatedness measure between each pair of industrial categories. This is done following the methodology of Hidalgo et al. (2007) for the creation of the *product space*. We want to create an *industry space* (Neffke et al., 2011) among the industrial categories in order to determine their proximity. However, in this case, the *industry space* is built in a different way because data about the labour flow between industries, or the co-occurrence in the same plant are not available. The number of workers in every industrial category will be used to determine if there is a higher or lower proximity among them (Innocenti and Lazzeretti, 2019). It also differs from the *product space* construction, where export data are used to compute the proximity among products. This is done because the aim of the work is to understand the industrial relatedness to infer the industrial diversification and the specialisation of each Italian province.

This way of measuring relatedness allows to infer that two sectors draw on similar knowledge and to overcome the problem of the classification-based measures (ex-ante determination of relatedness like related variety) with an ad-hoc determination of relatedness and so we do not rely on the number of digits shared between two industries to determine their level of relatedness.

In this specific case, measuring industry relatedness, from a theoretical point of view allow us to be near to the definition firstly made by Frenken et al., (2007) and the following works that rely on industries employment to determine relatedness (Cortinovis et al. 2015; Hartog et al., 2012; Fritsch and Kublina, 2018; etc.).

Summing up, higher relatedness implies that the two industries share similar knowledge that allows cross-fertilisation and spillovers between the two industries. Now, we explain briefly how we have created the *industrial space*. The *product space* represents in the network the exported products, where the nodes represent every different product and the lines, the relatedness degree between them, based on the idea that two products are related if they are co-exported by many nations.

In our case, we use the same concept but referring to the industrial categories and we will consider related those categories that are present together in many Italian provinces with an employment level higher than the national average.

We create an *n*n* matrix where *n* represents the number of industrial categories considered, that in our case are 560, classified following the NACE classification, and we will calculate the degree of relatedness as follows: (2)

$$\varphi_{ijt} = \min\left\{P\left(RCAx_{it}|RCA_{x_{jt}}\right), P\left(RCAx_{jt}|RCA_{x_{it}}\right)\right\} \qquad (2)$$

The relatedness of every pair of industrial categories is calculated as the minimum of the conditional probability for every Italian province to find an industrial category *I* given the category *j* is already available in the province.

Then, using this measure of relatedness among industrial categories, the following step is to compute a measure of relatedness of each new industrial specialisation. This leads to a measure of how the new specialisation is related to the already existing specialisation of the area.

$$C_{ip,t} = \frac{\sum_{k=1}^{n} \varphi_{ikt-1}}{n} \qquad (3)$$

Where *i* is the industrial category of the new specialisation, *p* represents the province, *k* represents the industries that province *p* was specialised at time *t-1*, and φ is the proximity among the new specialisation *i* and industry *k*.

This measure is specific of each new industrial specialisation in each province (as each province has its specialisation tree) and each year (as the specialisation tree changes every year). This measure is then aggregated at provincial level, the results give us a measure of how the new specialisations of each province are connected to the already existing specialisations.

$$RC_{pt} = \frac{\sum_{i=1}^{n} C_{ipt}}{n} \qquad (4)$$

Figure 2 presents the measure of relatedness of new specialisations of each Italian province, respectively in the year 2007, 2011 and 2013. They show that the relatedness of new specialisations is not following the mere occurrence of new specialisations. However, also in this case it is possible to see how higher levels are reached in the center and south of Italy than in the North.

Meaning that in the north of Italy there is a larger search for new paths, searching for new specialisations unrelated to the already existing specialisations. This is an interesting pattern that could be due to the high competition that favours the search of new sectors less related to those where there is already high competition in the considered area.

Following the framework developed in the theoretical background we infer that:
- A high value of relatedness indicates a propension for a '**related diversification**'.
- A low value of relatedness indicates that new specializations are '**un-related**' to the existing specialisations.

Figure 2. *Relatedness of new specialisations.*
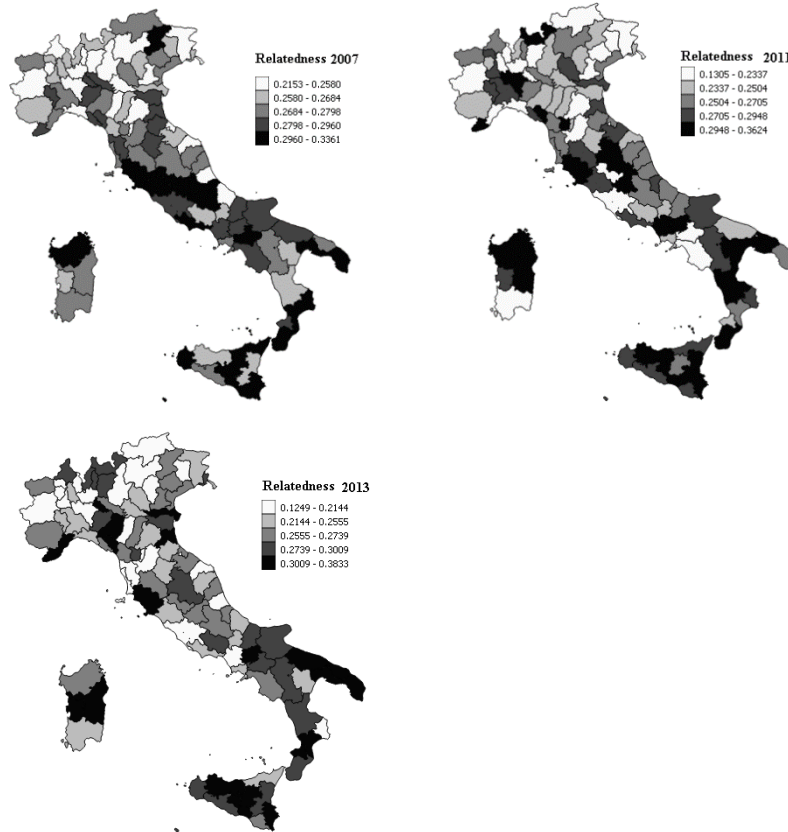
Source: Authors' elaboration using QGis software.

