

The Link Between Quality of Government and Regional Resilience in Europe*

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Abstract

This study analyzes the robustness of the link between quality of government and resilience in a sample of 264 NUTS-2 regions of 28 European countries during the Great Recession. Bayesian Model Averaging techniques are used to analyze the relevance of the quality of government together with a large set of macroeconomic, institutional, innovation, socio-demographic and labor market and sectoral specialization factors that may affect observed resilience patterns in Europe. The robustness of individual covariates is measured through posterior inclusion probabilities. The empirical analysis provides conclusive evidence on the role played by the regional quality of government as it appears to be one of the most robust drivers of resilience. In a second step, posterior jointness is investigated finding that factors related to the knowledge and innovation environment reinforce the relevance of quality of government while others such as trade openness act as substitutes.

Keywords: Resilience, Quality of Government, Determinants, Bayesian Model Averaging, Posterior Jointness, European Regions.

JEL classification: H11, R12.

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1. Introduction

The Great Recession has affected European labor markets more severely than any other crisis since the end of the Second World War, but its effect has been very asymmetric across regions and countries (Capello *et al.*, 2015). Since the European Commission is highly concerned with both, territorial cohesion and the resilience of the economy to hybrid threats that could damage stability in the European Union, increasing our understanding on the drivers of the geographical variation in labor market resilience is of major importance from a regional policy perspective (European Commission (2016, 2018)).

To investigate differentials in the economic performance across regions during the Great Recession one should investigate the factors behind regional economic resilience. Indeed, triggered by the context of the Great Recession, the concept of resilience has begun to be extended in economic analysis to try to understand the dynamics that occur in different spatial environments (countries, regions, cities, etc.) in relation to how they are affected by shocks and how they respond to them (Martin and Sunley, 2015; Martin *et al.*, 2016).

From an empirical perspective, this strand of literature has highlighted the relevance of different factors in shaping regional reactions to external shocks, including the sectoral composition of economic activity and its degree of diversity (Cuadrado-Roura and Moroto, 2016), the degree public sector shelter (Fratesi and Rodríguez-Pose, 2016), the endowment of human capital and the intensity of innovation activities (Bristow and Healy, 2018), national macroeconomic conditions (e.g. Crescenzi *et al.*, 2016a) or urbanization patterns (Brakman *et al.*, 2015; Giannakis and Bruggeman, 2017). From an academic perspective, resilience has also attracted lot of attention and different scientific journals have devoted special issues on the topic.¹

¹ See for instance the *Cambridge Journal of Regions, Economy and Society*, 2016, Volume 9, Issue, 1, “The Economic Crisis in Europe: Urban and Regional Consequences”, *Regional Studies*, Volume 50, 2016 - Issue 4, “Theme Issue:

Recently, two studies using different methodologies and research designs, have investigated the link between the quality of institutions and the economic performance during the Great Recession in Europe. Ezcurra and Rios (2019) employ spatial econometric methods in a sample of European regions whereas Sondermann (2018) combines time-series Vector Autorregressions and probit modeling in a sample of European countries. Both studies find a positive impact of the quality of institutions on resilience. Nevertheless, a problem in the existing literature focusing on regional resilience is that it has employed limited sets of variables to analyze this phenomenon and ignored uncertainty surrounding the true model or data generating process (DGP). From an econometric perspective, the omission of relevant explanatory variables that could affect regional resilience patterns is of major importance given that estimates may be inefficient and/or biased (Moral-Benito, 2015). Since it is often not clear a priori which set of variables should be included in the “true” regression model, a naive approach that ignores specification and data uncertainty may result in biased estimates, overconfident (too narrow) standard errors and misleading inference and predictions. A second issue with existing analysis on resilience based on traditional single-regression frameworks or shift share analysis is that they fail to derive a rank of the various factors in terms of their importance, thus, hampering the consensus on what policies could be implemented to promote and increase resilience.

To solve these problems, in this study we investigate if the link between quality of government (QoG) and regional resilience observed in previous studies is robust to model uncertainty by means of Bayesian Model Averaging (BMA) techniques, which also allows us to produce a probabilistic ranking of relative importance. Compared with the limited set of regressors analyzed in the existing empirical literature, this study rigorously assesses model

Resilience Revisited” and *The Annals of Regional Science*, 2018, Volume 60, Issue 2, “Regional Determinants of Economic Resilience”.

uncertainty over a larger set of resilience determinants while minimizing omitted variable bias. The set of potential determinants considered at the regional level includes: (i) macroeconomic factors, (ii) institutional factors, (iii) knowledge and innovation intensity factors, (iv) socio-demographic factors and (v) labor market and sectoral specialization factors. In addition, the analysis controls for country fixed-effects given that country characteristics are deemed to be relevant to explain regional labor market differentials (Rios, 2017; Giannakis and Bruggeman, 2017). Through the computation of the posterior inclusion probability (PIP) for the different variables we generate a probabilistic ranking of the various determinants of resilience. Hence, the key differential feature of this study with respect to Ezcurra and Rios (2019) or Sondermann (2018) is methodological, given that unlike previous studies using a small fraction of the information available in the data set, we use the Monte Carlo Markov Chain Model Composition (MC^3) methodology for linear regression models to explore the large model space formed by different combinations of regressors to draw conclusions. Finally, to complement the information of the BMA and provide further insights that might be useful for policy makers we perform a Posterior Jointness analysis following Doppelhofer and Weeks (2009). This analysis aims at increasing our understanding on the factors that might be complementary or substitutes to the effect of QoG on resilience.

This study is organized as follows. Section 2, which follows this introduction, describes the measurement of resilience and its geographical distribution across European regions. In Section 3, the BMA econometric modeling framework is presented. Section 4 describes the data set used in this study and the various factors considered in the analysis. The empirical findings and robustness checks are presented in Section 5, while Section 6 discusses the policy implications that can be derived from this research and offers the main conclusions of the study.

2. Measuring resilience

Martin and Sunley (2015) suggest the existence of different interpretations of the concept of resilience stemming from different disciplines of knowledge such as engineering, ecology or complex systems theory. The “*engineering view*” stresses the role of resistance to disturbances and the speed of recovery of the system to its pre-shock state. The “*ecological approach*” defines resilience as the capacity to absorb shocks without shifting the system to a new state or phase whereas in the “*complex adaptive systems*” field, resilience is understood as the ability to perform anticipatory re-organizations and to develop new growth paths. These different approaches to resilience, allow us to identify common central elements and the key concepts that together create what can be conceptualized as economic resilience: (i) disturbances and exogenous shocks, (ii) context, (iii) responses to the shocks (resist, withstand, adjust, renew) and (iv) outcomes (pre-shock state, new growth paths). Taken together, these elements allow us to define resilience as “*the capacity of the system to resist, withstand or quickly recover from negative exogenous shocks and disturbances and to renew, adjust or re-orientate from these shocks*”.

