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Towards regional renewal: a multilevel perspective for the EU

Nicola Pontarollo[a] and Carolina Serpieri[b]

ABSTRACT

The 2008 financial crisis reopened the debate on regions' ability to deal with shocks within the European Union. We identify the spatial dimension of the renewal capacity, among the dimensions of economic resilience, and estimate its main drivers. We investigate the variables that determine the regional renewal capacity using different model specifications focusing upon several socioeconomic factors at two geographical scales: national and regional. The results highlight the fact that regional renewal has to be analysed including both local and contextual (national) factors. This multilevel perspective is useful for policy strategies in terms of reorienting their targets to the proper geographical and socioeconomic dimensions.

KEYWORDS

regional renewal; multilevel; resilience; European Union

JEL C38, P25, R11, R12

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INTRODUCTION

Great challenges have been posed by the recent economic and financial crisis to the world economic development and its maintenance. The European Union (EU) has been hit asymmetrically in time, strength and speed. Regions within countries have been differently impacted and have shown different degrees of resilience, that is, differentiated reactions to the negative economic downturn (Crescenzi, Luca, & Milio, 2016). Martin (2012) identifies four main dimensions of resilience: (1) resistance refers to how sensitive regional output and employment are to a shock; (2) recovery investigates how fast and comprehensively the region bounces back from a negative shock; (3) reorientation concerns the extent to which a regional economy changes after a shock; and (4) renewal examines the extent to which regional economies 'renew' their growth paths.

The literature on resilience focuses generally on the factors affecting the recovery at the country level,[1] with few studies analysing all European regions. We recall Davies (2011), who discusses a case of regions within 10 countries, while Brakman, Garretsen, and van Marrewijk (2014) analyse 255 NUTS-2 regions and Marelli, Patuelli, and Signorelli (2012), Giannakis and Bruggeman (2017a), Ezcurra and Rios (2019) and the European Observation Network for Territorial Development and Cohesion (ESPON) (2014) analyse all regions of the EU-27. More recently, Rizzi, Graziano, and Dallara (2018) create synthetic indicators of social, economic and environmental resilience for EU regions. Webber, Healy, and Bristow (2018) find connections between regional economic resilience and regional and national growth trajectories. Finally, Tsiapa, Kallioras, and Tzeremes (2018) test if sectoral labour productivity contributes to the resilience of regions, defined as changes in employment.

To the best of our knowledge, while the previous regional resilience literature concentrates especially on resistance and recovery, the present research focuses for the first time on its fourth dimension, that is, renewal. Inspired by the resilience framework provided by Manca, Benczur, and Giovannini (2017), we operationalize the concept introduced by Pontarollo and Serpieri (2017) identifying (1) its spatial pattern across EU regions and (2) the local and contextual characteristics that influence the renewal capacity. Among the different estimation techniques used, we, as far as we know, are pioneering in addressing spatial multilevel filtering techniques in the regional resilience literature.

As shown by Crescenzi et al. (2016), not only can local characteristics shape and influence the reaction to the crisis but also national factors such as macroeconomic conditions strengthen local economies and their capacities to adapt and recover after shocks. The contingency of the multilevel structural conditions helps mitigate the contraction of regional economic growth from the short-term

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consequences of the external negative shocks and accumulating necessary resistance capacities in transforming the economic structure in the long run.

Fratesi and Perucca (2018) focus upon regional characteristics and identify a set of assets, either material or immaterial, or public or private, which have been termed as 'territorial capital' that have aided some regions to resist and react to the crisis better than others.

Although studies have been conducted by many authors to identify the drivers of resilience, the renewal phase has previously never been addressed, making it more challenging for one to form reasonable expectations at the start of the research project. In spite of this literature gap, we aimed to be consistent with what has been found in previous more broad regional research on resilience (Fratesi & Perucca, 2018). However, as explained in detail below, the geography of regional renewal is characterized by a certain degree of homogeneity within countries, claiming for the role of both local and national factors such as welfare policies.

The paper is organized as follows. The next section describes the theoretical background. The third section presents the methodology and data employed. The fourth section illustrates the results of the empirical analysis. The last section concludes and provides policy implications.

THE RENEWAL CAPACITY OF EUROPEAN REGIONS AND ITS SPATIAL DISTRIBUTION

This section focuses on identifying the spatial distribution of the EU regional renewal capacity to the global economic crisis.

Following the conceptualization of Pontarollo and Serpieri (2017), we measured regional renewal capacity as the difference between the slopes of the trends before and after the crisis.[2] A positive value represents a positive renewal capacity of the economy, a negative value the absence of renewal capacity, that is, a decline. If the value tends to zero, the trends before and after the crisis overlap, meaning that there are no significant differences between the two periods.

