Papers in Evolutionary Economic Geography

18.23

Does related variety affect regional resilience? New evidence from Italy

Giulio Cainelli & Roberto Ganau & Marco Modica

Utrecht University
Urban & Regional research centre Utrecht

Does related variety affect regional resilience? New evidence from Italy

Giulio Cainelli

Department of Economics and Management "Marco Fanno", University of Padova
Via del Santo 33, 35123 Padova, Italy
Tel: (0039) 0498274227 − Fax: (0039) 0498274221 − E-mail: giulio.cainelli@unipd.it

Roberto Ganau*

Department of Economics and Management "Marco Fanno", University of Padova
Via del Santo 33, 35123 Padova, Italy
Tel: (0039) 0498274057 − Fax: (0039) 0498274221 − E-mail: roberto.ganau@unipd.it
Department of Geography and Environment, London School of Economics and Political Science
Houghton Street, London WC2A 2AE, United Kingdom
E-mail: r.ganau1@lse.ac.uk

Marco Modica

Research Institute on Sustainable Economic Growth (IRCrES), National Research Council
and Gran Sasso Science Institute (GSSI)
Via M. Iacobucci, 2, 67100 L'Aquila, Italy
E-mail: marco.modica@gssi.it

* Corresponding Author.

Does related variety affect regional resilience? New evidence from Italy

Abstract: Although several contributions have studied the effect of related variety on the economic performance of firms and regions, its influence on regional resilience – that is, regions' capacity to adapt to external shocks – has received little attention. This paper contributes to this debate by analysing empirically the relationship between related variety and regional resilience at the Italian Local Labour Market (LLM) level. The analysis adopts the definition of regional resilience developed by Martin (2012), and employs spatial econometric techniques − besides standard non-spatial models − to analyse the role played by related variety as a short-run shock absorber with respect to the 2008 Great Recession. The results obtained from the estimation of Spatial Error Models suggest that LLMs characterised by a higher level of related variety have shown a higher capacity to adapt to an external shock, that is, the Great Recession. This evidence is confirmed with respect to two different short-run time horizons, the one-year period 2012-2013 and the three-year period 2010-2013.

Keywords: Regional Resilience; Related Variety; Local Labour Markets; Italy.

JEL Codes: B52; C21; R11.

1. INTRODUCTION

The 2008 Great Recession – which hit all European regions, although with different intensity – prompted interest in the concept of regional resilience, which refers, from an evolutionary perspective, to a region's capacity to react positively to a short-term external shock or disruption (Simmie and Martin 2010; Martin 2012).

With different European regions reacting differently to the same external shock, several attempts have been made to identify empirically the main determinants of this regional resilience heterogeneity (e.g. Fingleton et al. 2012; Martin 2012; Modica and Reggiani 2014; Bristow and Healy 2017; Faggian et al. 2017; Fratesi and Perucca 2017). Among the drivers identified, one of the most important appears to be the region's current industrial structure and, in particular, its level of related diversification (Boschma 2015). As it is well known, the concept of related variety, which has been widely discussed and investigated during the last ten years (Frenken et al. 2007), stresses that what matters is not the level of productive diversification per se, but the presence of diversified domains allowing complementarities to be exploited across different industries. These complementarities arise from the existence of shared competencies, and depend on the cognitive proximity among local actors (Nooteboom 2000). Although the concept of related variety has several theoretical and empirical drawbacks (Iacobucci 2014), it has been widely employed in empirical studies. These works generally identify a positive effect of related variety on the economic performance of firms and regions, regardless of the country analysed or the econometric methodology adopted (e.g. Quatraro 2000; Cainelli and Iacobucci 2012; Cainelli et al. 2016; Lazzeretti et al. 2017).

Despite the relevance of the notions of related variety and industrial relatedness for economic geography and regional economics, analysis of their impact on regional resilience is scarce. This is surprising given that, according to the evolutionary approach to regional resilience (Boschma 2015), industrial relatedness seems to play a relatively important role in the short-run ability of regions to absorb an external shock. The few studies that focus on this issue find a positive effect of related variety and industrial relatedness on regional resilience, that is, they confirm the "shock absorbing" ability of related diversification. The contribution by Sedita et al. (2017) is of particular interest for the Italian case. They employ a simple Ordinary Least Squares (OLS) econometric strategy and show that related variety has a positive effect on local resilience simply measured as the growth of the employment rate after the 2008 Great Recession.

The present paper develops this kind of analysis in two directions. First, regional resilience is defined following the approach proposed by Martin (2012), and adopted by Lagravinese (2015) among others, who defines a resistance index as the ratio between the changes in regional employment with respect to the employment change at the national level. Thus, resilience is not identified simply with local employment growth, but rather with the ability of the local system to react to an exogenous shock − in this case, the 2008 Great Recession. A value of this resilience indicator greater than 1 means that the local system is highly sensitive to an exogenous shock; a value lower than 1 indicates a highly resilient local system. Second, the empirical analysis, which is performed at the Italian Local Labour Market (LLM) level, employs spatial econometric techniques in order to provide a more accurate picture of the related variety-resilience relationship.

The main results suggest that LLMs characterised by higher levels of related variety show higher capacity to adapt to external shocks. In other words, the analysis identifies related variety as being a shock-absorber.

The paper is organised as follows. The second Section discusses the related literature; the third Section describes the dataset and the econometric methodology adopted; the fourth Section presents and discusses the empirical findings; the fifth Section concludes the work.