Measuring Resilience

We measure Resilience through resistance and recovery indices using the index firstly developed by Martin (2012). Particularly, resistance is measured using the method adapted by Faggian et al. (2018) and recovery through the measure proposed by Lagravinese (2015).

The measure of resistance is used to understand how each province resisted to the shock occurred.

$$RES = \frac{\frac{E_{p,t}}{E_{p,t-1}}}{\frac{E_{n,t}}{E_{n,t-1}}} \qquad (5)$$

Where E_p is the total employment in the province of interest and E_n is the total employment in the nation. The period (t) represents the recessionary period and the period (t_{-1}) represents the pre-recessionary period. In this case, following the literature, the recession period is considered as the variation between the 2009 and the 2010.

A value of the index higher than 1 indicates that the province resisted better than the other to the shock, while a level lower than 1 indicates a performance lower than the average compared to other provinces.

The figure 3 shows the resistance of Italian provinces to the great recession of the 2008. It is possible to see that there is not a precise pattern of resistance through the north south divide. However, a slightly higher resistance appears in the center-north of Italy even if there are some highly resistant provinces in the north of the Sardinia and in the extreme south and Sicily and that the crisis hit so bad also in some provinces of the north.

Figure 3. *Resistance of Italian provinces*
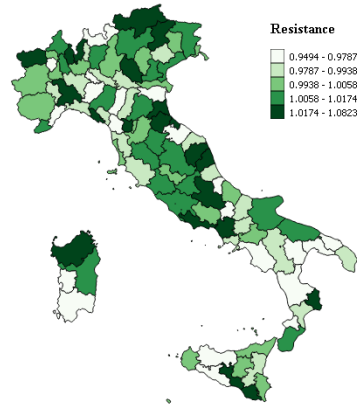
Source: Authors' elaboration using QGis software.

The following index of recovery shows how a province has reacted after the occurrence of the shock.

$$REC = (\frac{\Delta E_p}{E_p})/(\frac{\Delta E_N}{E_N}) \qquad\qquad (6)$$

It is represented by the change in percentage of the employment of the province after the shock and it is usually computed between one and five years after the crisis[1]. In this case the figure 4 show the recovery of Italian provinces after one year, to capture the recovery in the very short-term, after three years representing a short/mid-term recovery and five years, that represents a mid-term recovery after the crisis occurrence.

It is possible to see how in this very short term the levels of recovery are quite similar to those of resistance, meaning that the provinces that resisted to the crisis also continue to grow in the following period, while after three and five years the north started to recover and grow much more than the south of Italy.

Figure 4. *Recovery of Italian provinces after 1, 3 and 5 years*

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[1] Here the indexes of recovery have been computed after one, three and five years after the occurrence of the crisis, to understand if different diversification strategies where effective in short or medium term.
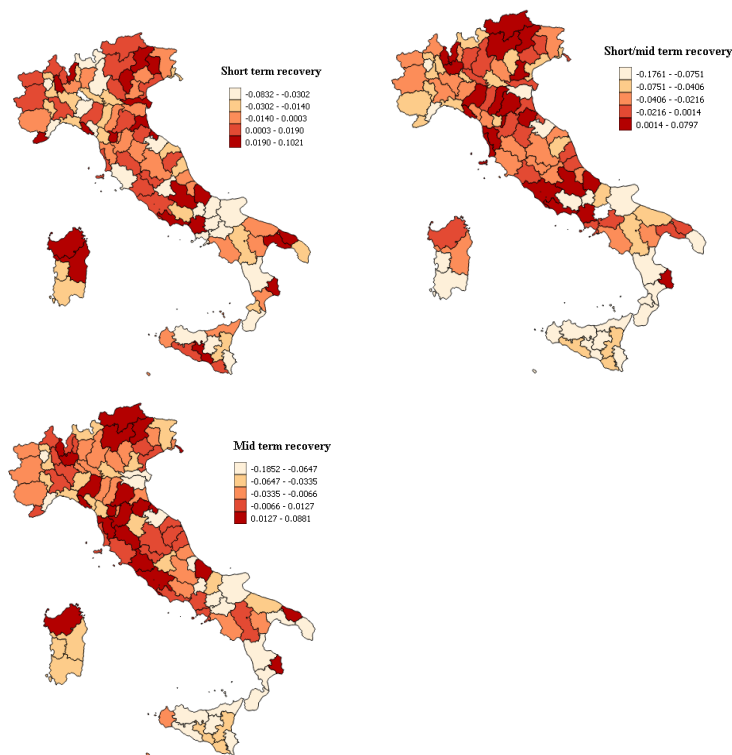
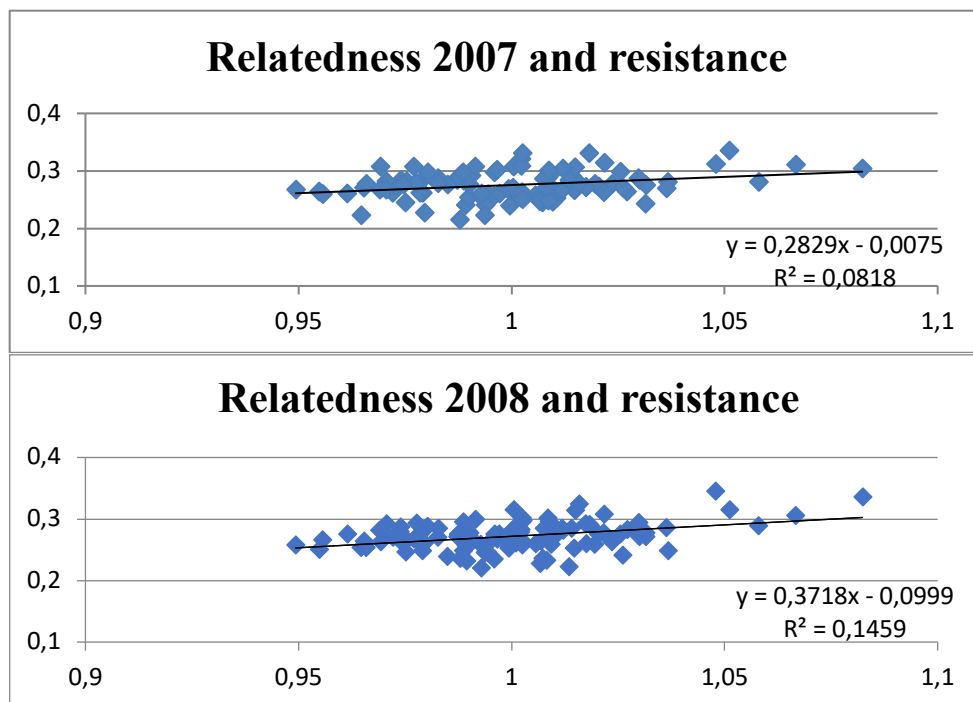*Source:* Authors' elaboration using QGis software.