In Figure 1, the x-axis represents the time and the y-axis the level of gross domestic product (GDP) per capita. The left panel shows the evolution of GDP per capita before and after a shock (black straight line), and the dotted lines the trends before and after the shock. In the right panel we translate both trend lines to get them starting from the origin of the axes. In a certain time t we can draw a rectangle with base $\overline{Ot}$ and height $\overline{Oa}$ ($\overline{Ob}$) to account for the welfare gain generated before (after) the crisis. The smaller (upper) rectangle represents the welfare gain or loss related to the extent to which regional economies 'renew' or do not change their growth paths. Obviously, this hypothetical welfare loss/gain is related to the time t in which it is calculated. Thus, assuming that the trends in the medium run are approximated linearly and tend to be stable, we avoid the issue of time dependency by computing the difference of the slopes of these two trends.

Figure 2 illustrates per capita GDP renewal capacity of the NUTS-2 regions in the EU-27.[3] Darker colours identify regions with a post-crisis growth trend closer or eventually better than the pre-crisis trend, while lighter colours have a large negative gap compared with the pre-crisis growth path.

As observed by Pontarollo and Serpieri (2017), per capita GDP regional renewal has a clear spatial pattern. Country dynamics tend to dominate. This is particularly evident in France, Portugal, Austria, Poland and Germany, which demonstrate higher economic renewal. Except for Portugal, peripheral regions, specifically the Mediterranean ones, have the lowest renewal rate. Within-country heterogeneity is more observable in Italy, where northern regions have higher renewal capacities than the southern regions; in the UK, where England's regions are the most resilient; and in smaller EU countries such as Hungary, Belgium, the Netherlands, Bulgaria and Romania. In Spain, the Mediterranean and northern regions and the Madrid Community show a high renewal rate. Therefore, in countries with a greater heterogeneity, historically forward and economically more dynamic areas are better able to react to the crisis. The presence of a well-defined spatial pattern can be formally tested through the use of Moran's I (MI) (Moran, 1950). This statistic has been widely used in the literature to describe economic phenomena whose distribution in space is not random (Gregory & Patuelli, 2015).

The MI relates the value of a selected variable with the values of the same variable in the neighbouring areas, namely its spatial lag. If the MI is statistically significant, a phenomenon is not isolated in space and what happens in a certain location is correlated to what happens in the neighbour locations. The formal definition of this relation is:

$$MI = \frac{N}{\sum_i \sum_j w_{ij}} \frac{\sum_i \sum_j w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_i w_{ij}(x_i - \bar{x})} \quad (1)$$

where N is the number of regions indexed by i and j; x is the variable of interest; $\bar{x}$ is its mean; and w_{ij} is an element of the spatial weights matrix $\mathbf{W}$, defined as a k-nearest neighbours of degree 5, that is, the five closest regions considered a neighbour.[4] Then, as customary, the matrix is standardized by row.

The calculated MI for global autocorrelation, for $\mathbf{W}$ standardized by row, varies between −1 and 1. A positive (negative) coefficient points to positive (negative) spatial autocorrelation, that is, clusters of similar (dissimilar) values can be identified. A value close to zero indicates a random spatial pattern.

The MI for the regional renewal is equal to 0.55 and is significant at the 1% level, which confirms the presence of positive autocorrelation.[5]

The MI, in spite being a useful tool for spatial dependence, does not indicate if groups of regions that are close together are also compositionally similar in their renewal and if groups that are spatially distant from each other are also compositionally dissimilar. We verified this through the Mantel's test that has Z-statistics equal to 816298828 and $p < 0.01$, rejecting the null hypothesis of no relationship between spatial location and renewal. Furthermore, the MI does not allow one to have information

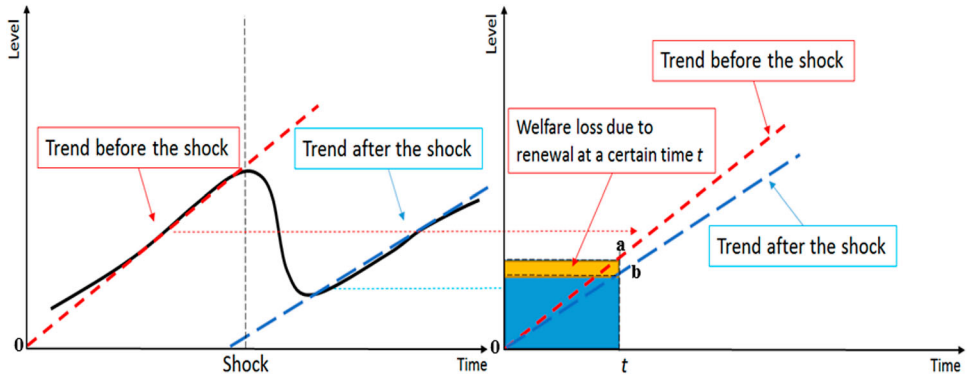

Figure 1. Renewal capacity.

on the within-country dynamics, that is, if regions close to each other are located in the same country or not. To overcome this limitation, we complement the analysis using the box plot[6] in Appendix A in the supplemental data online. We observe that the within-country variability is very low with the exception of Bulgaria and Romania, highlighting that regions belonging to the same country tend to move together. This finding induces one also to consider that the contextual socioeconomic environment could matter for renewal, and that not only regional characteristics might have a role in it. Thus, we will explicitly address both these dimensions in our empirical model.