2. RELATED LITERATURE

2.1. The concept of regional resilience

The concept of resilience, whose popularity has increased in recent years, is multi-faceted and, if not properly defined and contextualised, can result in confusions. The literature considers various different dimensions of resilience, including (i) its definition and (ii) the ways that it can be operationalised and measured empirically.[1]

In relation to its definition, the literature proposes three different interpretations (Angulo et al. 2017). The so-called "ecological approach" defines regional resilience as the region's capacity to move from one possible steady-state path to another without changes to its structure, identity and function (Holling 1973; Reggiani et al. 2002). The so-called "engineering approach" defines regional resilience as the region's capacity to return to a persistent steady-state equilibrium following a shock (Pimm 1984; Rose 2004; Fingleton et al. 2012). Finally, the so-called "evolutionary approach" defines regional resilience as the ability, following a shock, to adapt in the short run or to develop new growth paths in the long run (Martin 2012; Boschma 2015). All these definitions share a common feature: the presence of a certain threatening event, such as a natural disaster (e.g. the Northern Italy earthquake), a terroristic attack (e.g. the September 11 attacks) or a financial crisis (e.g. the 2008 Great Recession).

Similarly, operationalisation and measurement issues are important. For instance, typically, resilience to natural disasters is analysed through indices, while the analysis of economic shocks is based mainly on econometric models. Both simple and composite indicators can be used to assess the resilience of a given territory (Modica and Reggiani 2015). According to Martin (2012) and Martin and Sunley (2015), the ratio between the drop in regional employment or output and the corresponding drop in the country as a whole, is an appropriate simple indicator to evaluate the regional resistance to recessions.[2] In the case of composite indicators, the selection procedure of variables ranges from the identification through the study of previous literature (Cardona et al. 2008; Cutter et al. 2008; Briguglio et al. 2009; Foster 2011), to statistical methods based on factor analysis (Graziano 2013). In the context of econometric analyses, most are based on time-series.

[1] Note that, frequently, both definition and measurement depend on the analytical context (e.g. economic vs. natural shocks). For details, see Modica and Reggiani (2015) and Faggian et al. (2017).

[2] This indicator was slightly modified by Lagravinese (2015) to better account for asymmetric regional behaviours and longer time periods.

For instance, Fingleton et al. (2012) and Cellini and Torrisi (2014) test for differences in regional resilience through Seemingly Unrelated Regression Equations (SURE) models. Sensier et al. (2016) operationalise regional economic resilience by adopting a business cycles approach, which allows for the measurement of comparability in a cross-country analysis. Finally, Di Caro (2017) analyses both engineering and ecological resilience using non-linear smooth transition auto-regressive models.

2.2. Related variety and regional resilience

The industrial structure is generally considered a key determinant of regional resilience. Starting from this insight, a new stream of research in economic geography has enabled a deeper analysis through a focus on a specific feature of the regional industrial structure: the level of related diversification, or industrial relatedness. This literature strand, which originated from the debate on related variety (Frenken et al. 2007), investigates the role played by related variety in terms of regional resilience from two different time perspectives. According to the evolutionary approach (Boschma 2015), industrial relatedness may have a positive effect not only on the ability of a region to absorb an external shock in the short run, but also on its ability to develop new long-run growth paths.

Looking at the short-run effects of industrial relatedness, Balland et al. (2015) investigate the technological resilience of US cities over the 1975-2002 period. They find that cities with knowledge bases with high levels of relatedness with respect to the set of technologies in which they do not (yet) possess a comparative advantage, have a higher tendency to avoid crises or to limit the intensity and duration of a crisis event. Diodato and Weterings (2015) use Dutch data on 12 regions and 59 sectors to investigate how embeddedness of input-output linkages, skills relatedness and connectivity contribute jointly to the resilience of regional labour markets to economic shocks. They find that labour markets in centrally located and services-oriented regions recover more quickly irrespective of the type of shock hitting the economy. Sedita et al. (2017)

measure regional resilience simply as the growth in the employment rate following the Great Recession and, through a simple OLS approach, find that related variety has a positive effect on the resilience of Italian LLMs. They also investigate the role played by the local differentiated knowledge base (synthetic, analytical and symbolic) and find some interesting counter-intuitive results: symbolic and synthetic knowledge bases have a positive effect on regional resilience, while the role of the analytical knowledge base is negligible.

The long-run evolutionary approach to regional resilience was developed by Xiao et al. (2017). The main idea is that industrial relatedness can be a determinant of both long-run economic development and long-run regional resilience. Xiao et al. (2017) investigate the ability of 173 European regions to develop new industrial specialisations after the 2008 Great Recession, assuming industrial relatedness as a major determinant. They propose four measures of industrial proximity: unrelated variety, related variety, industrial relatedness − measured as the average proximity among the industries of specialisation with respect to the other industries located within a region −, and technological relatedness − measured using a Los (2000) index. Their main finding is that industrial relatedness has a positive effect on regional resilience following the crisis only in the case of knowledge intensive sectors.