Regarding the measurement of economic resilience, the literature has employed different approaches (Martin and Sunley, 2015, Modica and Reggiani, 2015). Whereas some authors propose the use of univariate indicators based on GDP per capita or employment rates (Cellini and Torrìsi, 2014; Lagravinese, 2015), a different approach to measure the concept of resilience in the literature has been the elaboration of composite indexes based on a different number of variables that could affect the degree of economic vulnerability (Modica and Reggiani, 2015). Others such as Sondermann (2018) measure resilience as the reaction to a common shock identified by means of Vector Autoregression residuals.

To operationalize the concept of economic resilience at the regional level we employ as our baseline metric of resilience, a univariate indicator based on employment rates. A reason for this choice is to make our results directly comparable to recent studies on the field (Lagravinese, 2015; Giannakis and Bruggeman, 2017; Ezcurra and Rios, 2019). The index of regional resilience for each region i is calculated as:

$$RES_i = \frac{\Delta E_i - \Delta E_{EU}}{|\Delta E_{EU}|} \quad (1)$$

where ΔE_i is the change in the employment rate in region i between the turning points of the recession and the recovery. In turn, ΔE_{EU} stands for the average variation in the employment rate in the EU regions. A positive value of this index means that region i exhibits greater resistance to a recessionary shock than the EU average, while a negative value implies that region i is less resistant than the EU average.

The period over which the analysis is carried out comprises the 2008-2013 window given that these dates correspond to the peak and the valley of the aggregate European employment rate. We calculate the index of regional resilience just described for 264 NUTS2 regions of 28 European countries. As is usual in the literature, this measure of regional resilience concentrates on the capacity of regional labor markets to withstand adverse shocks.

The distribution of scores of the resilience index is displayed in Figure (1) whereas Table (1) reports the top and bottom 10 regions. As can be observed, the impact of the Great Recession has been far from homogeneous across the EU, and there are important cross-country geographical differences. In the lower 10% of the distribution of our index, we find the majority of Spanish and Greek regions, whereas in the lower interval ranging from 10% to the 30% percentiles, we find a myriad of Portuguese, Italian, Irish and Bulgarian regions. This result shows that the periphery of Europe has been severely affected showing relatively low levels of

resistance to the recessive shock. On the other hand, we find that German regions located in the top 10% of the distribution of resilience scores, experienced a continued increase in employment rates and exhibited the best performance. Austria, Belgium, Finland, and Sweden also show a relatively high values, with a number of their regions displaying resilience scores within the top 30% of the distribution. The geographical distribution of resilience in Figure 1 shows that in addition to the core-periphery pattern there is an east-west differential given that a large share of Romanian and Hungarian regions experienced a markedly good labor market performance. In a medium level of performance, we find regions from Poland, France or United Kingdom. The observed differences between countries, however, do not hide the existence of important within-country disparities which is particularly evident in countries such as France, Italy, Poland, Romania or the United Kingdom (Ezcurra and Rios, 2018). This is confirmed by divergences in the size of employment rate changes with respect to the national average, from 4% more to 4% less.

INSERT TABLE (1) ABOUT HERE

INSERT FIGURE (1) ABOUT HERE

3. Econometric Methodology

In empirical research, although some variations of a baseline model are often reported, basing inference on a single model has become a common practice. Typically, researchers draw their conclusions on this model acting as if the model was the true model. Nevertheless, this procedure understates real uncertainty associated with the specification of the empirical model (see, Moral-Benito, 2015) and existing resilience analysis are no exception. To address this concern in our analysis of the drivers of regional resilience we employ a Bayesian Model Averaging (BMA) approach. We begin by considering the following regression model:

$$y = \alpha \iota_n + X\beta + C_F\gamma + \varepsilon \quad (2)$$

where y denotes a $N \times 1$ dimensional vector consisting of observations for the average resilience index during 2008-2013, for each region $i = 1, \dots, N$. α reflects the constant term, ι_n is a $N \times 1$ vector of ones, X is an $N \times K_1$ matrix of regional explanatory variables with associated response parameters β contained in a $K_1 \times 1$ vector. In turn, C_F is an $N \times K_2$ (Common Factor matrix) of fixed binary dummy variables that take a value of 1 if region i belongs to country c and zero otherwise. γ captures the country effects in a vector of size $K_2 \times 1$.² In turn, ε is $N \times 1$ vector of disturbances. Note that there are many sub-models M_k of the model in Equation (2) given by the subsets of coefficients $\eta^k = (\alpha, \beta^k, C_F)$ and combinations of regressors where K_1 is the total number of regional regressors.³ A number of questions arise when there are many potential explanatory variables in the matrix X . Which set of variables $X_k \in X$ should be then included in the model? And how important are they? Model averaging techniques solve these questions by estimating all the candidate models implied by the combinations of regressors in X (or a relevant sample of them) and computing a probabilistic weighted average of all the estimates of the corresponding parameter of X_h (where the sub-index h here denotes a single regressor and not a model or a combination of regressors k). By proceeding in this way, estimates consider both the uncertainty associated to the parameter estimate conditional on a given model, but also the uncertainty of the parameter estimate across different models. By following the Bayesian logic, the posterior for the parameters η_k calculated using model M_k is written as:

² Given that our model includes an intercept and in our empirical application we have 28 EU countries, to avoid linear dependence problems the column size of our matrix of country dummies C_F is $K_2 = 27$ in this context.

³ We consider 25 potential explanatory variables. Thus, the cardinality of the model space in this context is of $2^{25} = 33,554,432$ models, based on different combinations of regressors.

$$g(\eta_k|y, X, M_k) = \frac{f(y, X|\eta_k, M_k)g(\eta_k|M_k)}{f(y, X|M_k)} \quad (3)$$

where $g(\eta_k|y, X, M_k)$ is the posterior, $f(y, X|\eta_k, M_k)$ is the likelihood and $g(\eta_k|M_k)$ is the prior.

The key metrics in BMA analysis are the Posterior Mean (PM) of the distribution of η :

$$E(\eta|y, X) = \sum_{k=1}^{2^K} E(\eta_k|M_k, y, X)p(M_k|y, X) \quad (4)$$

and the Posterior Standard Deviation (PSD):

$$PSD = \sqrt{Var(\eta|y, X)} \quad (5)$$

where the $Var(\eta|y, X)$ is given by:

$$\begin{aligned} Var(\eta|y, X) &= \sum_{k=1}^{2^K} Var(\eta_k|M_k, y, X)p(M_k|y, X) \\ &+ \sum_{k=1}^{2^K} (E(\eta_k|M_k, y, X) - E(\eta|y, X))^2 p(M_k|y, X) \end{aligned} \quad (6)$$

To derive these metrics, it is necessary to calculate the Posterior Model Probability $p(M_k|y, X)$ of each of the sub-models M_k . These can be obtained as:

$$p(M_k|y, X) = \frac{p(y, X|M_k)p(M_k)}{\sum_{k=1}^{2^K} p(y, X|M_k)p(M_k)} \quad (7)$$

where $p(y, X|M_k)$ is the marginal likelihood and $p(M_k)$ is the prior model probability. The marginal likelihood of a model k is calculated as:

$$p(y, X|M_k) = \int_0^\infty \int_{-\infty}^\infty p(y, X|\eta_k, \sigma^2, M_k)p(\eta_k, \sigma^2|g)d\eta d\sigma \quad (8)$$

where $p(y, X|\eta, \sigma, M_k)$ is the likelihood of model k and $p(\eta_k, \sigma^2|g)$ is the prior distribution of the parameters in model M_k conditional to g , the Zellgner's g-prior. In addition, the BMA

framework can be extended to generate probabilistic on the relevance of the various regressors, using the Posterior Inclusion Probability (PIP) for a variable h :

$$p(\eta_h \neq 0|y, X) = \sum_{k=1}^{2^K} p(M_k|\eta_h \neq 0, y, X) \quad (9)$$

In addition, it is possible to calculate the Conditional Posterior Positivity of regressor h as:

$$p(\eta_h \geq 0|y, X) = \sum_{k=1}^{2^K} p(\eta_{k,h}|M_k, y, X)p(M_k|y, X) \quad (10)$$

where values of conditional positivity close to 1 indicate that the parameter is positive in the vast majority of considered models and values close to 0 indicate the effect on the dependent variable is negative.