METHODOLOGY AND DATA

Methodology

Since the renewal capacity of EU regions has been introduced as a multidimensional hierarchical concept, we consider two groups of variables related to regional and national characteristics. The empirical model is:

$$renewal_{i,c,t} = \alpha + \beta_0 national_{c,t-1} + \beta_1 regional_{i,c,t-1} + \varepsilon_{i,t} \quad (2)$$

where *renewal* is the renewal capacity; *national* is a vector of national variables that includes general government debt-to-GDP ratio, yield, trade openness, political stability and absence of violence, social protection; *regional* is a vector of regional variables, which comprises per capita GDP, gender difference in unemployment rate, patents per million of the active population, specialization and diversification indexes and secondary education; i is the i-th NUTS-2 region, of which there are 250, belonging to country c, of which there are 27; and ε_i is the i.i.d. error term. Following Crescenzi et al. (2016) and Giannakis and Bruggeman (2017a), $t-1$ stands for the average between 2000 and 2007, meaning that the pre-crisis conditions might determine the post-crisis renewal capacity. Variables on the period 2000–07 are selected to account for the assets endowment acquired by a region over time and thus reflecting a policy planning that strengthens the resilience capacity to cope with a shock. The shock wave in the after-crisis period induces unexpected and unplanned changes over which a region can exercise limited control and that probably would not have been implemented in the absence of the shock. Moreover, the effects of such changes, for example, investments in education and/or innovation, require time in order to produce results and, in the long-run, could generate structural reforms that lead to invest more in technological progress that, in turn, can influence and shape the growth path of the economic systems (Diebolt & Hippe, 2019). This process, which refers to the third dimension of the resilience-building capacity, namely the reorientation, is beyond the scope of our research, and could be analysed through an evolutionary approach to resilience that 'focuses more on the long-term evolution of regions and their ability to adapt and reconfigure their industrial, technological and institutional structures in an economic system that is restless and evolving' (Boschma, 2015, p. 735).

The multilevel structure of the data requires addressing some econometric issues mainly related to the non-independence of the error terms. To deal with this problem and to end up with reliable and robust results, we explore a set of alternative techniques: standard and spatial models with clustered standard errors, hierarchical multilevel models and spatial filtering multilevel models.[7] Spatial models allow one not only to deal with spatial dependence in the data that can lead to bias and/or inefficient results but also to account formally for the spatial spillover effects (Anselin, 2003). Whether the spatial structure is in the residuals of an ordinary least squares (OLS) regression model or in the data, a spatial error or a spatial lag model will be adopted, (Anselin, 1988). Spatial models, as well as the benchmark OLS, are estimated accounting for clustered standard error at national level. As observed by McNeish, Stapleton, and Silverman (2017) and Primo, Jacobsmeier, and Milyo (2007), in fact, correcting for the clustered standard errors allows one to deal with the hierarchical data structure. At this regard, Moulton (1986) shows that clustered standard errors, modelling the nested structure of observations within countries, account for the unobserved characteristics that regions share within a country, leading to a correct estimation of the standard errors of the dependent variables.

When variables have a nested structure and covariates have different aggregation level, the hierarchical multilevel models are a natural option (Goldstein, 2011):