Results

New specialisations and Resilience

This section investigates the relation among the relatedness of new specialisations of the Italian provinces compared to the resistance and recovery. This allows us to understand if following a strategy of diversification in industries related to those already existing in the province, during the years before the crisis, is associated to a higher resistance to the shock occurred in 2008.

Figure 5 and 6 present the scatterplot between the relatedness of new specialisations occurred in the Italian provinces in the period 2006-2007 and 2007-2008 and the resistance in term of employment after the occurrence of the great recession 2008-2010.

The results show how provinces that were following a strategy of diversification into related industries before the crisis resisted better to the great recession. This is confirmed in the case of the relatedness of both years before the advent of the crisis.

Figure 5, 6. *Relatedness before the crisis and resistance of Italian provinces*

Relatedness 2007 and resistance

y = 0,2829x - 0,0075
R² = 0,0818

Relatedness 2008 and resistance

y = 0,3718x - 0,0999
R² = 0,1459

Source: Authors' elaboration.

The following figures use the same methods to establish a relationship between the relatedness after the occurrence of the great recession and the recovery of the Italian provinces. In the very short-term recovery – two years - (Figure 7), the relation with the strategy of diversification followed immediately after the crisis is positive but very weak. Meaning that the new specialisations relatedness to the already established specialisations of the area does not seem to have a clear impact on the recovery of the regions in the very short-term.

Figure 7. *Relatedness and recovery of Italian provinces*

Relatedness 2009 and recovery 2011

y = 0,2213x + 0,2701
R² = 0,039
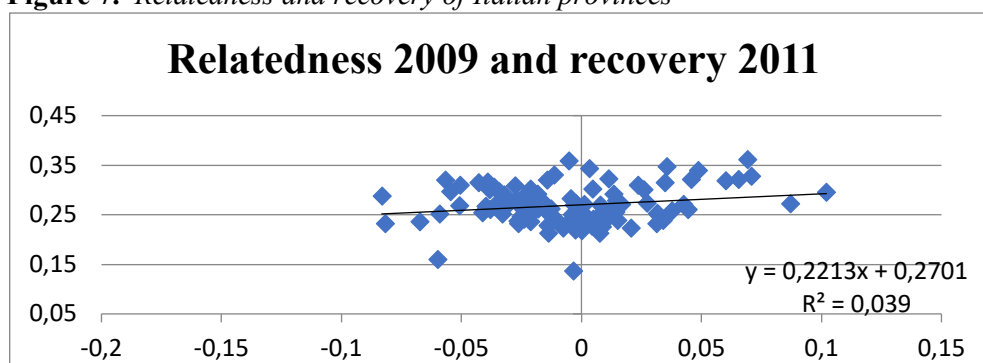
Source: Authors' elaboration.

But when we look at the short/mid-term recovery (Figure 8) the relation becomes negative and this is even more evident in the mid-term recovery (Figure 9), meaning that in relation to the capacity to grow after the occurrence of the crisis,

the strategy that seems to play a positive role is to diversify into less related activities.