The calculation of previous metrics in the BMA approach requires to define priors on the model space and priors on the parameter space. As our baseline prior on the parameter space we use a Zellgner g-prior based on the Bayesian Risk Inflation Criterion (BRIC) whereas we use a Binomial prior the model space adjusted to such that every model has the same a priori probability.⁴ As regards, the numerical implementation of the BMA, we rely on the Monte Carlo Markov Chain Model Composition (MC^3) methodology proposed by Madigan and York (1995) based on the so called “*reverse jump*” algorithm in order to explore the model space. The key feature of this econometric procedure is that it eliminates the need to consider all possible models by constructing a sampler that explores relevant parts of the large model space.

⁴ In particular, the g-prior hyper-parameter takes the value of $g_k = 1/\max\{n, K^2\}$ such that $g(\eta_k) \sim N[0, \sigma^2(g_k X_k' X_k)^{-1}]$. The Binomial prior on the model regulates prior model probabilities according to $p(M_k) = \phi^k(1 - \phi)^{K-k}$, where each covariate k is included in the model with a probability of success ϕ . We set $\phi = 0.72$ which implies a prior model size of 45 regressors out of which 27 correspond to country fixed effects.

Following early discussion of Bayesian measures of variable importance, PIPs in Equation (9) have become a standard tool for interpreting the results in econometric applications of BMA (Doppelhofer and Weeks, 2009). However, although they provide valuable insight into the overall importance of single variable, they neglect the interdependence of inclusion and exclusion of variables. Thus, PIPs do not help to conclude if the importance of the variable is evenly spread out across all model specifications or if it is specific to a certain combination of explanatory variables. To gain insights into the interdependence of the inclusion of sets of different variables, several studies investigate the joint posterior of pairs of variables. Jointness reveals generally unknown forms of dependence. Positive jointness implies that regressors are complements, representing distinct but mutually reinforcing effects. Negative jointness implies that explanatory variables are substitutes and capture similar underlying effects. To analyze this issue, we follow Doppelhofer and Weeks (2009), who propose the use of log of a cross-product ratio of inclusion probabilities. For any pair of regressors A and B of the set of K potential variables, we calculate their bivariate jointness as:

$$J(A, B) = \ln \left(\frac{p(AB|y)p(\overline{AB}|y)}{p(A\overline{B}|y)p(\overline{A}B|y)} \right) \quad (11)$$

Where values of the J statistic above 1 are considered as evidence on significant complementarity, values below -1 suggest significant substitutability and values between -1 and 1 suggest independence. \overline{AB} indicates that event AB did not occur, $p(\overline{AB})$ denotes the probability of models where AB did not occur, etc.

4. The Drivers of Regional Resilience

To investigate and learn about the drivers causing the large heterogeneity in resilience outcomes observed in Figure (1) researchers have focused on diverse sets of variables. In fact, the initial

focus of empirical analysis on the field of resilience was to explore the role played the composition of the productive structure and the degree of specialization (Cuadrado-Roura and Moroto (2016), Crescenzi *et al.* (2016a)), which can be explained by the fact that in biological and ecological research diversity has been argued to play a relevant driver of development robustness (Ulanowicz *et al.*, 2009; Goerner *et al.*, 2009). However, as shown by Ezcurra and Rios (2019) and Sondermann (2018), resilience may be better thought as a reduced form of a variety of factors where institutions can also play an important role. We now discuss and provide a conceptual justification for the effects of the QoG on resilience and describe the set of factors that we have considered in the BMA analysis.

4.1 Quality of Government

We first consider the role played by Regional Quality of Governance (RQoG) as it is our variable of interest. To measure QoG we use the index developed by (Charron *et al.*, 2014). The indicator is built upon three different pillars that refer to the degree of impartiality, corruption and quality of public services.⁶

There are a number of reasons to expect a positive relationship between QoG and resilience. First, the QoG may exert a moderating effect on the type, frequency and intensity of the shocks (La Porta *et al.*, 2003; Ahren and Goujard, 2012; Caldera- Sánchez and Gori, 2016). The idea is that the QoG can play a crucial role minimizing the vulnerability to adverse financial shocks hitting labor markets given that well-regulated capital markets are likely to experience a

⁶ We resort to the European Quality of Government Index (EQI), which has recently been constructed with the aim to provide scholars and policy makers with a comparable and homogeneous measure of governance at the regional level. The EQI is based on survey data about the perceptions and experiences of European citizens on the quality, impartiality and level of corruption in education, public health care and law enforcement. This data is combined with four of the six Worldwide Governance Indicators (WGI).

lower frequency of crisis and less intense crisis (OECD, 2017). The reason is that in corrupt environments, financial stability is lower given that practices such as related lending and excessive debt financing are more likely to happen, which reduces the quality of the bank loan portfolio and increases concentration risk (La Porta *et al.*, 2003).

Additionally, higher QoG can help reducing the likelihood of sudden stops of capital inflows (Honing, 2008) and sustain FDI inflows (Alguacil *et al.*, 2011). Second, the quality of governance may increase regional resilience by improving policy responses, in particular, in what refers to the efficiency of public investment. At the European regional level there is evidence linking good institutions to the returns on public good investment (Crescenzi *et al.*, 2016b). Third, QoG can increase resilience by strengthening contract enforcement and the overall efficiency of the judicial system. Efficient bankruptcy regulations are crucial to allow for low-cost exit of less productive and insolvent firms and therefore, improving resource allocation (OECD, 2017). Finally, QoG can strengthen antitrust enforcement, minimize barriers of entry and decrease privileges of established firms, which is likely to boost private sector dynamism as there is evidence that corruption can act as a barrier of entry for new firms (Campos *et al.*, 2010), reducing entrepreneurship (Nistotskaya *et al.*, 2015) and innovation (Rodríguez-Pose and Cataldo, 2015). Therefore, QoG may also have an impact on ability to replace and renew inefficient and unproductive firms and technologies.