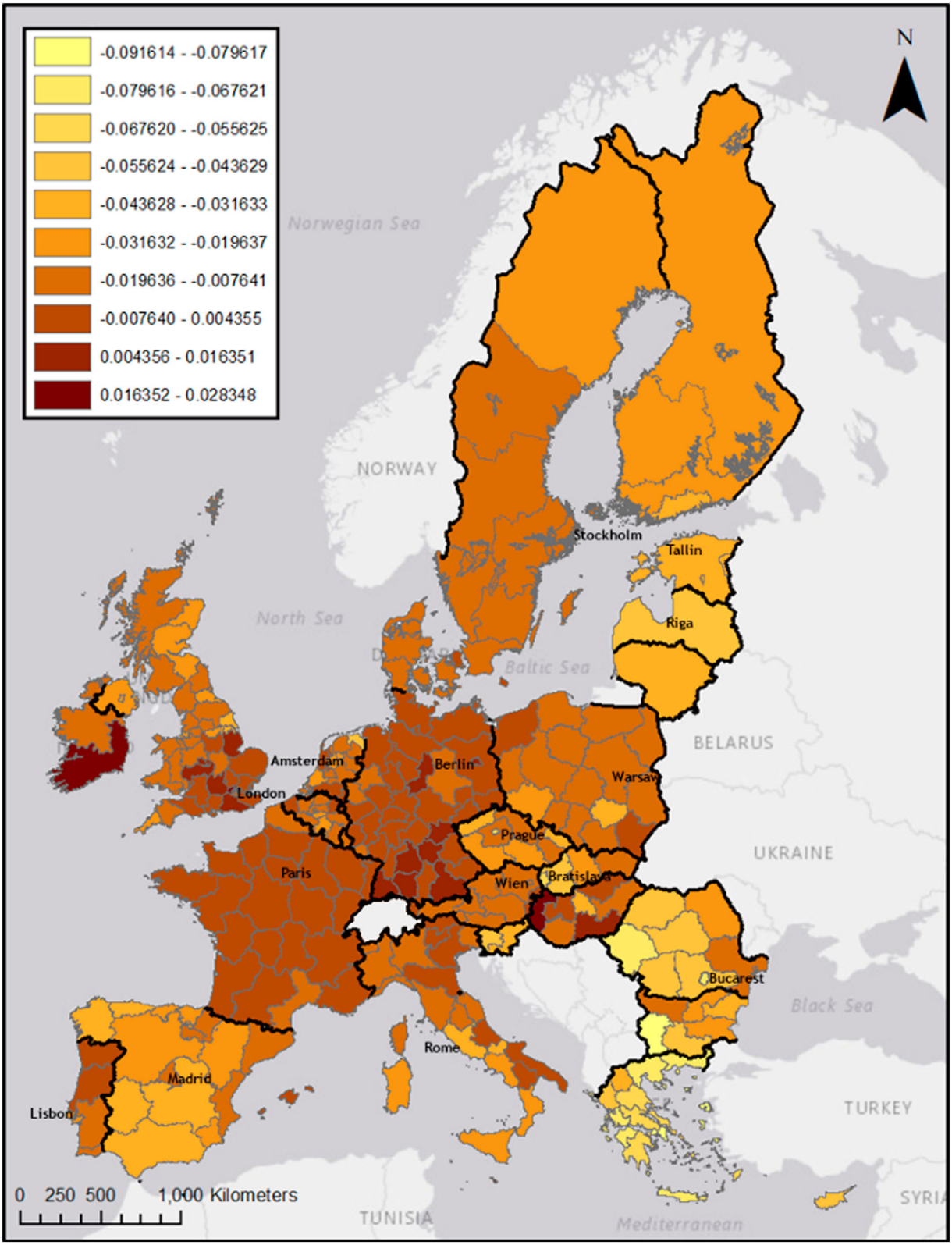

Figure 2. Decile map of per capita gross domestic product (GDP) renewal capacity of European Union regions.

> [They] may be the appropriate choice when the context is defined in a way that is not strictly geographical … ; when investigating processes that operate on the scale of administrative areas … ; or when spatial correlation can be reduced to the correlation within areas.
>
> (Chaix, Merlo, & Chauvin, 2005, p. 524)

This methodology is conveniently carried out by resorting to mixed-effects models, that is, statistical regression models that incorporate both fixed effects (constant across groups) and random effects (that randomly vary across groups). By associating common random effects with observations in the same group, mixed-effects models

flexibly represent the covariance structure induced by the grouping of the data in two different geographical levels (Hox, 2010, p. 1). In our case, as conceivable, the random effects are at the higher geographical scale, that is, the country level.

Park and Kim (2014) and Murakami and Griffith (2015) mix the spatial and hierarchical approaches applying the spatial filtering technique of Tiefelsdorf and Griffith (2007) to a multilevel model to deal with spatial autocorrelated errors. This approach filters out the residual spatial autocorrelation induced by either a pure spatial autoregressive process or omitted variables including a linear combination of eigenvectors as random effects. First, eigenvectors are extracted by doubly centred spatial weight matrix, MWM, where $M = I - \iota(\iota'\iota)^{-1}\iota$, where I stands for an identity matrix; and ι a ones vector. A subset is then selected following a stepwise procedure that maximizes the log likelihood. The aim of the procedure is to take explicitly into account the spatial patterns in the residuals and also potential spatial structures present in the regressors, reducing multicollinearity and separating spatial effects from the 'intrinsic' impact the employed regressors exert on the dependent variable. The estimation is performed with the function *resf* from package *spmoran* (Murakami, 2018).

Compared with other applications (Ezcurra & Rios, 2019; Giannakis & Bruggeman, 2017a), we not only address the spatial and multilevel structure of the data but also explicitly introduce variables at both regional and national levels.

Data

This study employs annual data in 2005 constant price euros over the period 2000–15 from different data sources.