The present paper focuses on the short-term, adaptive dimension of regional resilience, and on the role played by related variety as a shock absorber. The concept of related variety assumes that it is not the level of productive diversification per se which matters, but the presence of diversified domains that allow the exploitation of complementarities across different sectors (Frenken et al. 2007). Complementarities arise from existing shared competencies and their diffusion depends on the level of cognitive proximity among local actors (Nooteboom 2000). The diversified productive structure of a local system can improve the opportunity to interact, copy, modify and recombine ideas, practices and technologies across industries. These processes can lead to the development of new products and services. Also, they can favour the transfer of skills, capabilities and technologies among the industries in the same local system. For these reasons, related variety is expected to have a positive effect on regional resilience since skills, capabilities and technologies can be rapidly re-allocated across different local industries sharing the same knowledge base, thus improving the capacity of the region to respond to an external shock. From this perspective, related variety can be considered a short-run shock absorber.

3. EMPIRICAL FRAMEWORK

3.1. Measuring regional resilience and related variety

The empirical analysis focuses on the relationship between industrial relatedness and local economic resilience. The spatial unit of analysis is the Italian LLM, which is a functional area encompassing the municipality and identified on the basis of workers' commuting flows. Therefore, LLMs are defined according to economic rather than administrative criteria.

Following the evolutionary approach proposed by Martin (2012), the regional resilience index in the LLM $l = 1, \dots, 686$ over the period $T - t$, with $T > t$, is defined as follows:

$$Resilience\ Index_l^{T-t} = \left(\frac{Employment_l^T}{Employment_l^t} - 1\right) \Big/ \left(\frac{\sum_{l=1}^{686} Employment_l^T}{\sum_{l=1}^{686} Employment_l^t} - 1\right) \quad (1)$$

where $Employment_l$ denotes employment in LLM l and $\sum_{l=1}^{686} Employment_l$ is employment in Italy. The resilience index is calculated as the ratio between employment change in the LLM and employment change in Italy. Hence, LLMs characterised by a resilience index value greater than 1 are highly sensitive to exogenous shocks, that is, they show a low level of resilience, whereas LLMs characterised by a resilience index value lower than 1 show a high level of resilience to exogenous shocks.

The resilience index is constructed for two periods: the three-year period 2010-2013 and the one-year period 2012-2013. As Figure 1 shows, the Italian GDP recorded an increase following the 2008 Great Recession in the year 2009, although it reached its pre-crisis level only in 2010, when it also recorded a positive annual growth rate. However, a new recession affected the Italian economy over the 2011-2012 period, which was characterised by a negative annual GDP growth. Then, the GDP started to increase again from the year 2012. Therefore, the analysis considers these two short-run post-crisis periods in order to evaluate the effects of industrial relatedness over time periods of pure recovery.

[--- Figure 1 ---]

Following Frenken et al. (2007), industrial relatedness is captured by an index of related variety, built using employment data at the five-digit level of the Ateco classification of the economic activities adopted by ISTAT (Italian National Institute of Statistics) in 2001. The related variety index for the l-th LLM is constructed for the year 2001 as follows:

$$Related\ Variety_l^{2001} = \sum_i^I P_{li}^{2001} H_{li}^{2001}$$

$$H_{li}^{2001} = \sum_{s \in i} \left(\frac{p_{ls}^{2001}}{P_{li}^{2001}} \right) \log_2 \left[\frac{1}{\left(p_{ls}^{2001} / P_{li}^{2001} \right)} \right] \tag{2}$$

where P_{li}^{2001} denotes the two-digit level employment share for the l-th LLM obtained by summing the five-digit level employment shares (p_{ls}^{2001}) under the hypothesis that all five-digit sectors s belong to a unique two-digit sector i; H_{li}^{2001} is an entropy measure computed for each LLM. A high related variety index value denotes a high level of related diversification across the economic sectors in the same LLM.

Figure 2 maps the spatial distribution of LLMs which can be identified as resilient and non-resilient over the two periods considered according to Equation (1). It also maps the spatial distribution of the related variety index. The maps show clearly that Northern LLMs performed better than LLMs located in the other Italian macro-areas. They show also that the performance of some LLMs that were able to react to the crisis over the one-year period was lower than the performance of other LLMs over the three-year period, and vice versa. Moreover, the comparison of the three maps suggests that, overall, LLMs characterised by high levels of related variety in 2001 have been those performing better in terms of resilience capacity over the periods 2012-2013 and 2010-2013. This seems to be particularly relevant for the Northern and Central LLMs.

[--- Figure 2 ---]

3.2. The empirical model

The following empirical model is specified to test the relationship between related variety and regional resilience:

$$Resilience_l^{T-t} = \alpha + \beta \log(Related\ Variety_l^{2001}) + x_l'\delta + \boldsymbol{\gamma}_g + \varepsilon_l \quad (3)$$

where $Resilience_l^{T-t}$ denotes the economic resilience in LLM l over either the one-year period 2012-2013 or the three-year period 2010-2013, and is defined as follows:

$$Resilience_l^{T-t} = \frac{\log(Employment_l^T) - \log(Employment_l^t)}{\log(\sum_{l=1}^{686} Employment_l^T) - \log(\sum_{l=1}^{686} Employment_l^t)} \quad (4)$$

The vector x_l' includes control variables defined at the LLM level for the year 2001. It includes an index of unrelated variety, which is defined using a two-digit level entropy measure to capture the overall degree of productive diversification of a LLM. Following Frenken et al. (2007), the index of unrelated variety is constructed as follows:

$$Unrelated\ Variety_l^{2001} = \sum_i^I P_{li}^{2001} \log_2 \left(\frac{1}{P_{li}^{2001}} \right) \quad (5)$$