However, QoG may also decrease resilience as it matters for the ex-ante degree of vulnerability to external shocks. The intuition is that low QoG levels may act as barrier to trade (Yu *et al.*, 2015; Alvarez *et al.*, 2018) and to financial flows in the region of destination (Rodríguez-Pose and Cols, 2017) thereby affecting the connectivity of the region under consideration with the rest of system. Thus, a higher QoG by increasing the connectivity of the

region, can increase its exposure to external shocks and in the context of a recessionary shock from abroad, this higher exposure can translate into greater labor market disruptions.

Accordingly, further empirical research is required to clarify the nature of the link between quality of government and resilience at the regional level. In this sense, given that both QoG and resilience might be correlated with a number of regional characteristics, it is necessary to control for the effects of a variety of potential determinants of resilience. Moreover, the posterior jointness analysis among these factors and QoG, is relevant from a policy perspective as it is informative on what regional characteristics can reinforce or decrease the relevance of QoG as an effective tool to deal with recessions.

4.2 Other determinants of resilience

In order to properly account for model uncertainty in the analysis of the link between QoG and resilience and to produce a comprehensive probabilistic ranking of importance of the factors influencing resilience based on the PIPs, we consider a large set of (i) macroeconomic factors, (ii) institutional factors, (iii) knowledge and innovation intensity factors, (iv) socio-demographic factors and (v) labor market and sectoral specialization factors. Table (2) presents the detailed definitions and sources of all the control variables used in the paper. Several descriptive statistics are included in Table (2).

INSERT TABLE (2) ABOUT HERE

Regional macroeconomic factors are included to control for differences implied by heterogeneous historical long-run growth paths, which are expected to have an impact of resilience differentials (Weber *et al.*, 2018). In this line of reasoning, Martin and Sunley (2015) point to the cumulative nature of regional growth suggesting that a region's resistance and

recovery from shocks might be a consequence of its previous growth path and cyclical dynamics. The variables included to control for differences in regional macroeconomic characteristics are (i) the logarithm of income per capita, (ii) the output growth volatility measured by the standard deviation of the output gap estimated with the Hodrick-Prescott filter (iii) the historical employment growth rate, (iv) the regional trade openness and (v) the logarithm of wages.

On the other hand, to proxy for *regional institutional factors* we use the indicator of economic self-rule based and its square following Ezcurra and Rios (2019). This indicator is based on the contribution to fiscal federalism of Sorens (2014). Decentralization can affect resilience via several different mechanisms that may work in opposite direction. On the one hand, the provision of public goods may be more efficient if diseconomies of scale exist. However, if large economies of scale and scope exist, regional governments may lack the necessary size to deliver public goods efficiently. In addition, subnational governments may lack the adequate expertise and human resources to apply viable policies. Other authors argue that decentralized frameworks may be more sensitive to the problem of soft budget constraints than centralized ones and that borrowing rules may not always be effective enough which could increase economic vulnerability to financial shocks. Others argue that increased tax autonomy could lead to improved fiscal discipline and responsibility thus increasing regional stability in the context of a recession (see Martínez-Vázquez *et al.* (2017)).

The third group of regressors are related to *intensity of invention and innovation factors* and draws from previous studies of knowledge and development (Capello and Lenzi, 2014). This group of factors consists on (i) the logarithm of the number of patents per millions of people, (ii) the logarithm of the R&D spending per capita, (iii) an innovation index measuring the share of small and medium firms introducing a new product and/or a new process in the market, (iv) an index of infrastructure density based on the logarithm of kilometers of motorways network and

(v) the human capital, proxied by the share of population with tertiary education. Overall, these factors are expected to enhance resilience.

The fourth group of regressors considers *factors defining sectoral specialization and its degree of diversity* as they have been found to exert a relevant impact on labor market differentials (Rios, 2017). To control for differences in labor market characteristics and sectoral specification the following variables are considered: the share of GVA (i) in agriculture, (ii) manufactures, (iii) non-market services and (iv) financial services, (v) the employment rate in high-tech sectors, (vi) the long term unemployment rate and (vii) the diversity of the sectoral specialization measured by the Herfindal index.⁷

Apart from institutional and innovation factors, *socio-demographic characteristics* might also have effects on resilience. To control for the potential effect of agglomeration we include in our specification an indicator of (i) population density. In addition, we control for the demographic composition, which is directly related to the availability of adequate labor supply for the different labor markets and to the degree of social vulnerability. For this reason, we include the (ii) share of population aged between 15-24 years old (i.e. young population) and (iii) the share of population aged between 55 and 64 years old. We also consider the effect of the (iv) net migration rate as it affects labor supply and labor demand dynamics. Finally, we include a proxy of (v) social capital that considers the degree of interpersonal trust in the region.

Figure 1 shows that regional resilience in the EU is clearly affected by national patterns (Crescenzi *et al.*, 2016a; Giannakis and Bruggeman, 2017). In view of this, our empirical analysis incorporates country dummies (i.e, C_F in Equation (2)) to ensure that the observed link between

⁷ The Herfindal index indicates the extent to which GVA is dispersed throughout regional sectors: the closer to zero the value of the index, the higher the diversity of the regional economy

the various factors and resilience is not simply capturing the latent influence of institutional, economic, financial and/or historical factors at the national level.

5. Results

5.1 Main Results

Table (3) reports the results obtained from the BMA analysis whereas Table (4) reports the model-averaged standardized effects of the sub-components of the QoG index. However, before continuing with the discussion of the results, it is worth mentioning the problems that the methodology applied here is able to solve and those problems that may persist, affecting the quality of the estimates. The strong point of the BMA methodology employed here is that it accounts for the uncertainty of the parameter estimates across different models while controlling for omitted variable bias (Moral-Benito, 2015). However, it does not correct for the potential negative effect of endogeneity generated by reverse causal relationships or measurement errors. Therefore, to minimize the potential problems caused by reverse causality most of the explanatory variables are taken as the average value between 2000-2007 whereas the volatility is calculated over the 1995-2007 period to capture long run effects. Therefore, most of our regressors are measured prior to the Great Recession.⁸

We scale the PIPs of the different variables in intervals to classify evidence of robustness of resilience drivers into three categories so that regressors with $PIP \in [0 - 25\%]$ are considered as weak determinants, variables with $PIP \in [25 - 75\%]$ as moderate determinants and with $PIP \in [75 - 100\%]$ as relevant determinants. As observed in Column (1) of Table (3), there is a set

⁸ The only exceptions are the QoG and the trade openness, for which data exists only for 2010, 2013 and 2017 and 2010 and 2013 respectively. For these regressors we use the average of 2010-2013 values.

of top variables that appears to have been visited with high frequency by the MC³ sampler, and therefore, conforms the group of very important determinants. The share of young population with (98.9%) and the quality of government (94.8%) appear to be the key drivers of resilience. In a lower level of relevance, we find the historical level of volatility of the business cycle (69.6%), the human capital (59%), the sectoral specialization (47.9%) and the past employment growth rates (36.3%). Finally, weak resilience drivers include a myriad of factors related to the macroeconomic environment, the specific composition of the productive structure, innovation and knowledge factors and socio-demographic factors.⁹ Overall, our findings suggest, that analysis focusing only on the role played by the productive structure and the sectoral specialization might be miss-leading.