The rationale behind the inclusion of *national* variables is below described:

- *General government debt-to-GDP ratio* is included following Crescenzi et al. (2016). It corresponds to a country's total gross government debt as a percentage of its GDP. It is an indicator of an economy's health and a key factor for the sustainability of government finance. Data are drawn from the Ameco Database.
- *Yield* is computed as the difference between the nominal long- and short-term interest rates. Also known as the 'term structure of interest rates', it describes the yields of similar quality bonds against their maturities, ranging from shortest to longest. Data are drawn from Ameco Database.
- *Trade openness* refers to the outward or inward orientation of a given country. Evidence on trade openness in relation to growth is mixed in literature with some authors who find negative effects (e.g., Yanikkaya, 2003) and others, such as Manole and Spatareanu (2010), who find a positive impact. Trade openness is the sum of exports and imports of goods and services at constant prices as a percentage of GDP. Data are collected from The World Bank.
- *Political stability* measures perceptions of the likelihood of political instability and/or politically motivated violence at the country level. A high uncertainty regarding the political situation is conceived to affect economic growth negatively and consequently the renewal capacity because it decreases productivity growth, human capital accumulation and trust (Ari & Veiga, 2011). Data are from The World Bank.
- *Social protection* is a measure of the extent to which countries assume responsibility for supporting the standard of living of disadvantaged or vulnerable groups. It consists of government expenditures on sickness/healthcare, invalidity and disability, old age, parental responsibilities, survivors, unemployment, housing, and social exclusion. The World Bank averages are included in the analysis. In this regard, Arjona, Ladaique, and Pearson (2003) argue that an increasing expenditure on social protection is a stimulus for growth in Organisation for Economic Co-operation and Development (OECD) countries.

Regarding the vector of *regional* variables, we have:

- *Gender difference in unemployment rate between females and males*, aged 15–64 years, is selected to consider the gender gap in the labour market. The higher the difference, the less a job market is receptive with respect to female employment, that is, the higher is female unemployment compared with males. This means a lack of opportunities for women. Data are drawn from the OECD.
- *Patents per million of active population* are considered to capture the general propensity to innovate of EU regions (Crescenzi, Rodriguez-Pose, & Storper, 2007). Data are drawn from Eurostat.
- *Absolute*[8] *specialization* and *diversification* indexes were considered to measure market concentration and economic diversity.[9] The absolute specialization index is calculated taking the maximum of the share of the sectoral employment. The absolute diversification index is the inverse of a Hirschman–Herfindahl index, which is the sum of the square of the sectoral employment share. It increases as the composition of activities in a region tends to mirror the diversity of the national economy. The ratio of the inclusion of these two measures is that a specialized region is closer to the productivity frontier and takes advantage of higher productivity, but might be less adaptable to market shocks, and vice versa. The two situations can coexist in a region since high specialization in a single sector can go hand by hand with a diversified economic structure.[10]
- *Share of the working-age population that has attained secondary education*: used to measure the average level of human capital in each region, which, according to growth theories, is an important driver of growth (Crescenzi et al., 2007). Data employed are drawn from Eurostat.

For descriptive statistics, see Appendix B in the supplemental data online.

RESULTS

Results of the specification in equation (2) are presented in Table 1. Estimations were performed through standard and spatial models with clustered standard errors, and multilevel hierarchical models, and show comparable results in terms of coefficients and, to a lesser extent, in terms of standard errors. The results are also robust to changes in the considered variables when national and regional drivers are isolated, as shown in Tables C1 and C2 in Appendix C in the supplemental data online. The Lagrange multiplier (LM) and robust LM tests were carried out to check whether a spatial lag or an error model[11] had to be selected. This confirms that the first has to be chosen, highlighting the fact that the renewal capacity in a certain region is related to the renewal in the neighbours. Comparing the significance of the MI in the models' residuals, computed with the R function *moran.mc* implemented within library *spdep*, we observe that it is significant only for the OLS. The standard hierarchical model, in particular, is not affected by spatial autocorrelation and the country random effects explain around half the residual variance. Together with the spatial lag, it has the highest Akaike information criterion (AIC).

Among the national drivers, social protection has a strong positive effect on regional renewal, which is confirmed by all five estimated models. The yield curve shows a negative and significant coefficient, which is confirmed in the OLS, spatial filtering and spatial lag models. Among the variables belonging to the regional vector, the gender difference in unemployment rate is negative and significant, while specialization and diversification have a positive and significant sign.

The existing literature suggests that social protection may play an important role in growth and economic empowerment (Arjona et al., 2003) and limits the need for coping strategies to face shocks, inducing a potential renewal (Food and Agriculture Organization (FAO), 2017). Active social spending may more likely be growth enhancing at local levels, empowering community assets and infrastructure, increasing local consumption, and improving labour market conditions and outcomes (Alderman & Yemtsov, 2012). Contributing to the resilience literature, Roca and Ferrer (2016) demonstrate that higher government expenditures on social protection explained the stronger economic performance of 16 developing countries during the recent crisis.