It also includes a dummy variable which equals 1 if the LLM is identified as an industrial district by ISTAT ($Industrial\ District_l^{2001}$), and 0 otherwise; a variable capturing labour productivity ($Productivity_l^{2001}$) defined as value added per employee; a variable capturing the average size of firms in the LLM ($Firm\ Size_l^{2001}$) defined as the ratio between the number of employees and the number of firms (Paci and Usai 2008); a variable capturing the availability of human capital ($Human\ Capital_l^{2001}$) defined as the ratio between people with tertiary education and the total population aged at least 24 years.[3] The term $\boldsymbol{\gamma}_g$ denotes a set of geographic dummy variables defined at the NUTS (*Nomenclature des Unités Territoriales Statistiques*) level 1 – North West, North East, Centre, South and Islands – and aimed at capturing different socio-economic and institutional features that might influence the economic performance of LLMs located in the same macro-area. Finally, ε_l is an $N\times1$ vector of the error terms assumed to be independent and identically distributed (i.i.d.). Table 1 reports some descriptive statistics of the dependent and explanatory variables; Table 2 reports the correlation matrix among the key explanatory variables.

[--- Table 1 ---]

[--- Table 2 ---]

3.3. The role of spatial externalities

Although Equation (3) can be estimated easily using an OLS estimator, recent contributions in regional economics have underlined how regional (economic) phenomena tend to be

[3] Both the dependent and the explanatory variables are calculated using data provided by ISTAT.

characterised and influenced by spatial spillover effects (e.g. Ramírez and Loboguerrero 2002; Fingleton and López-Bazo 2006; Garrett et al. 2007; Paci and Usai 2008; Arbia et al. 2010). The spatial dependence issue arises because local economic systems are not isolated units. In fact, they tend to generate externalities that are likely to influence the performance of neighbouring local systems (LeSage and Pace 2009). The spatial econometric literature identifies two main forms of spatial dependence (Anselin and Rey 1991): (i) substantive spatial dependence, driven by interaction effects across local units (e.g. the LLM's economic resilience is likely to influence the economic resilience of neighbouring LLMs); and (ii) nuisance spatial dependence, due to measurement errors (e.g. wrongly identified spatial units) or random shocks occurring in a local unit but producing effects in neighbouring units (Rey and Montouri 1999).

Recent empirical contributions propose (substantive) spatial externalities modelled using a Spatial Durbin Model (SDM), specified by including the spatial lags of both the dependent and the explanatory variables on the right-hand side of the equation. It follows that Equation (3) can be specified as follows (Arbia 2014; Elhorst 2014):

$$Resilience_l^{T-t} = \alpha + \beta \log(Related\ Variety_l^{2001}) + x_l'\delta + \boldsymbol{\gamma}_g + \rho \boldsymbol{W_N} Resilience_l^{T-t}$$
$$+\pi \boldsymbol{W_N} \log(Related\ Variety_l^{2001}) + \boldsymbol{W_N} x_l' \varphi + \varepsilon_l \quad (6)$$

where $\boldsymbol{W_N}$ denotes the spatial weights matrix used to model spillover effects across LLMs. Specifically, the spatial matrix is defined as a binary row-standardised matrix with distance cut-off value ($\bar{d}$) defined as the minimum distance (about 55 kilometres) such that each LLM l has at least one neighbour m. The single element w_{lm} of the matrix is defined as follows:

$$w_{lm} = \begin{cases} 0, & if\ l = m \\ 1, & if\ d_{lm} \leq \bar{d}\ with\ l \neq m, \\ 0, & if\ d_{lm} > \bar{d}\ with\ l \neq m \end{cases} \quad (7)$$

The term ρ is the spatial parameter referring to the spatially lagged dependent variable and capturing the potential effect of the LLM's resilience on neighbouring LLMs' resilience; the term π is the spatial parameter referring to the spatially lagged related variety variable; and φ is a vector of the spatial parameters referring to the spatially lagged control variables for industrial district, labour productivity, firm size and human capital.

Having estimated Equation (6) by Maximum Likelihood (ML), it is possible to test for restrictions on the spatial parameters in order to identify which (spatial) model best describes the resilience process: (i) if $\rho = \pi = \varphi = 0$, then the SDM reduces to the a-spatial model specified in Equation (3); (ii) if $\rho = 0$, then the SDM reduces to a Spatial Cross-Regressive Model (SXM) incorporating only spatially lagged explanatory variables; (iii) if $\pi = \varphi = 0$, then the SDM reduces to a Spatial Lag Model (SLM) incorporating only the spatial lag of the dependent variable; (iv) if $\pi = -\rho\beta$ and $\varphi = -\rho\delta$, then the SDM reduces to a Spatial Error Model (SEM) implying nuisance spatial dependence, such that Equation (3) can be augmented assuming a spatial auto-regressive structure of the error term, and can be specified as follows:

$$Resilience_l^{T-t} = \alpha + \beta \log(Related\ Variety_l^{2001}) + x_l'\delta + \boldsymbol{\gamma}_g + \lambda \boldsymbol{W_N} \varepsilon_l + u_l \qquad (8)$$

where ε_l is an $N \times 1$ vector of the spatially correlated errors, λ is the spatial auto-regressive parameter, and u_l is an $N \times 1$ vector of the spatial disturbance terms with i.i.d. properties. Finally, the SDM can be reduced to a Spatial Autocorrelation Model (SAC), which simultaneously models substantive and nuisance spatial dependence through the spatial lag of the dependent variable and the spatial process of the error term.