INSERT TABLE (3) ABOUT HERE

INSERT TABLE (4) ABOUT HERE

We now turn our attention to the model averaged estimates of regional-level variables as they provide the basis for posterior inference regarding the parameters. Model averaged estimates were constructed based on the alternative sets of variables identified by the MC³ procedure described in Section 3. These results are based on the top 10,000 highest probability models and for the sake of brevity, in the discussion of our results we will focus only on the variables with PIPs above the 25%.

As regards our variable of interest, we find that QoG has a positive impact on regional resilience outcomes with a posterior mean of 0.251. Moreover, as shown in Column (4) the posterior sign certainty of the QoG is 100%, which implies the parameter estimate is always

⁹ Information on the country effects is omitted for the sake of brevity but can be provided upon request.

positive irrespective of the model under consideration. This positive effect of QoG on regional resilience is in line with previous literature and supports the findings of Ezcurra and Rios (2019) and Sondermann (2018). The positive impact on resilience can be explained by the moderating effect on financial shocks, the improved policy responses due to higher spending efficiency, the improved resource allocation or the ability to foster private sector dynamism. Looking at the aggregate impact of the QoG index in the first row of Table (4), we find that a one standard deviation increase in QoG is associated with an increase in the indicator of resilience of around 0.179 standard deviations, which is for example the difference in resilience scores between Dél-Alföld (HU33) and Aland (FI2) or between Franche-Comté (FR43) and Stockholm (SE11).

As stated in Section 4, our measure of QoG, is based on three concepts related to different aspects of governance: the quality, impartiality and level of corruption in different services such as education, public health care and law enforcement. Although they are positively correlated, it is not clear beforehand which of these dimensions of governance affect regional resilience. For this reason, we now examine separately the role played in this context by the quality, impartiality and degree of corruption in the public services mentioned above. The results displayed in Table (4) reports standardized model averaged impacts and show that these three aspects of the quality of government exert a positive effect on regional resilience. However, while corruption and the quality of public services appear to have high PIPs, the component of the QoG measuring impartiality seems to have lower explanatory power explaining the variability of resilience across regions and should be only considered as a moderate determinant. This result contrasts with the findings of Ezcurra and Rios (2019) who just analyze statistical significance and conclude the three dimensions are equally important.

The results in Table (3) regarding the other variables identified as relevant and moderate drivers are also worth discussing. The share of young population appears to be negatively related

to resilience. This result suggests that the negative effect implied by the lack of skills, experience and productivity of younger populations might dominate the higher adaptability to rapid technological change. Another reason is that the fall in aggregate demand implied by the Great Recession, lead to a decline in the demand for labor in general and since young workers are affected more strongly than older workers by such changes in aggregate demand, regions where the share of young population was higher experienced worse resilience outcomes.

Second, we find that historical levels of volatility appear to be of major importance and exert a strong negative effect on resilience during the Great Recession. In general, this result is in line with studies that find evidence of a negative relationship between higher volatility and regional growth (Martin and Rogers, 2000; Ezcurra and Rios, 2015) and can be explained by a learning by doing mechanism. Given that our proxy of volatility captures unstable historical development paths, the finding of past regional volatility being one of the major drivers of resilience during the Great Recession points to the existence of strong path dependence: as the process of development for unstable regions continues, it becomes increasingly difficult to become stable and the possibilities of entering in a resilient path after being hit by exogenous shocks is increasingly restricted. The fact that the posterior sign positivity is 0%, suggest this negative impact is robust. This in turn, reinforces the need of counter-cyclical policies aiming at stabilizing fluctuations.

Third, we find that human capital also exerts a positive effect on resilience. As the sign certainty of this variable is 100%, we can safely predict this result holds for any combination of regressors. This finding supports previous results of Crescenzi *et al.* (2016b) and Giannakis and Bruggeman (2017) and can be explained by the fact that the endowment of human capital is closely connected with the capacity of regional economies to absorb externally generated new ideas and create new knowledge fostering organizational innovations, reducing production costs

to maintain regional competitiveness and attracting the most sophisticated value added functions of multinational firms. Nevertheless, a difference with respect the results of Crescenzi *et al.* (2016b) and Giannakis and Bruggeman (2017) is that human capital in our analysis is not the most important driver of resilience since the QoG or the volatility are more relevant in this context.

We also find the effect of past employment growth rates matters to explain the high heterogeneity observed in resilience outcomes. In particular, the estimated effect is negative, which suggests that regions with better pre-crisis labor performance are non-resilient to economic crisis. This finding shows there has been a trend inversion in the labor market as observed by (Marelli *et al.*, 2012). Finally, we find that a higher sectoral specialization of the GVA increases resilience. This result contradicts the view that a diversified productive structure is more able to resist and withstand shocks (see Cuadrado-Roura and Moroto, 2016; Martin *et al.*, 2016). This could be explained by the fact that firms located in more specialized regions might gain from agglomeration effects such as knowledge spillovers and be more productive than similar firms in less specialized regions.

In Figure A1 in the Online Appendix, we present the results of additional robustness checks of our findings regarding elicitation of the g-prior and the prior over the model space.

5.2 Posterior Jointness Analysis

To complement previous results and to gain further insights that might be useful for policy making, we carry out an analysis of the posterior jointness to detect dependencies among regressors. Figure (2) reports the posterior jointness relationships of the different determinants included in the analysis, as calculated by the metric proposed by Doppelhofer and Weeks (2009). The investigation of the jointness of QoG and other regressors is relevant from a policy-making

perspective as it helps to better understand what regional characteristics may reinforce or hamper the efforts of increasing resilience via QoG. Thus, the information contained in Figure (2) is very useful to complete the analysis on the relevance of the QoG as a determinant of resilience performed so far.¹⁰

The main findings are as follows. We find evidence of both positive and negative jointness among resilience determinants. Significant positive jointness (with $J > 1$) is not restricted to variables considered significant by the PIPs. In this respect, a complex explanation emerges, given that there is a myriad of factors with low PIPs that become significant determinants of resilience, conditional on the inclusion of other variables. This is for example the case of population density, R&D spending per capita, wages and the patents per capita, which all become relevant drivers of resilience once QoG is accounted for. This is also the case of R&D spending per capita and education, which reinforce the relevance of each other determining resilience. Other variables appear to reduce the importance of human capital as a driver of resilience, as it is the case of the degree of economic self-rule. Moreover, some sectoral composition variables such as the share of manufactures, which exert a negative effect on resilience, increase their relevance after conditioning of the sectoral specialization.

Given that describing all the interdependencies across the set of variables considered is difficult and beyond the purpose of this study, we focus on the jointness statistics of QoG. In this regard, is important to note that in the case of very little significant jointness among QoG and other variables, which implies little complementarity (i.e, with $-1 > J > 1$) the decisions of policy makers are greatly simplified, as the impact of investing in QoG as a way to increase resilience does no longer depend on other factors that may reinforce or reduce the importance of QoG. However, if we find significant positive jointness among the QoG and other determinants, in

¹⁰ Table A1 in the Online Appendix also reports the same information provided in Figure 2.

such scenario, a structural reform or a policy aiming at improving the QoG and/or the functioning of the administration, may not produce the expected results unless we take into account the conditioning variables that complement QoG. On the other hand, policy makers that overlook the presence of strong substitutes (i.e, $J < -1$) reducing the importance of the QoG, may fail in achieving the desired outcomes if they try to foster resilience through improvements in QoG.