Yield is negatively related to GDP growth and thus to renewal. Many studies aim to predict economic growth with the slope of the yield curve, expressed as the difference between the longest and the shortest maturity yield (Ang, Piazzesi, & Wei, 2006). The higher the slope, the stronger the economic growth is likely to be in future. At this regard, a steep positive curve indicates stronger economic activity, rising economic growth, and inflation expectations and thus higher interest rates. However, in the pre-crisis period until the outbreak of the financial crisis, the yield curve was extremely flat and eventually became inverted in some EU countries, implying a negative relation with the post-crisis growth and eventually the economic renewal.[12] Moreover, an inverted yield curve suggests investors expect sluggish economic growth and lower inflation (and thus lower interest rates) forecasting economic slowdowns and tightening monetary policy (hitting the short end).[13] In this scenario, the higher the slope, the lower the expected GDP growth and thus the opportunity of renewal.

We find that specialization and diversification are both drivers of economic renewal in the crisis. Despite the literature having no consensus on their effect on regional resilience, and there is no evidence on renewal, we identify some possible explanations for the results. Following Crescenzi et al. (2016), diversification might boost regional renewal because either it might guarantee a higher degree of flexibility to accommodate sector-specific shocks and/or it might improve labour matching and thus labour market performances. Hausmann et al. (2013) attribute to diversified regional economic structures a higher stability that matters for economic growth. Being specialized, on the other hand, can be a successful strategy to improve productivity growth (Van Oort, de Geus, & Dogaru, 2015) and/or to gain a comparative advantage over one's neighbours and speed up the recovery process (Steijn, Balland, Boschma, & Rigby, 2019). This finding is in line with Giannakis and Bruggeman (2017a) who define 'resilient' as the regions with a smaller relative loss in employment (or a higher relative increase) than the EU-28 average. Martin and Sunley (2015), furthermore, suggest that specialization in technology- and knowledge-led sectors is a crucial element in order to shape resilient regional structures due to their innovation orientation and adaptable employment. Di Caro (2017), when analysing the Italian context, finds a positive effect of specialization on resistance.

Our results interestingly demonstrate that regions generally have the options of specializing or diversifying, but they can also place an emphasis strategically in one sector diversifying their structure with respect to the others. Farhauer and Kröll (2012) consider different intensities of specialization and support this hypothesis by introducing the notion of 'diversified specialization' for cities specializing in a few sectors.

The unemployment gender gap negatively affects the economic renewal. Women work fewer hours (part-time prevails) than men, earn in proportion less (hourly wages) and are more exposed to the risk of poverty as they are often employed by small and medium-sized enterprises (SMEs) under fixed-term contracts.[14] These limits explain at the same time why the progress of the labour market and the consequent economic empowerment can mainly be sustained by women (Kabeer, 2012). It is not by chance that our results confirm that the regions where the recovery is more hesitant are those that show quite high female unemployment rates.

Among the national variables showing a non-significant effect there is debt, trade and political stability.

Table 1. Estimation results.

	Ordinary least squares (OLS)		Random effects		Spatial filtering random effects		Spatial lag		Spatial error	
	Estimate	**SE**	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**
Intercept	−0.17546	0.05145***	−0.10880	0.02986***	−0.14002	0.02732***	−0.11960	0.03772***	−0.15804	0.05530***
log (Debt)	−0.00428	0.00375	−0.00429	0.00486	0.00007	0.00325	−0.00103	0.00263	−0.00239	0.00426
Yield	−0.42521	0.14128***	−0.41650	0.30410	−0.49869	0.16923***	−0.26249	0.13586*	−0.34764	0.22938
Trade	0.00952	0.00594	0.00996	0.00670	0.00536	0.00479	0.00578	0.00446	0.00805	0.00640
Social protection	0.28648	0.06138***	0.19830	0.06510***	0.20893	0.04723***	0.16350	0.04254***	0.23075	0.07191***
Political instability, violence	−0.01097	0.00731	−0.00178	0.00791	0.00355	0.00512	−0.00535	0.00530	−0.00445	0.00810
Patents	0.00000	0.00000	0.00001	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Specialization	0.13502	0.06813**	0.06078	0.04458	0.10446	0.04182**	0.10641	0.05307**	0.13263	0.07956*
Diversification	0.01056	0.00404***	0.00495	0.00220**	0.00863	0.00208***	0.00820	0.00316**	0.00963	0.00428**
Difference between female and male unemployment rates	−0.00180	0.00064***	−0.00086	0.00044*	−0.00152	0.00043***	−0.00135	0.00048***	−0.00162	0.00058***
Secondary education	−0.02081	0.01314	−0.01833	0.01379	−0.02044	0.01085*	−0.01788	0.01086	−0.02299	0.01354*
Observations	250		250		250		250		250	
Rho							0.41776	0.07048***		
Lambda									0.45742	0.07655***
Akaike information criterion (AIC)	−1426.824		−1448.400		−1344.210		−1452.100		−1445.100	
National random effect (variance)			0.00010							
Sp. filtering random effects (variance)					0.00004					
Residual (variance)			0.00013		0.00013					
Moran's *I*	0.16651 ($p < 0.01$)		0.013746 ($p = 0.3047$)		−0.01173 ($p = 0.5814$)		−0.01302 ($p = 0.5914$)		−0.00815 ($p = 0.5185$)	
Eigenvectors included	19/250									
Lagrange multiplier (LM) error	19.37405***									
LM lag	29.43326***									
Robust LM error	0.17665									
Robust LM lag	10.23587***									