Figure 8, 9. *Relatedness and recovery of Italian provinces*
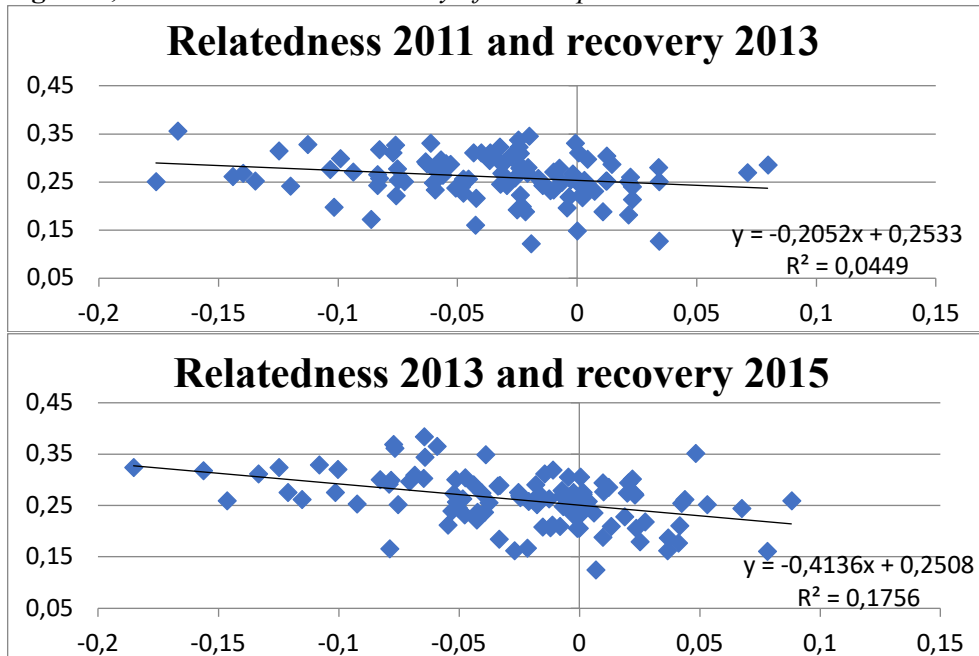
Source: Authors' elaboration.

The results are in an opposite direction compared to those of the resistance to the shock. This implies that to resist to the shock occurrence following a more conservative strategy and diversifying into related activities enable the region to better absorb the shock. Thus, those regions that followed a riskier diversification, specialising into less related activities had a lower capacity to resist to the shock. An explanation could be that new specialisations, born immediately before the crisis and unrelated to those already present in the area, are probably less consolidated in the region and thus less suited to resist to a shock occurred few years after their birth. While, after the crisis, it seems that to enable a recovery of the region and thus starting to grow again a riskier diversification path is needed. This could be associated to new opportunities and new niches that arise after the occurrence of the shock.

Differentials of development
The different effect on resistance and recovery of new specialisations relatedness to the industrial structure of the region may be due to differentials in the industrialisation between regions. For this purpose, the Italian case is particularly relevant, in fact it is well known that the differentials in the industrial development between the north and the south of the Italian peninsula (Cellini and Torrisi, 2014; Di Caro, 2015) could have influenced the capacity to react to the shock occurrence. To better investigate this phenomenon, in the following Figures 10 and 11 are the results of the relation between the level of relatedness and resistance divided

respectively for the provinces located in the north-center and the south of the Italian peninsula.

The results clearly show that the positive association between the relatedness of new specialisations occurred in the period before the crisis and the resistance is strongly driven by the provinces located in the south of Italy. In fact, the results for the provinces located in the north-center are still positive but largely less robust than those of provinces located in the south.
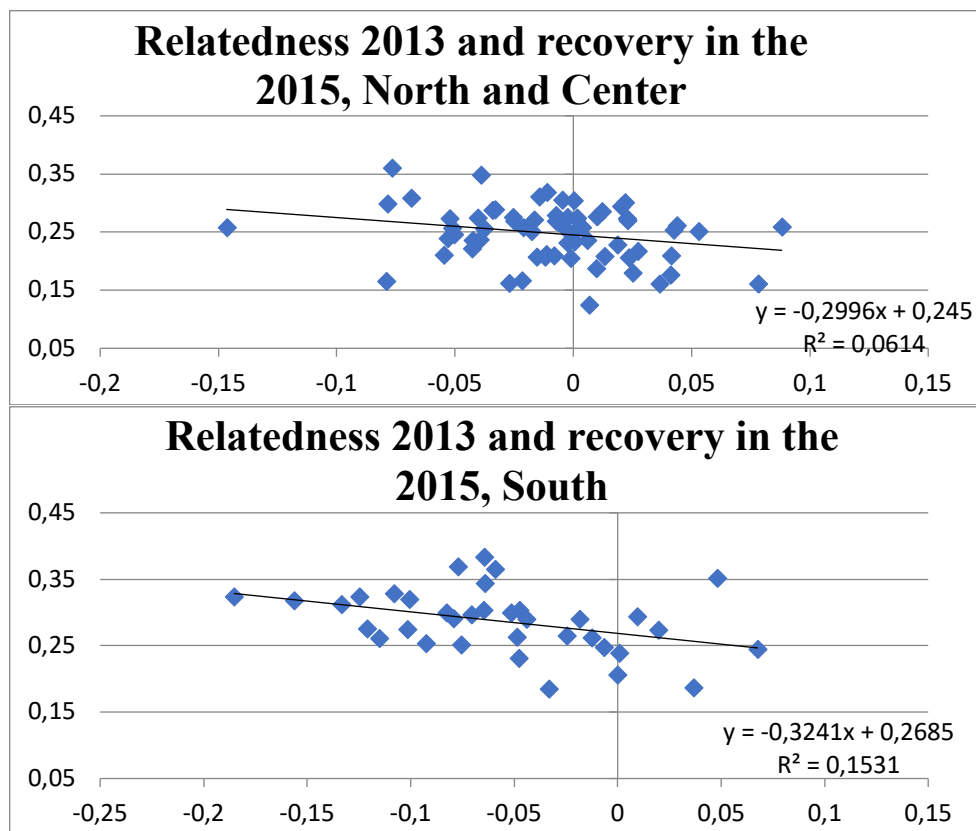
Figure 10, 11. *Relatedness before the crisis and resistance of Italian provinces divided by north and south of Italy*
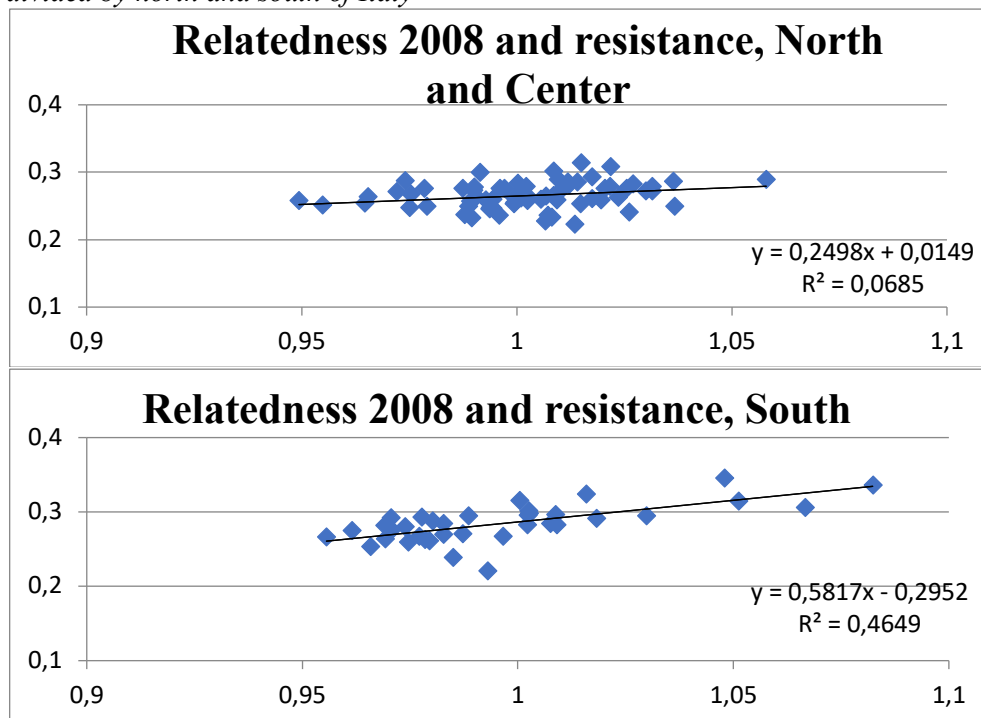
Source: Authors' elaboration.