4. EMPIRICAL RESULTS

Table 3 reports the results of the OLS estimation of Equation (3). The Breusch-Pagan test underlines the presence of heteroskedasticity, suggesting the need to use White-robust standard errors. The maximum value of the Variance Inflation Factor (VIF) is 2.66, which suggests the absence of multicollinearity problems in the estimated specifications.

The related variety variable has negative coefficients that are statistically significant only when the three-year period resilience is considered. This result suggests that LLMs characterised by a high level of industrial relatedness tend to react better to exogenous shocks (i.e. the crisis) than LLMs characterised by a low level of relatedness over a longer time horizon.[4] The results suggest a negligible effect of the variables for unrelated variety, industrial district and human capital, while labour productivity seems to have a negative effect on resilience over the longer time horizon considered (i.e. the 2010-2013 period). LLMs characterised by the presence of larger firms seem to perform better over both time periods. A possible explanation for the negative productivity effect may be related to the greater international openness of the most productive firms, and, consequently, of the most productive LLMs, such that a high level of global interconnections tends to amplify the effects of the crisis. In contrast, the presence of larger firms, that are not necessarily also the most productive firms, operates as a sort of protection for the local market due, perhaps, to these firms' greater availability of internal financial and human resources.

[--- Table 3 ---]

Table 3 also reports the results of the Moran's I test, which suggests the presence of spatial autocorrelation across LLMs. Therefore, the SDM specified in Equation (6) is estimated via ML, and restrictions on its spatial parameters were tested to identify which (spatial) model best describes the data.

Table 4 reports the results of the spatial diagnostic tests performed on the estimated SDM − the specifications correspond to those reported in Table 3. Panel A reports p-values for the tests

[4] Recall that a resilience index value greater than 1 means higher sensitivity to an exogenous shock.

performed on the SDM. The SDM performs better than the SLM, the SXM and the a-spatial model, while the SEM seems to perform better than the SDM when considering one-year resilience and excluding LLM-level control variables from the estimated specification. In all other cases, both the SLM and the SEM seem to perform better than the SDM – which outperforms the SXM and the a-spatial model. Therefore, the SAC model was estimated for these specifications. Panel B reports p-values for tests performed on the SAC model: in all cases, the SAC outperforms both the SLM and the a-spatial model, while the SEM outperforms the SAC. Overall, spatial diagnostic tests highlight the presence of nuisance spatial dependence across LLMs and suggest estimation of a SEM – see Equation (8).

[--- Table 4 ---]

Table 5 reports the results of the ML estimation of the SEM. The coefficients of the related variety variable are negative and statistically significant in all the estimated specifications. This suggests a positive effect of industrial relatedness on both the one-year and three-year period resilience. The coefficients of the variables for unrelated variety, industrial district, labour productivity and human capital are not statistically significant, while the coefficients of the firm size variable are negative and significant, meaning that the presence of larger firms favours LLMs' resilience. The spatial error parameter (λ) shows positive and statistically significant coefficients, suggesting the presence of random shocks producing effects across neighbouring LLMs.

[--- Table 5 ---]

5. CONCLUSIONS

The 2008 Great Recession highlighted the concept of regional resilience. According to the evolutionary approach, the region's current industrial structure plays a key role; it may absorb an external shock in the short run or develop new growth paths in the long run (Martin and Sunley 2015).

By adopting a short-run evolutionary perspective, this paper contributes to this literature by investigating empirically the relationship between related variety and short-run regional resilience in Italy. Specifically, the analysis adopts the definition of regional resilience developed by Martin (2012), and employs spatial econometric techniques. The results suggest that LLMs characterised by a higher level of related variety have a greater capacity to adapt to external shocks in the short run, that is, a higher capacity to adapt to the crisis.

This result has interesting policy implications. Regional policies should be redefined in order to stimulate and promote the capacity of individual regions to both resist external macroeconomic shocks (e.g. the 2008 Great Recession) and adapt to the changed context through re-conversion/re-organisation of the productive structure, as well as promoting growth processes and increasing local competition. The re-configuration of assets is significant for reinforcing a region's capacity to react and adapt to exogenous shocks, that is, to reinforce its resilience. It is clear that the Great Recession has renewed the role of regional policies to both promote local competition and sustain regional resilience. The process of re-configuration/re-organisation of local assets – driven by a process of related diversification – reinforces regional resilience and identifies new development paths and new patterns of local competition (Boschma and Gianelle 2014). It follows that traditional policy goals – such as local development and competition – should be re-defined to put more emphasis on regional capacity for resilience, that is, on the capacity of regions to adapt to changed (economic) conditions.

This stream of research leads to the identification and development of new analytical perspectives. The existence of a positive relationship between related diversification and regional resilience is an interesting topic to explore further from both an economic analysis perspective and in terms of the implications for policy.

REFERENCES

Angulo AM, Mur J, Trívez FJ (2017) Measuring resilience to economic shocks: an application to Spain. The Annals of Regional Science, DOI: 10.1007/s00168-017-0815-8.

Anselin L, Rey S (1991) Properties of tests for spatial dependence in linear regression models. Geographical Analysis 23: 112-131.

Arbia G (2014) A primer for spatial econometrics. With applications in R. Basingstoke: Palgrave Mcmillan.

Arbia G, Battisti M, Di Vaio G (2010) Institutions and geography: empirical test of spatial growth models for European regions. Economic Modelling 27: 12-21.