Note: ***$p < 0.01$; ***$p < 0.05$; *** < 0.1. Country clustered standard errors are for OLS, spatial lag and spatial errors. Moran's *I* on residuals is based on 1000 permutations. Rho and lambda significance are based on the likelihood ratio test.

The result regarding the first is coherent with Crescenzi et al. (2016). Regarding trade, a null effect might be due to the missing capitalization of the advantages offered by openness in the pre-crisis period as a result, among others, of higher levels of trade towards a saturated intra-EU market for some countries, rather than towards more dynamic areas such as the major emerging and growing-market BRIC (Brazil, Russia, India and China) economies.

On the other hand, the higher trade openness might have exposed national and regional economies to international market fluctuations and to the terms-of-trade variability induced by external shocks that might have had a negative effect. In this regard, another plausible interpretation is that the two effects counterbalance, that is, the higher exposure to international channels of open countries smoothed the benefits deriving from trade linkages.

The null effect of political stability is probably related to the quite homogeneous perception throughout Europe which, despite being hit by occasional episodes of instability and insecurity, is still perceived as a generally fairly safe and stable area.

In the category of regional variables, the less spatial sticky factors, education and patents, are not supporting renewal, as proved by Fratesi and Perucca (2018) in a different but similar context. The idea introduced by the authors is that factors that are mobile in space are likely to react to a regional crisis by moving to a place with more opportunities.

CONCLUSIONS

This paper innovatively contributes to the existing resilience literature focusing on the renewal dimension, and operationalizing the concept introduced by Pontarollo and Serpieri (2017). We first analysed the spatial pattern of the renewal capacity in the EU and then identified the local and contextual characteristics that determine it. The MI confirms the presence of positive autocorrelation and supports the intuition that EU regions with similar values of renewal are located close to each other. A deeper focus upon this pattern shows that intra-country variability is quite low, pointing to the fact that regions belonging to the same country tend to have similar renewal capacity. Crescenzi et al. (2016) when analysing another dimension of resilience, that is, the recovery, find a heterogeneous distribution across EU regions. This dichotomy between renewal and recovery potentially opens room for further analysis on the spatial distribution of the dimensions of the regional resilience.

In the second step, namely, the regression analysis, we find that the determinants of the economic regional renewal are distributed between national and regional assets. The self-fulfilling of macroeconomic country-level conditions seems to be very important since the crisis spreads out mainly through international financial channels, but also the endowment of structural territorial assets have influenced the differential regional economic response to the crisis in Europe.

More active is the government in redistributing income and wealth through public expenditure: the higher benefits are in terms of regional renewal. Specialized and diversified regions were both able to renew their pre-crisis growth path, and being highly specialized and competitive in a sector or diversifying and protecting themselves from risky investments are among coping strategies that face a negative response to the shocks. To investigate these highly debated dynamics, Xiao, Boschma, and Andersson (2018) adopted an evolutionary perspective to analyse regional industrial resilience, that is, the extent to which the ability of regions to develop new industries has been affected by a shock. They show that sectorial composition and tradability, industry entry level, and firm size matter to explain the specialization–diversification dichotomy and its role in addressing resilience. Following our framework, an interesting extension would be to link renewal to the evolutionary approach considering, for example, the ability of regions to develop new industries with respect to a pre-crisis benchmark period.

A higher gender gap has not incentivized the regional renewal and asks for policies in favour of women's economic participation and opportunity.

Also worth mentioning is the fact that, as in Crescenzi et al. (2016) and Fratesi and Perucca (2018), we find a null effect of human capital and innovation effort (patents) which has been explained by the latter authors as the low spatial stickiness of these factors.

Overall, we observe that the inclusion of variables at two geographical scales matters for renewal and this leads one to support a multilevel perspective. Regions are by definition nested within countries, and the latter affect their performances under various perspectives. In this regard, a multilevel perspective is carried forward by the European Commission since it 'championed a partnership approach to work with the key players at every level. It has [also] made clear that the job is not done until the impact is felt on the ground' (European Commission, 2008, p. 2). This is essential for policy strategies in terms of reorienting their targets and financial resources to the proper geographical and socioeconomic dimension. If higher dimension contextual variables matter for regional renewal, then regions within a country with a high (low) renewal capacity can do much better (worse) if the central government sets up its policies in the right (wrong) way. In practical terms, as an example, investing in social protection measures would support the standard of living of disadvantaged or vulnerable groups, reducing inequality and guaranteeing a higher social and territorial cohesion, which would end up with a higher regional renewal.