The same results could be seen in Figures 12 and 13, in fact when we decompose the results related to the connection between the relatedness of new industrial specialisations occurred after the crisis and the recovery, we can observe that the negative relation is much stronger for those located in the south of the Italian peninsula.

Figure 12, 13. *Relatedness and recovery of Italian provinces divided by north and south of Italy*

Relatedness 2013 and recovery in the 2015, North and Center

y = -0,2996x + 0,245
R² = 0,0614

Relatedness 2013 and recovery in the 2015, South

y = -0,3241x + 0,2685
R² = 0,1531

Source: Authors' elaboration.

What seems to emerge from an in depth analysis of the new specialisations occurred before the crisis and that drive the south to a higher resistance of those provinces specialising into related activities is that they diversified their specialisations into activities more connected with the heavy industry and this lead to a higher capacity to absorb the shock in respect to the provinces located in the north of the country.

However, what seems to really have a negative impact is the diversification into related activities after the occurrence of the shock. And what emerges, is that, after the shock, the diversification into related activities leads to a lower growth in term of employment and thus to a slower recovery of the provinces. In fact, with the great recession, many firms were driven to failure and even if the market shrunk, new opportunities arise that before the advent of the crisis where occupied by less competitive firms, and this leads the provinces that diversified in those less related activities to achieve higher performance and a faster recovery.

Discussion and conclusions

As shown in the previous sections, regions reacted differently to the crisis and the effect of the diversification was strongly affected by the industrial development of the area. Results show that regions following a related diversification are resistant in a very short-term but, however, considering a recovery of short and mid-term, the adoption of a related diversification unexpectedly is not associated to higher

performances in the following years. Such results may be explicated assuming that when regions face a crisis, a radical change is required because the relatedness effect may reduce in the long-term (Saviotti and Frenken, 2008).

In general, the principle of relatedness (Hidalgo et al., 2018) affirms that the probability of the entry of a region in a new economic activity depends on the number of related activities, so the related diversification is a key driver of economic growth (Boschma, 2017). However, a part of empirical evidences suggests that cases of unrelated diversification may lead to a higher growth rate under certain conditions (Pinheiro et al., 2018). This could also be revealed by the case of economic crisis.

The canonical model of path dependence suggests that a paradigmatic change occurs as a response to an external shock (Arthur, 1994; David, 2001). This implies that certain lock-in mechanisms supporting path-dependent industrial trajectories may be de-locked by the advent of an economic shock, leading actors to explore unusual and less-related paths. A crisis context makes diversification/specialisation strategies different from a usual context of economic growth. It may open possibilities to fill underused potentialities of regions in order to favor growth.

Both resilience and smart specialization approaches look at the structural change as a positive output of regions and as a successful application of the policies. Structural change involves the creation of new industrial specialisations – new domains – and consequently the transformation of the industrial structure. In line with the existing literature (Martin, 2012), our results suggest that the structural change is the output of the resilient process and that the resilience can be influenced by the industrial structure. Contrary to the expectations, this emerge as an unrelated-diversification. These implications are highly interesting for a further development of the approaches of smart specialisation and resilience.