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

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

Boschma R, Gianelle C (2014) Regional branching and smart specialisation policy. S3 Policy Brief Series No. 06/2014, JCR Technical Reports, European Commission.

Briguglio L, Cordina G, Farrugia N, Vella S (2009) Economic vulnerability and resilience: concepts and measurements. Oxford Development Studies 37: 229-247.

Bristow G, Healy A (2017) Innovation and regional economic resilience: an exploratory analysis. The Annals of Regional Science, DOI: 10.1007/s00168-017-0841-6.

Cainelli G, Iacobucci D (2012) Agglomeration, related variety and vertical integration. Economic Geography 88: 255-277.

Cainelli G, Iacobucci D, Ganau R (2016) Do Geographic concentration and vertically-related variety foster firm productivity? Micro-evidence from Italy. Growth and Change 47: 197-217.

Cardona OD, Ordaz MG, Marulanda MC, Barbat AH (2008) Fiscal impact of future earthquakes and country's economic resilience evaluation using the disaster deficit index. The 14th

World Conference on Earthquake Engineering, Beijing, China.

Cellini R, Torrisi G (2014) Regional resilience in Italy: a very long-run analysis. Regional Studies 48: 1779-1796.

Cutter SL, Barnes L, Berry M, Burton C, Evans E, Tate E, Webb J (2008) A place-based model for understanding community resilience to natural disasters. Global Environmental Change 18: 598-606.

Di Caro P (2017) Testing and explaining economic resilience with an application to Italian regions. Papers in Regional Science 96: 93-113.

Diodato D, Weterings A (2015) The resilience of regional labour markets to economic shocks: exploring the role of interactions among firms and workers. Journal of Economic Geography 15: 723-742.

Elhorst JP (2014) Spatial econometrics. From cross-sectional data to spatial panels. Berlin Heidelberg: Springer-Verlag.

Faggian A, Gemmiti R, Jaquet T, Santini I (2017) Regional economic resilience: the experience of the Italian local labor systems. The Annals of Regional Science, DOI: 10.1007/s00168-017-0822-9.

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

Fingleton B, López-Bazo E (2006). Empirical growth models with spatial effects. Papers in Regional Science 85: 177-198.

Foster KA (2011) "Resilience Capacity Index". Data, maps and findings from original quantitative research on the resilience capacity of 361 US metropolitan regions. URL: http://brr.berkeley.edu/rci/.

Fratesi U, Perucca G (2017) Territorial capital and the resilience of European regions. The Annals of Regional Science, DOI: 10.1007/s00168-017-0828-3.

Frenken K, van Oort FG, Verburg T (2007) Related variety, unrelated variety and regional economic growth. Regional Studies 41: 685-697.

Garrett TA, Wagner GA, Wheelock DC (2007) Regional disparities in the spatial correlation of state income growth, 1977-2002. The Annals of Regional Science 41: 601-618.

Graziano P (2013) Vulnerability and resilience of the economic, social and environmental dimensions of Italian provinces. Regional Studies Association European Conference, Tampere, Finland.

Holling CS (1973) Resilience and stability of ecological systems. Annual Review of Ecological System 4: 1-23.

Iacobucci D (2014) Developing and implementing a smart specialisation strategy at regional level: some open questions. Scienze Regionali − Italian Journal of Regional Science 13: 107-126.

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.

Lazzeretti L, Innocenti N, Capone F (2017) The impact of related variety on the creative employment growth. The Annals of Regional Science 58: 491-512.

LeSage J, Pace K (2009) Introduction to Spatial Econometrics. Boca Raton: CRC Press.

Los B (2000) The empirical performance of a new inter-industry technology spillover measure. In: Saviotti P, Nooteboom B (eds) Technology and knowledge. From the firm to the innovation systems. Celthenham UK and Northampton MA: Edward Elgar.

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

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

Modica M, Reggiani A (2014) An alternative interpretation of regional resilience: evidence from Italy. ERSA Conference Paper No. ersa14p369, European Regional Science Association.

Modica M, Reggiani A (2015) Spatial economic resilience: overview and perspectives. Networks and Spatial Economics 15: 211-233.

Nooteboom B (2000) Learning and innovation in organization and economics. Oxford: Oxford University Press.

Paci R, Usai S (2008) Agglomeration economies, spatial dependence and local industry growth. Revue d'Economie Industrielle 123: 87-109.

Pimm SL (1984) The complexity and stability of ecosystems. Nature 307: 321-326.

Quatraro F (2000) Knowledge coherence, variety and economic growth. Manufacturing evidence from Italian regions. Research Policy 20: 321-328.

Ramírez MT, Loboguerrero AM (2002) Spatial dependence and economic growth: evidence from a panel of countries. Borradores de Economia 206, Banco de la Republica de Colombia, Colombia.

Reggiani A, De Graaf T, Nijkamp P (2002) Resilience: an evolutionary approach to spatial economic systems. Networks and Spatial Economics 2: 211-229.

Rey SJ, Montouri BD (1999) US regional income convergence: a spatial econometric perspective. Regional Studies 33: 143-156.

Rose A (2004) Defining and measuring economic resilience to disasters. Disaster Prevention and Management 13: 307-314.

Sedita SR, De Noni I, Pilotti L (2017) Out of the crisis: an empirical investigation of place-specific determinants of economic resilience. European Planning Studies 25: 155-180.

Sensier M, Bristow G, Healy A (2016) Measuring regional economic resilience across Europe: operationalizing a complex concept. Spatial Economic Analysis 11: 128-151.