Figure (2) reveals that QoG has significant positive jointness with volatility, education, patents per capita, population density, R&D spending per capita and the wages. Given that some of these variables reinforcing the effect of QoG are related to the knowledge and innovative environment of the region, it seems clear that regional policy makers should base their policies in a “package” of measures aiming at improving the knowledge base and the innovation system of the region. It is also worth mentioning that conditional to the existence of volatile environments and high population densities, QoG increases its relevance as a determinant of resilience. Moreover, given that QoG also shows significant negative jointness with the share of young population, the share of trade openness in the GDP and long-term unemployment rates, these regional characteristics should be considered when designing policies. The fact that QoG has its importance reduced in regions experiencing high long-term unemployment rates or high rates of young, suggests that any structural reform in the functioning of the administration that is not accompanied by active-labor market policies targeting the youth and their inclusion in the labor market, may have a limited effectiveness in the strengthening of regional labor markets.

In addition, the high substitutability observed between QoG and trade openness suggests that the underlying mechanisms that make QoG an important factor explaining resilience differentials are similar to those associated to the regional openness, which goes in line with the insights of Yu *et al.*, 2015, Alvarez *et al.* (2018) or Rodríguez-Pose and Cols (2017) among

others, who suggest that low QoG levels may act as barrier to trade and to foreign direct investment. We conjecture that this substitutability among factors can arise because of some of the transmission channels of the effects of QoG on resilience can also be stimulated through increased trade openness. The intuition is that trade openness fosters international competition, strengthens incentives for firms to make productivity improvements, helps firms to adopt better practices, improve technology diffusion and increase productivity via upgrading. These effects can also be triggered by good institutions, since institutional factors are key enablers of innovation, mutual learning and productivity growth Putman (2000).

INSERT FIGURE (2) ABOUT HERE

6. Conclusions and Policy Implications.

This paper has examined the determinants of regional resilience in the EU during the Great Recession. The key contribution of this analysis is methodological given that we consider the effect of a great number of determinants by employing BMA techniques to account for model uncertainty in cross-regional resilience regressions. We compute the PIPs for the different indicators to generate a probabilistic ranking of relevance for the various resilience determinants. Our results point out the existence of a set of relevant determinants of resilience that explain regional differentials. To complement BMA results, we also carry out a posterior jointness analysis.

The BMA analysis reveals the QoG is a top determinant shaping regional reactions to the crisis in the EU. We also find that other regional level factors such as the share of young population, the level of volatility in the business cycle, human capital, past employment growth rates or the sectoral specialization are of major importance. Therefore, the results of the paper raise potentially important policy implications, especially at a time in which there is an active

public debate on the most appropriate instruments to reduce the impact of recessionary shocks on regional economies.

Our analysis suggests that improving the QoG may contribute to increasing the ability of regions to react to economic downturns. Accordingly, when designing effective development strategies, not only policy makers but also the civil society should pay particular attention to the way in which authority is exercised by regional governments. Actions aimed at reducing corruption or focusing in the efficiency of the judiciary might increase resilience. However, jointness analysis reveals that policy makers aiming at increasing resilience via institutional reforms need to take into account a number of complementary and substitute factors, which can reinforce or decrease the relevance of the QoG. Hence, the picture that emerges from our study is complex and suggests that “packages of reforms” that promote QoG together with improvements in education and the innovative environment of the region might be more effective than focusing on the institutional design alone. Moreover, our findings suggest that active labor market policies targeting the youth and the long-term unemployment seem to be a pre-requisite for institutional reform effects to develop its full potential. In addition, our results also suggest that in regions where the trade openness is already high, increasing QoG might not be so clue.

An important issue for policy makers and the civil society is how to increase the QoG of a region in practice. Although we would like to turn the labor market resilience and the QoG of Sicily into that of an idealized place like Thüringen, who experienced continued employment growth during the Great Recession and has one of the highest QoG scores, this is a difficult thing to achieve, given that persistent corruption has deep geographical and historical roots (Goel *et al.*, 2010) and the empirical evidence on how to bring down corruption is scant. Nevertheless, some studies such as An and Kweon (2016) find that increasing wages of public servants reduces corruptions which could be an avenue to improve QoG. Alternatively, increasing gender-equality

can be a strategy to curb corruption and increase QoG, given that sub-national regions with high numbers of female politicians exhibit lower levels of corruption than other regions (Grimes and Wängnerud, 2010). Another option suggested by Dahlström and Lapuente (2017) is the recruitment of civil servants in a meritocratic manner, that is to say strictly on the basis of their qualifications and skills; as opposed to political appointment.

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Figures and Tables

Figure 1: Regional resilience in the EU during the Great Recession (2008-2013).