Concerning resilience, before the advent of a crisis, a strategy of related diversification can lead to a higher resistance to shocks because it may favor the consolidation of acquired regional advantages and an easy integration of new specialisations with those already existing. On the contrary, a path of diversification in unrelated sectors may expose the region to a higher sensitivity to an external shock, in the short-term, because synergies and connections with other sectors are not yet stabilized. However, during the recovery period, further dynamics come into play and these are linked to new opportunities where the crisis forced the exit of firms outside the market. Furthermore, sector-specific crises may entail the need to invest in less related activities, less affected by the crisis and, therefore, still profitable. This may be even more significant for those countries strongly specialized in certain industrial fields and where a big difference in the levels of development of northern and southern regions exists, as Italy is. The effect of unrelated variety on the growth of specific sectors, such as manufacturing (Bishop and Gripaios, 2010; Mameli, et al., 2012), or in all sectors (Fritsch and Kublina, 2018) is confirmed by empirical evidence. Moreover, concerning the specific case analysed, previous studies on resilience in Italy (Di Caro, 2015; Lagravinese, 2015) underline the inability of the Italian southern regions to recover from a series of economic crises over time. This has exacerbated their 'un-resilience' and, probably, has favoured the conditions to develop related specialisations due to a low innovative capability and consequent inability of creating new and un-related sectors. On the contrary, longer and higher resilience

of northern regions may explicate their higher innovation capacity in generating new less path dependent trajectories.

Concerning policy implications for smart specialisation, results suggest that a higher risky context, such those of crisis, may lead towards unexplored opportunities and the structural change advocated by smart specialization may coincide with patterns of *radical foundation* where the new domain has not any connections with the existing industrial structure (Foray, 2015). A variety of strategies of smart specialisation exists and these deal not only with 'related diversification'. Among the others, they may be connected to a combination of unrelated knowledge to move into new related and unrelated industries or a strategy based on related activities to move into unrelated industries (Asheim et al., 2017). What is important is to consider also contextual elements, such as those that can characterize an uncertain economic environment, in order to achieve the most desirable model of structural change. These should coincide with the search for the entrepreneurial knowledge that corresponds to this vision (Foray and Rainoldi, 2013).

Moreover, some characteristics such as quality of institutions and propensity for innovation by policy makers can inhibit the application of smart specialisation policies and lead to the failure of the entrepreneurial discovery process (Marques and Morgan, 2018). Indeed, if a successful strategy should be based on the economic structure of regions and should support the discovery process undertaken by companies and organisations operating within that economic structure (Foray et al., 2011), this requires a high level of institutional capabilities. These are therefore 'place-based' and may lack in those economically weaker regions that most need innovation policies (McCann and Ortega-Argilés, 2016). This may be the case of the southern Italian regions where the poor quality of institutions and a weaker socio-economic structure can interfere with the application of innovative policies based on existing local capacities. It follows that the planning of a successful strategy of smart specialisation should take into account not only the strengths of the regions, such as their competitive advantages, but also their weaknesses, often linked to a socio-economic context not inclined to innovation due to absence of entrepreneurial capacity, low quality of the government, unemployment, few propensity for R&D investments, etc.

Despite this evidence, there is still little knowledge about the relationship between 'smart specialisation' and resilience. This article represents a first contribution to combine such approaches. The analysis explores the transformation of industrial structure in relation to economic shocks, both in a short and mid-term perspective through the evaluation of dimensions of resistance and recovery. It wants to understand if a in a crisis context new industrial specialisations may emerge as related to the existing one. Moreover, applying the methodology of relatedness, the research has made an effort to develop a framework to operationalize the concept of smart specialisation and connect resilience with a policy dimension.

Of course, the paper is not free of limitations. Firstly, the rather short period under consideration does not allow to make considerations regarding long term structural change. In the same direction also the few years considered before the advent of the great recession limit the strength of the association between structural change and resilience. For this purpose, studying resilience and smart specialisation is particularly interesting and opens the discussion for further researches. Future

analysis should go deep in understanding which characteristics of the pre-shock industrial structure may influence the recovery trajectories, taking into account other place-specific features, such as innovation capacity, endowment of territories, quality of institutions or interregional linkages. These are arguments discussed from both resilience and smart specialisation literatures. Finally, future researches should investigate deeper the implications for the process of discovery of domains to prioritize when contexts of change and uncertain are considered. This could be useful for the orientation of the policy of smart specialization to cope with the challenge of the global scenario.

References

Arbolino, R., Di Caro, P. and Marani, U. (2016) *Regional resilience during the Great Recession: the role of the European Union cohesion policy*, Mimeo.

Arthur, W. B. (1994) *Increasing Returns and Path Dependence in the Economy*, Michigan: Michigan University Press.

Asheim, B., Grillitsch, M. and Trippl, M. (2017) Smart Specialization as an innovation-driven strategy for economic diversification: Examples from Scandinavian regions, *Advances in the theory and practice of smart specialization*, Academic Press, 73-97.

Bailey, D. and Turok, I. (2016) Editorial: Resilience Revisited, *Regional Studies*, 50: 557-560.

Balland, P. A., Boschma, R., Crespo, J. and Rigby, D. (2018) Smart specialisation policy in the European Union: relatedness, knowledge complexity and regional diversification, *Regional Studies*.

Balland, P. A., Rigby, D. and Boschma, R. (2015) The technological resilience of US cities, *Cambridge Journal of Regions, Economy and Society*, *8*: 167-184.

Barca, F. (2006) *Italia frenata*. Roma: Donzelli Editore.

Bishop, P. and Gripaios, P. (2010) Spatial Externalities, Relatedness and Sector Employment Growth in Great Britain, *Regional Studies*, 44: 443-454.

Boschma, R. (2015) Towards an evolutionary perspective on regional resilience, *Regional Studies*, 49: 733-751.

Boschma, R. (2017) Relatedness as driver of regional diversification: A research agenda, *Regional Studies*, 51: 351-364.