Simmie J, Martin R (2010) The economic resilience of regions: towards an evolutionary approach. Cambridge Journal of Regions, Economy and Society 3: 27-43.

Xiao J, Boschma R, 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 specializations. Industrial and Corporate Change, 27: 15-47.

TABLES

Table 1. Descriptive Statistics

	Mean	Std. Dev.	Min.	Max.
$\text{Resilience}_l^{2013-2012}$	1.745	1.854	-3.445	8.423
$\text{Resilience}_l^{2013-2010}$	2.154	2.549	-9.626	11.429
$\text{Related Variety}_l^{2001}$	0.922	0.168	0.138	1.227
$\text{Unrelated Variety}_l^{2001}$	1.394	0.099	0.822	1.554
$\text{Industrial District}_l^{2001}$	0.223	0.417	0	1
$\text{Productivity}_l^{2001}$	-2.691	0.204	-3.309	-1.743
$\text{Firm Size}_l^{2001}$	1.028	0.284	0.380	1.763
$\text{Human Capital}_l^{2001}$	-1.264	0.184	-1.907	-0.773

Notes: All variables are log-transformed, except for the Industrial District dummy variable.

Table 2. Correlation Matrix among Explanatory Variables

		[1]	[2]	[3]	[4]	[5]	[6]
Related Variety_l^{2001}	[1]	1					
Unrelated Variety_l^{2001}	[2]	0.491	1				
Industrial District_l^{2001}	[3]	-0.111	0.179	1			
$\text{Productivity}_l^{2001}$	[4]	0.305	0.109	-0.336	1		
Firm Size_l^{2001}	[5]	0.023	0.503	0.421	-0.318	1	
Human Capital_l^{2001}	[6]	0.402	0.490	0.005	0.140	0.377	1

Notes: All variables are log-transformed, except for the Industrial District dummy variable.

Table 3. Baseline Results: A-Spatial Model

Dependent Variable	$\text{Resilience}_l^{2013-2012}$		$\text{Resilience}_l^{2013-2010}$	
Specification	(1)	(2)	(1)	(2)
$\text{Related Variety}_l^{2001}$	-0.537	-0.789	-1.425**	-2.112**
	(0.470)	(0.501)	(0.629)	(0.642)
$\text{Unrelated Variety}_l^{2001}$	-0.499	0.461	-1.171	0.627
	(0.778)	(0.895)	(1.044)	(1.175)
$\text{Industrial District}_l^{2001}$	...	0.013	...	-0.043
		(0.161)		(0.225)
$\text{Productivity}_l^{2001}$	...	0.497	...	1.465**
		(0.374)		(0.534)
$\text{Firm Size}_l^{2001}$	...	-0.591*	...	-1.143**
		(0.353)		(0.470)
$\text{Human Capital}_l^{2001}$	...	-0.451	...	-0.827
		(0.488)		(0.627)
NUTS-1 Fixed Effects	Yes	Yes	Yes	Yes
No. Observations	686	686	686	686
R^2	0.267	0.276	0.204	0.230
Adj. R^2	0.261	0.266	0.198	0.219
F Statistic	50.77***	31.69***	35.49***	23.50***
Breusch-Pagan Test	78.14***	63.35***	75.38***	63.02***
VIF (mean value)	1.32	1.74	1.32	1.74
VIF (max. value)	1.52	2.66	1.52	2.66
Moran's I Test	18.728***	18.944***	21.203***	20.044***

Notes: * p<0.1; ** p<0.05; *** p<0.01. Robust standard errors are reported in parentheses. All specifications include a constant term. All explanatory variables are log-transformed, except for the Industrial District and NUTS-1 dummy variables.

Table 4. Spatial Diagnostic Tests: SDM and SAC

Dependent Variable	$Resilience_i^{2013-2012}$		$Resilience_i^{2013-2010}$	
Control Variables	No	Yes	No	Yes
Panel A – Restrictions to Spatial Durbin Model (SDM)				
Spatial Lag Model (SLM)	0.0717	0.2337	0.3982	0.5438
Spatial Error Model (SEM)	0.3368	0.7726	0.5898	0.6013
Spatial Cross-Regressive Model (SXM)	0.0000	0.0000	0.0000	0.0000
A-Spatial Model	0.0000	0.0000	0.0000	0.0000
Panel B – Restrictions to Spatial Autocorrelation Model (SAC)				
Spatial Lag Model	...	0.0000	0.0573	0.0996
Spatial Error Model	...	0.7359	0.8380	0.8645
A-Spatial Model	...	0.0000	0.0000	0.0001

Notes: The table reports p-values of the tests on the spatial parameters.