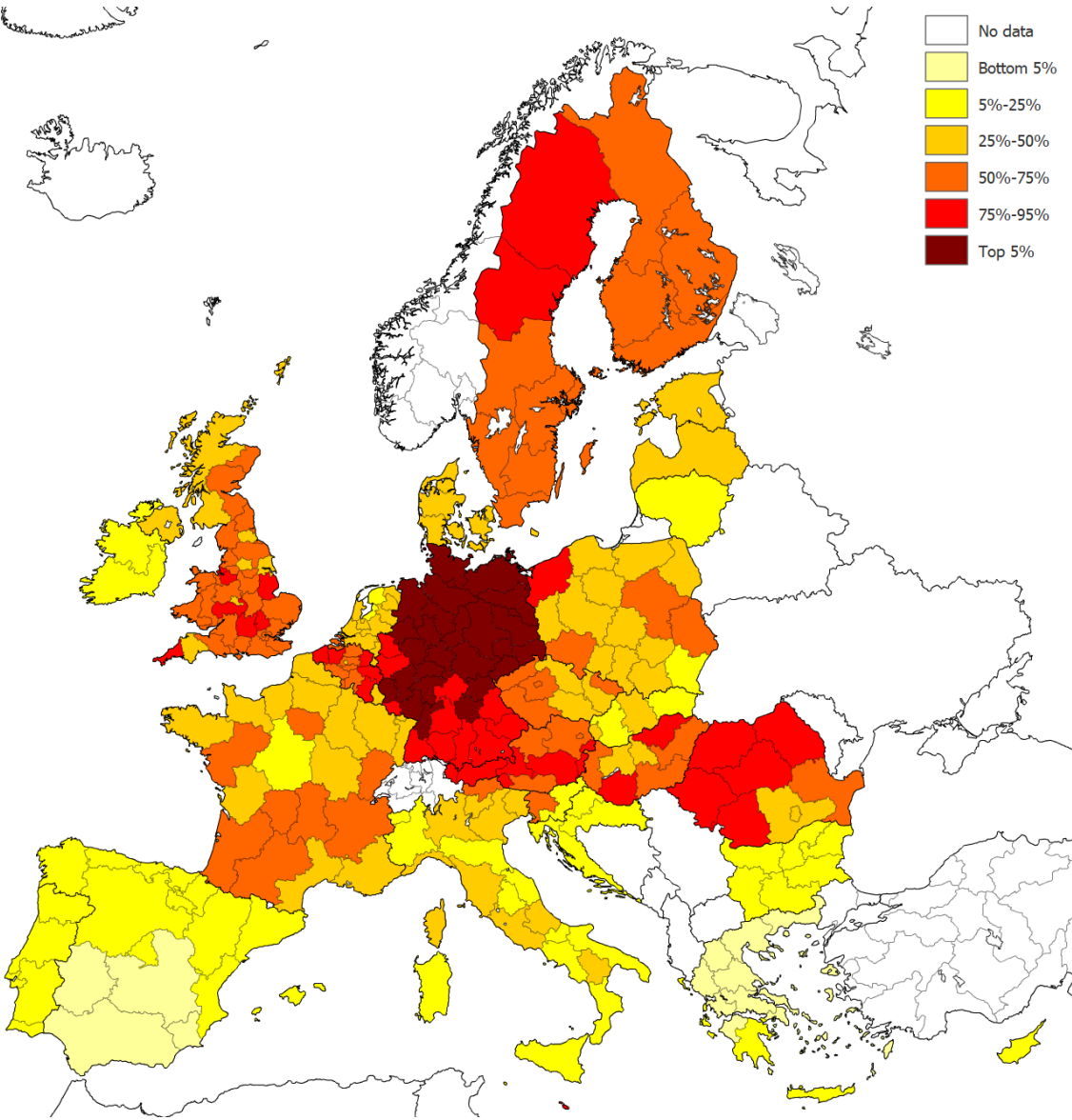
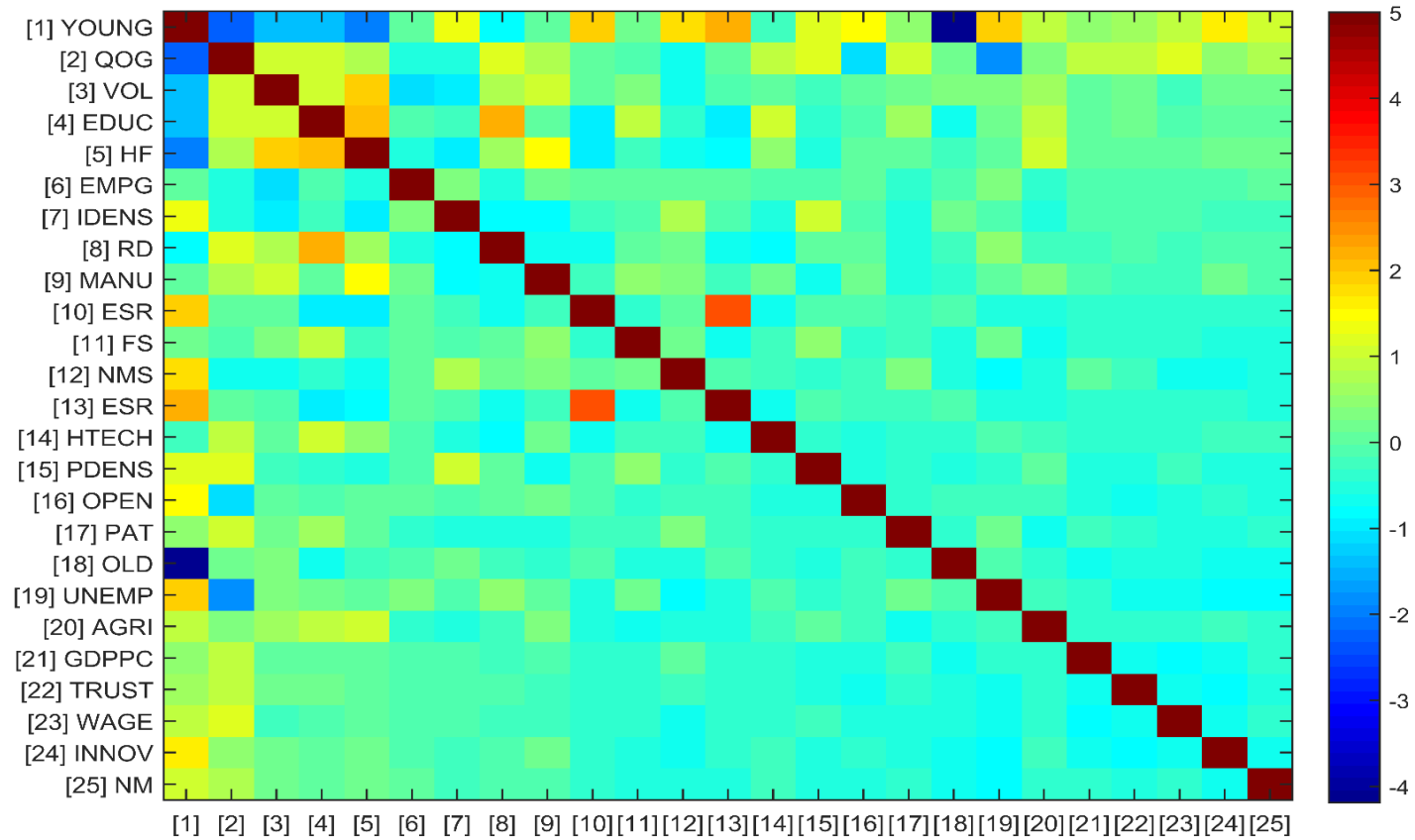


Figure 2: Posterior Jointness of the Determinants of Resilience



Note: the entries (in red) in the main diagonal are in fact not numbers as the J statistic is not defined for them. Values of the J statistic above 1 are considered as evidence on significant complementarity, values below -1 suggest significant substitutability and values between -1 and 1 suggest independence

Table 1: Top and worst performing European Regions

Top 10 Regions			Bottom 10 Regions		
Rank	Region	Score	Rank	Region	Score
1	Sachsen-Anhalt (DE)	2,38	256	Anatoliki Makedonia, Thraki (EL)	-3,58
2	Chemnitz (DE)	2,33	257	Castilla-la Mancha (ES)	-3,64
3	Leipzig (DE)	2,28	258	Andalucía (ES)	-3,68
4	Dresden (DE)	2,27	259	Dytiki Ellada (EL)	-3,69
5	Berlin (DE)	2,21	260	Extremadura (ES)	-3,69
6	Thüringen	2,18	261	Attiki (EL)	-3,70
7	Mecklenburg-Vorpommern (DE)	2,16	262	Dytiki Makedonia (EL)	-3,83
8	Brandenburg - Südwest (DE)	2,06	263	Stereia Ellada (EL)	-3,98
9	Kassel (DE)	1,81	264	Kentriki Makedonia (EL)	-4,50
10	Bremen (DE)	1,66	265	Voreio Aigaio (EL)	-4,57

Note: A detailed regional ranking with resilience scores is included in Table A1 in the Online Appendix.