Boschma, R. (2018) The geographical dimension of structural change, *Papers in Evolutionary Economic Geography*, No. 1839, Utrecht University.

Boschma, R. and Gianelle, C. (2014) Regional branching and smart specialisation policy, *S3 Policy Brief Series No. 06/2014*, Institute for Prospective and Technological Studies, Joint Research Centre.

Boschma, R. and Iammarino, S. (2009) Related Variety, Trade Linkages, and Regional Growth in Italy. *Economic Geography*, 85: 289-311.

Bristow, G. and Healy, A. (2015) Crisis response, choice and resilience: insights from complexity thinking, *Cambridge Journal of Regions, Economy and Society*, 8: 241-256.

Bristow, G. and Healy, A. (2018) Innovation and regional economic resilience: an exploratory analysis, *The Annals of Regional Science*, 60: 265-284.

Cellini, R. and Torrisi, G. (2014) Regional Resilience in Italy: A Very Long-Run Analysis, *Regional Studies*, 48: 1779-1796.

Christopherson, S., Michie, J. and Tyler, P. (2010) Regional resilience: theoretical and empirical perspectives, *Cambridge journal of regions, economy and society*, 3: 3-10.

Cooke, P. (2001) From technopoles to regional innovation systems: the evolution of localised technology development policy, *Canadian journal of regional science*, 24: 21-42.

Cooke, P. (2017) Resilience in ruins: The idea of the 'arrested dialectic'in art after resilience's failures, *European Planning Studies*, 25: 48-66.

Cooke, P., Uranga, M. G. and Etxebarria, G. (1997) Regional innovation systems: Institutional and organisational dimensions, *Research policy*, 26: 475-491.

Cortinovis, N. and Van Oort, F. (2015) Variety, economic growth and knowledge intensity of European regions: a spatial panel analysis, *The Annals of Regional Science*, 55: 7-32.

Crescenzi, R., Luca, D. and Milio, S. (2016) The geography of the economic crisis in Europe: national macroeconomic conditions, regional structural factors and short-term economic performance, *Cambridge Journal of Regions, Economy and Society*, 9: 13-32.

David, P. A. (2001) Path dependence, its critics and the quest for 'historical economics. In P. Garrouste and S. Ioannides (eds) *Evolution and Path Dependence in Economic Ideas: Past and Present*, pp. 15-50. Edward Elgar Publishing, Cheltenham, England.

Di Caro, P. (2015) Recessions, recoveries and regional resilience: evidence on Italy, *Cambridge Journal of Regions, Economy and Society*, 8: 273-291.

Eraydin, A. (2016) Attributes and characteristics of regional resilience: Defining and measuring the resilience of Turkish regions, *Regional Studies*, 50: 600-614.

European Commission (2010) *Europe 2020. A strategy for smart, sustainable and inclusive growth*, Brussels: European Commission.

European Commission (2012) *Guide to regional/national Research and Innovation Strategies for Smart Specialisation (RIS3)*, Brussels: European Commission.

European Commission (2017) *Strengthening Innovation in Europe's Regions: Strategies for resilient, inclusive and sustainable growth*, Brussels: European Commission.

Evenhuis, E. (2017) New directions in researching regional economic resilience and adaptation, *Geography Compass*, 11.

Faggian, A., Gemmiti, R., Jaquet, T. and Santini, I. (2018) Regional economic resilience: the experience of the Italian local labor systems, *The Annals of Regional Science*, 60: 393-410.

Fingleton, B., Garretsen, H. and Martin, R. (2012) Recessionary shocks and regional employment: evidence on the resilience of UK regions, *Journal of Regional Science*, 52: 109-133.

Foray, D., (2015) *Smart specialisation: Opportunities and challenges for regional innovation policy*, Routledge.

Foray, D., Morgan, K. and Radosevic, S. (2018) The role of smart specialisation in the eu research and innovation policy landscape, *European Commission*.

Foray, D., David, P. A. and Hall, B. (2009) Smart specialisation–the concept, *Knowledge economists policy brief*, 9: 100.

Foray, D., David, P. A. and Hall, B. H. (2011) *Smart specialisation from academic idea to political instrument, the surprising career of a concept and the difficulties involved in its implementation*, No. EPFL-WORKING-170252, Lausanne: EPFL.

Foray, D., and Rainoldi, A. (2013) Smart Specialisation programmes and implementation, *S3 Policy Brief Series*, (02).

Frenken, K., Van Oort, F. G. and Verburg, T. (2007) Related variety, unrelated variety and regional growth, *Regional Studies*, 41: 685–697.

Fritsch, M. and Kublina, S. (2018) Related variety, unrelated variety and regional growth: the role of absorptive capacity and entrepreneurship, *Regional Studies*, 52: 1360-1371.

Fröhlich, K. and Hassink, R. (2018) Regional resilience: a stretched concept?, *European Planning Studies*.

Grabher, G. (1993) The weakness of strong ties: the lock-in of regional development in the Ruhr Area. In G. Grabher (ed) *The Embedded Firm: On the Socio- Economics of Industrial Networks*, pp. 255–277. London: Routledge.

Grabher, G. and Stark, D. (1997) Organizing diversity: evolutionary theory, network analysis and postsocialism, *Regional studies*, 31: 533-544.

Hartog, M., Boschma, R. and Sotarauta, M. (2012) The impact of related variety on regional employment growth in Finland 1993–2006: High-tech versus medium/low-tech, *Industry and Innovation*, 19: 459-476.

Hassink, R. (2010) Regional resilience: a promising concept to explain differences in regional economic adaptability?, *Cambridge journal of regions, economy and society*, 3: 45-58.