Table 5. Results of the Spatial Error Model

Dependent Variable	$Resilience_l^{2013-2012}$		$Resilience_l^{2013-2010}$	
Specification	(1)	(2)	(1)	(2)
$Related\ Variety_l^{2001}$	-0.844**	-1.084**	-1.911***	-2.600***
	(0.416)	(0.458)	(0.545)	(0.577)
$Unrelated\ Variety_l^{2001}$	-0.523	0.041	0.030	0.736
	(0.682)	(0.787)	(0.898)	(1.002)
$Industrial\ District_l^{2001}$	...	0.038	...	-0.196
		(0.152)		(0.201)
$Productivity_l^{2001}$	...	0.539	...	0.670
		(0.372)		(0.485)
$Firm\ Size_l^{2001}$	...	-0.637*	...	-1.018**
		(0.326)		(0.424)
$Human\ Capital_l^{2001}$	...	-0.129	...	0.458
		(0.462)		(0.604)
λ	0.707***	0.705***	0.755**	0.748***
	(0.053)	(0.053)	(0.056)	(0.055)
NUTS-1 Fixed Effects	Yes	Yes	Yes	Yes
No. Observations	686	686	686	686
Log Likelihood	-1,218.35	-1,214.29	-1,448.87	-1,443.34
Wald χ^2 $(\lambda = 0)$	178.98***	180.61***	182.06***	186.12***
LM χ^2 $(\lambda = 0)$	307.83***	305.95***	396.71***	343.52***

Notes: * p<0.1; ** p<0.05; *** p<0.01. Robust standard errors are reported in parentheses. All specifications include a constant term. All explanatory variables are log-transformed, except for the Industrial District and NUTS-1 dummy variables. λ denotes the spatial error parameter. LM denotes the Lagrange Multiplier test on λ.

FIGURES

Figure 1. Italian GDP Dynamics

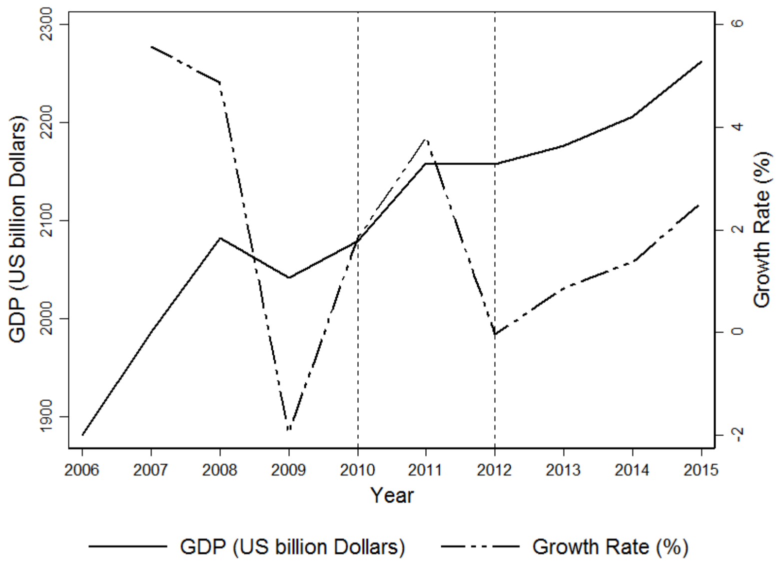
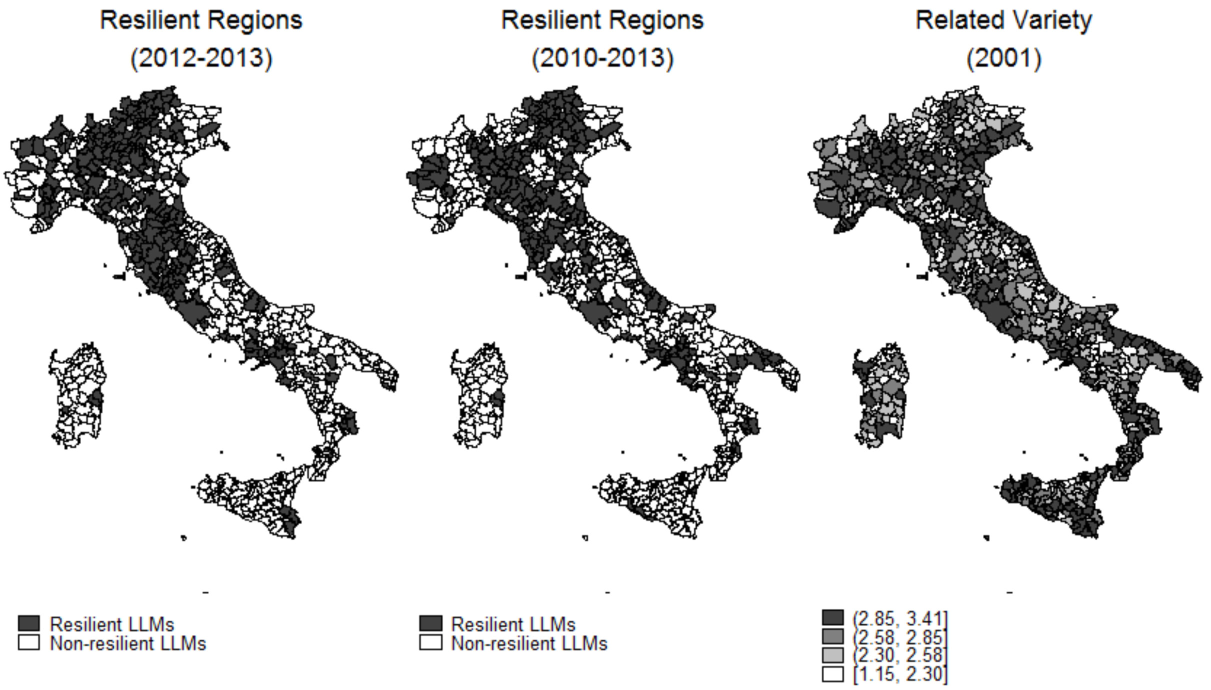


Figure 2. Regional Resilience and Related Variety



Notes: The distribution of the related variety index is based on four quartiles, and darker areas denote higher values of the index.