The analysis of the multilevel strategic response to the crisis under an institutional perspective is out of the scope of this study and is left for future research. Our results, in fact, stress that variables at multiple geographical scales matter for regional renewal capacity and advocate for a better understanding of how institutions at multiple scales coordinate among them in the perspective of maximizing resilience.

Finally, our approach relies on a medium-term analysis of resilience and that, for a long-term analysis, an evolutionary approach where a region can react to a shock by switching its economic sectoral composition or targeting innovation-driven growth strategies instead of more traditional investment ones (Boschma, 2004, 2015) should be considered.

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NOTES

1. Among the latest studies on resilience at the national level, see: Martin, Sunley, Gardiner, and Tyler (2016) and Kitsos and Bishop (2018) for the UK regions; Di Caro (2017, 2018), Sedita, De Noni, and Pilotti (2017), and Faggian, Gemmiti, Jaquet, and Santini (2018) for the Italian regions; Giannakis and Bruggeman (2017b) and Psycharis, Kallioras, and Pantazis (2014) for the Greek regions; Diodato and Weterings (2015) for the Dutch regions; and Cuadrado-Roura and Maroto (2016) and Angulo, Mur, and Trívez (2018) for the Spanish regions.
2. The trend has been computed as follows: (1) we regress the time period on the log of the selected variables and (2) we keep the coefficient associated with them. If it is positive (negative) and significant, it means that the slope rises (falls). If the coefficient is zero or not significant, the trend is not statistically different from zero.
3. Owing to missing data, Croatia has been excluded.
4. This contiguity scheme guarantees that there are no isolated regions, namely the islands. Alternative weighing schemes were used and the result did not change substantially.
5. Moran's *I* and the spatial econometric analysis were carried out using R library *spdep* (Bivand, Pebesma, & Gomez-Rubio, 2013; Bivand & Wong 2018).
6. The central tendencies of a distribution, that is, the middle 50% of the distribution, are described in the middle of each box plot. The solid thick line locates the median; the top and bottom edges are the 75th and 25th percentiles, respectively. The height of the box is the interquartile range. The upper (lower) adjacent value is the largest renewal value observed no greater than the 75th (25th) percentile plus 1.5 × *r*, where *r* is the interquartile range.
7. The models were estimated using the R function *lmer* of library *lme4* (Bates, Machler, Bolker, & Walker, 2015) and the R function *SpatialFiltering* from library *spdep*.
8. We follow Farhauer and Kröll (2012) and focus on the absolute, not relative, specialization to avoid distortions that may arise while using the relative specialization index (RZI). A region being largely employed in a nationwide small branch could have a higher value of RZI than a region with a high share of employment in a sector with high total national employment – even though the latter is much more specialized. Distortion then arises in the sense that the regional concentration of a sector would be confused with specialization. This rationale is also applied to diversification.
9. The indexes are based on 15 NACE-1 sectors from the Cambridge Econometrics European Regional Database.
10. There is no agreement on the effect of specialization and diversification on growth. De Groot, Poot, and Smit (2009), in a meta-analysis, find strong positive evidence of sectoral diversity and competition on growth but contrasting evidence on specialization effects. The same authors, in an updated version of their paper (De Groot, Poot, & Smit, 2016), find that specialization is more important in lower density areas and that more recent studies support less the importance of diversity externalities.
11. 'Lag' refers to the spatially lagged dependent variable, while 'error' stands for the spatial autoregressive process for the error term. If only one is significant, lag or error, we choose the correspondent model. If both are significant, then we check the robust LM tests. As for the LM tests, if only one is significant, we choose the correspondent model; alternatively, if both are significant, we choose the model with the biggest test value associated. We used the R function *lmtest* in library *spdep*.
12. A flat curve generally suggests that investors are unsure about the future (Harvey, 1988).
13. Chinn and Kucko (2010) proved yield spread's ability in forecasting future industrial production growth and recession for the United States as well as for European countries.
14. The OECD (2016) found that gender differences in working hours are driven by disproportionately high rates of part-time employment among female employees in OECD countries. Part-time employment rates for women reach four or five times the size of those for men in Austria, Belgium, Germany, Luxembourg and the Netherlands. Furthermore, a European Parliament (2016) report found that 'men are more likely to work on a full-time and permanent basis than women (65 % compared with 52 %), whereas women are much more likely than men to work on a part-time basis. A total of 12 % of women work on a part-time basis, compared with 2 % of men, and 15 % of women work on a marginal part-time basis, compared with 4 % of men'.

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