Hausmann, R. Hidalgo, C. A., Bustos, S., Coscia, M., Simeos, A. and Yildirim, M. A. (2013) *The Atlas of Economic Complexity: Mapping Paths to Prosperity*, Cambridge: MIT Press.

Hervas-Oliver, J., Jackson, I. and Tomlinson, P. (2011) May the ovens never grow cold': regional resilience and industrial policy in the North Staffordshire ceramics industrial district – with lessons from Sassoulo and Castellon, *Policy Studies*, 32: 377-395.

Hidalgo, C., Klinger, B., Barabasi, A. and Hausmann, R. (2007) The product space conditions the development of nations, *Science*, 317: 482-487.

Hidalgo, C. A., Balland, P. A., Boschma, R., Delgado, M., Feldman, M., Frenken, K., Glaeser, E., He, C., Kogler D. F., Morrison, A., Neffke, F., Rigby, D., Stern, S., Zheng, S. and Zhu, S. (2018) The Principle of Relatedness, *Papers in Evolutionary Economic Geography,* 18.30, Utrecht University.

Hu, X. and Hassink, R (2017) Exploring adaptation and adaptability in uneven economic resilience: a tale of two Chinese mining regions, *Cambridge Journal of Regions, Economy and Society,* 10: 527–541.

Innocenti, N. and Lazzeretti, L. (2019) Do the creative industries support growth and innovation in the wider economy? Industry relatedness and employment growth in Italy, *Industry and Innovation*.

Isaksen, A. (2015) Industrial development in thin regions: trapped in path extension?, *Journal of economic geography*, 15: 585-600.

Lagravinese, R. (2015) Economic crisis and rising gaps North-South: evidence from the Italian regions, *Cambridge Journal of Regions, Economy and Society*, 8: 331-342.

Mameli, F., Iammarino S. and Boschma, R. (2012) Regional Variety and Employment Growth in Italian Labour Market Areas: Services Versus Manufacturing Industries. *Papers in Evolutionary Economic Geography*, 12.03, Utrecht University.

Marques, P. and Morgan, K. (2018) The Heroic Assumptions of Smart Specialisation: A Sympathetic Critique of Regional Innovation Policy, In A. Isaksen, R. Martin and M. Trippl (eds) *New Avenues for Regional Innovation Systems - Theoretical Advances, Empirical Cases and Policy Lessons*, pp. 275-295. Springer.

Martin, R. (2010) Roepke Lecture in Economic Geography—Rethinking regional path dependence: beyond lock-in to evolution, *Economic geography*, 86: 1-27.

Martin, R. (2012) Regional economic resilience, hysteresis and recessionary shocks, *Journal of economic geography*, 12: 1-32.

Martin, R. and Sunley, P. (2015) On the notion of regional economic resilience: conceptualization and explanation, *Journal of Economic Geography*, 15: 1-42.

Martin, R., Sunley, P., Gardiner, B. and Tyler, P. (2016) How Regions React to Recessions: Resilience and the Role of Economic Structure, *Regional Studies*, 50(4): 561-585.

McCann, P. and Ortega-Argilés, R. (2015) Smart specialisation, regional growth and applications to European Union cohesion policy, *Regional Studies*, 49: 1291-1302.

McCann, P. and Ortega-Argilés, R. (2016) The early experience of smart specialisation implementation in EU cohesion policy, *European Planning Studies*, 24: 1407-1427.

Neffke, F., Henning, M. and Boschma, R. (2011) How do regions diversify over time? Industry relatedness and the development of new growth paths in regions. *Economic Geography*, 87; 237-265.

Ortega-Argilés, R. (2012) The Transatlantic Productivity Gap: A Survey of the Main Causes, *Journal of Economic Surveys*, 26: 395-419.

Pinheiro, F., Alshamsi, A., Hartmann, D., Boschma, R. and Hidalgo, C. (2018) Shooting Low or High: Do Countries Benefit from Entering Unrelated Activities?. *Papers in Evolutionary Economic Geography*, No. 1807, Utrecht University.

Pinto, H., Nogueira, C., Carrozza, C. and D'Emery, R. (2019) Smart Specialisation and the Entrepreneurial Discovery: A New Approach to Design Structural Change. In *New Paths of Entrepreneurship Development* (pp. 55-75). Springer, Cham.

Pike, A., Dawley, S., and Tomaney, J. (2010) Resilience, adaptation and adaptability, *Cambridge journal of regions, economy and society*, 3: 59-70.

Saviotti, P. and Frenken, K. (2008) Export variety and the economic performance of countries., *Journal of Evolutionary Economics*, 18: 201-218.

Simmie, J. (2017) The evolution of economic resilience in cities: reinvention versus replication. In N. Williams and T. Vorley (eds) *Creating Resilient Economies: Entrepreneurship, Growth and Development in Uncertain Times*, pp. 70-88. Cheltenham: Edward Elgar.

Simmie, J. and Martin, R. (2010) The economic resilience of regions: towards an evolutionary approach, *Cambridge journal of regions, economy and society*, 3: 27-43.

Storper, M., Kemeny, T., Makarem N. and Osman, T. (2015) *The Rise and Fall of Urban Economies: Lessons from San Francisco and Los Angeles*, Stanford: Stanford University Press.

Xiao, J., Boschma, R. and Andersson, M. (2017) Resilience in the European Union: the effect of the 2008 crisis on the ability of regions in Europe to develop new industrial specialisations, *Industrial and Corporate Change*, 27: 15-47.

Xiao, J., Boschma, R. and Andersson, M. (2018) Industrial diversification in Europe: The differentiated role of relatedness, *Economic Geography*.