Table 2: Data: Descriptive Statistics

Variables	Code	Mean	Standard Dev	Min	Max	Definitions	Sources
<i>1. Macroeconomic Factors</i>							
Income per capita	GDPPC	9.82	0.71	11.04	7.64	Log of Average Income per capita (in thousand euros)	CE
Volatility	VOL	2.87	1.63	12.45	0.75	Standard deviation of the output per capita gap (%)	CE
Employment growth	EMPG	0.98	1.16	4.30	-3.76	Average annual growth rate of employment rates (%)	CE
Trade Openness (a)	OPEN	165.77	172.25	2115.17	37.62	Trade Openness spending to GDP (%)	Thissen <i>et al.</i> (2019)
Wages	WAGE	9.97	0.67	10.89	7.30	Log Compensation per employee (euros)	CE
<i>2. Institutional Factors</i>							
Quality of government	QOG	0.14	0.96	1.76	-2.84	Regional quality of government index based on the indicators of corruption regulatory quality and impartiality	QOGI
Economic self-rule (b)	ESR	12.93	14.25	48.00	0.00	Economic self-rule index based on the indicators of policy scope, fiscal autonomy, political representation and institutional depth	Sorens (2014)
<i>3. Knowledge-Innovation Factors</i>							
Patents	PAT	-3.35	1.82	-0.26	-8.57	Log of Number of patent applications to the EPO by priority year (per capita)	Eurostat
Innovation (c)	INNOV	0.43	0.18	0.79	0.02	Innovation composite index measuring innovation in small and medium firms	RIS. CIS
R& D spending	RD	5.16	1.47	7.87	0.97	Log of research and development spending per capita (in euros)	Eurostat
Infrastructure density	IDEN	2.10	2.09	4.97	-2.30	Log of the number of kilometers of motorways and railways network	Eurostat
Human capital	EDUC	21.16	7.98	43.87	6.68	Tertiary education attainment	Eurostat
<i>4. Social-Demographic Factors</i>							
Population density	PDENS	4.97	1.15	8.73	1.13	Log of the inhabitants per squared kilometer	CE
Old population	OLD	16.63	2.82	26.03	8.73	Population share between 55-65 years old (%)	Eurostat
Young population	YOUNG	16.52	2.27	23.20	10.19	Population share between 15-24 years old (%)	Eurostat
Trust	SCAP	0.33	0.14	0.78	0.03	Index of social capital (scale 0-1)	ESVS
Net migration (d)	NM	0.34	0.64	2.80	-1.80	Net migration rate (%)	Eurostat
<i>5. Labor Market Factors</i>							
Agriculture	AGRI	3.49	3.46	17.29	0.01	GVA share in agriculture (%)	Eurostat
Manufactures	MANU	22.14	7.77	43.49	4.09	GVA share in manufacturing (%)	Eurostat
Financial services	FS	3.99	2.43	25.59	0.93	GVA share in financial market services (%)	Eurostat
Non-market services	NMS	18.81	4.16	31.44	10.14	GVA share in non market services (%)	Eurostat
High-tech employment	HTECH	3.97	1.76	9.99	0.89	Employment share in high-tech sector (%)	Eurostat
Long term unemployment	UNEMP	3.74	3.01	15.06	0.39	Economically active population who has been unemployed ≥ 12 months (%)	Eurostat
Sectoral specialization(e)	HF	16.74	2.29	28.76	13.39	Herfindal index calculated over the GVA shares in 10 different sectors	Eurostat

Notes: QOGI Quality of Government Institute, CE Cambridge Econometrics Database, RIS Regional Innovation Scoreboard CIS to Innovation Community Survey, ESVS European Social Value Survey and ICTWSS Database on Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts. Macroeconomic factors metrics are calculated in the 1995-2007 interval whereas the rest of the variables correspond to averaged values over the period 2000-2007. (a) Trade Openness is calculated following Thissen *et al.* (2019). (b) Economic self-rule index as in Sorens (2011). (c) The innovation index is calculated as the max-min normalized weighted average of the RIS (80%) and the CIS (20%) scores of 2009 for regions belonging to a country with more than one region. It takes the normalized value of the CIS when there is just one region in the country. (d) The net migration rate for each year of the period 2000-2008 is calculated using population growth rates and natural growth rates. (e) The sectors considered to obtain the Herfindahl Index are agriculture, industry, construction, distribution, information and communication, financial services, real estate activities, professional services, public services and other services

Table 3: Main Results

	<i>PIP</i>	<i>Post. Mean</i>	<i>Post.SD</i>	<i>Cond.Post. Sign</i>
	(1)	(2)	(3)	(4)
Young population	0.989	-0.075	0.021	0.000
Quality of government	0.948	0.251	0.094	1.000
Volatility	0.696	-0.047	0.037	0.000
Human capital	0.590	0.012	0.012	1.000
Sectoral specialization	0.479	0.018	0.021	1.000
Employment growth	0.363	-0.024	0.036	0.000
Infrastructure density	0.244	-0.011	0.022	0.000
Manufactures	0.200	-0.002	0.004	0.002
Research and development	0.196	0.016	0.039	0.816
Economic self-rule squared	0.130	0.000	0.000	1.000
GOV	0.110	-0.001	0.005	0.035
Financial services	0.108	-0.002	0.009	0.019
Economic self-rule	0.106	-0.003	0.013	0.345
High-tech employment	0.099	-0.003	0.011	0.039
Population density	0.092	0.003	0.015	0.966
Trade openness	0.091	0.000	0.000	1.000
Patents per capita	0.086	0.003	0.016	0.788
Long term unemployment	0.085	-0.001	0.006	0.023
Old population	0.084	-0.001	0.008	0.139
Agriculture	0.078	0.001	0.005	0.795
GDP per capita	0.062	-0.001	0.044	0.460
Trust	0.055	-0.011	0.105	0.035
Wages	0.054	0.001	0.020	0.497
Net migration	0.052	0.001	0.013	0.861
Innovation	0.051	0.006	0.121	0.670

Notes: The dependent variable in all regressions is the resilience index calculated over the period 2008-2013. All the results reported here correspond to the estimation of the top 10,000 models from the 33.554432 million possible regressions including any combination of the variables. Variables are ranked by Column (1), the posterior inclusion probability. Columns (2) and (3) reflect the unconditional posterior mean and standard deviations for the linear marginal effect of the variable, respectively. Column (4) denotes the sign certainty probability, a measure of our posterior confidence in the positivity of the coefficient.

Table 4: Effects: sub-components of the QOG

	Rank	<i>PIP</i>	<i>Post. Mean</i>	<i>Post. SD</i>	<i>Cond.Pos. Sign</i>
	(1)	(2)	(3)	(4)	(5)
Quality of government	2	0.948	0.179	0.068	1.000
Regulatory quality	2	0.948	0.180	0.067	1.000
Control of corruption	2	0.926	0.165	0.069	1.000
Impartiality	6	0.328	0.046	0.077	1.000

Notes: The dependent variable in all regressions is the resilience index for the period 2008-2013. All the results reported here correspond to the estimation of the top 10,000 models from the 33.554432 million possible regressions including any combination of the variables. The standardized effects of each of the sub-components of the QOG is analyzed independently in a different MC^3 pass. All the results correspond to unconditional posterior estimates.