Testing and explaining economic resilience with an application to Italian regions

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by

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Abstract

This paper studies regional economic resilience by exploiting the properties of the nonlinear smooth-transition autoregressive model. A testing procedure to distinguish between engineering and ecological resilience is presented, and a measurement of economic resilience is provided. Regional differences in economic resilience are explained by the presence of spatial interactions and by adopting a set of determinants like economic diversity, export performance, financial constraints, and human and social capital. An empirical investigation is conducted for analysing regional employment evolution in Italy from 1992 to 2012. Some concluding suggestions propose possible future areas of research.

Keywords: regional resilience, hysteresis, smooth transition regression.

JEL classification: R11, R12, C34.

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1. Introduction

During recessionary times the relation between negative shocks and economic growth usually regains its importance among academics and policymakers. For more than thirty years, starting from the 1970s and up to 2007, the view that economic recessions almost exclusively imply transient real effects in terms of employment and output has been predominant in the economic debate. Yet, the dramatic consequences of the recent financial crisis and the subsequent economic slump, with output losses soaring to unprecedented figures and employment still having trouble to bounce-back to pre-crisis levels in many countries, have claimed for alternative explanations and they have sustained a renewed interest for old-fashioned ideas like hysteresis, secular stagnation and structural change (IMF, 2009; Ball *et al.*, 2014).

To provide further insights on the spatial dimension of economic crises and adverse events, regional scientists and geographers have recently employed the idea of economic resilience (Reggiani *et al.*, 2002; Martin, 2012). Drawing from the theoretical precursors developed in other disciplines – like Engineering, Ecology and Physics - the regional resilience framework has been adopted for throwing some light on the spatial patterns of common-wide recessions such as: the presence of jobless recoveries in given places, whether or not output losses are reversed in particular contexts, the overall consequences of aggregate shocks on regional and local economic growth (Boschma, 2014; Fingleton *et al.*, 2014). A review of theoretical and empirical works analysing economic resilience has been recently provided by Modica and Reggiani (2014).

This paper aims to contribute to the regional resilience literature along three main directions. Firstly, it proposes an empirical framework which is able to address some of the featuring aspects of economic resilience like transient versus permanent place-specific effects of economic shocks, pre- and post-shock regional growth paths, and the way regions adjust to structural changes. Early studies in the resilience literature (Holling, 1973 and 1996; Pimm, 1984) highlighted the importance of making a distinction between two meanings of economic resilience: *engineering resilience*, the ability of a given economic system to remain stable when a shock occurs maintaining its long-run growth path; *ecological resilience*, the capacity of a particular economic context to resist to shocks before switching to different stable or unstable equilibria. In the first-step of the following analysis, the properties of the non-linear Smooth Transition Autoregressive (STAR) model will result helpful in order to provide an answer to which kind of economic resilience shall be taken into account for describing the evolution of a given area. A testing procedure is presented for distinguishing between engineering and ecological resilience, and a measure of economic resilience is provided. The spatial aspects of regional resilience are discussed, addressing the presence of neighbouring interactions and the relevance of trade linkages among regions within the same country.

The second-step of our analysis investigates which factors can explain the geographical asymmetries in economic resilience detected in the first-step, contributing to a growing literature looking at the determinants of resilience on a regional level (Fingleton and Palombi, 2013; Diodato and Weterings, 2014). Differences in regional resilience are explored by focusing on a specific set of explaining variables – such as the role of economic diversity, export propensity, human and social capital, and financial constraints – that have been built upon the main determinants of resilience presented in Martin and Sunley (2014). Finally, by studying employment dynamics across the twenty Italian regions over the past two decades, this paper makes a contribution to the analysis of regional economic inequalities in Italy by adopting a resilience-based perspective (Cellini and Torrisi, 2014; Di Caro, 2014). It looks at the rooted Italian economic divide between Northern and Southern regions by assessing the relations between regional economic growth, uneven disaggregate responses to national-wide shocks, and place-specific adjustments to structural changes.

The remaining of the work is organized as follows. Section 2 discusses the theoretical framework. Section 3 presents the empirical strategy, the testing procedure for discriminating between engineering and ecological resilience, and the measurement of economic resilience. The determinants of resilience and their ability to explain regional differences in Italy are described in section 4. Section 5 summarizes and concludes.

2. Theoretical background

2.1 Economic resilience

In a recent contribution, Martin and Sunley (2014) have proposed an evolutionary or adaptive definition of regional economic resilience, that is, the capacity of given places to resist to shocks, recover from unexpected events and sustain a long-term developmental growth path. This evolutionary view is based upon the idea that economic resilience shall be interpreted as a dynamic process of robustness and adaptability, where the interdependence of space- and time-specific institutional, economic and historical elements influences the way local economies react to adverse events. Therefore, it becomes crucial to understand the connections between the spatial effects of a particular crisis and the evolution of a local economy both in the short- and in the long-run. This interpretation has been suggested in order to combine the two original definition of resilience, namely engineering and ecological, in an unified framework, and provide a direct link between economic growth and responses to shocks.

Borrowing from physical sciences, the notion of engineering resilience has been applied in regional studies for characterizing the short-term resistance of given areas to aggregate disturbances and their ability to bounce-back to their pre-shock equilibrium state (Martin, 2012). Recessionary events are temporary random fluctuations around a quite stable equilibrium level, and the main focus shall be on cyclical rather than structural elements. The idea of engineering resilience has many aspects in common with the Friedman's plucking model and the traditional real business cycle literature where total factor productivity or neutral technology shocks have transient consequences. From an empirical point of view, engineering resilience implies the adoption of linear specifications and the measurement of the speed of the system's return to equilibrium (Fingleton *et al.*, 2012).

The definition of ecological resilience has been used for describing the long-term ability of places to withstand shocks in the long-run and cope with destabilizing pressures in a multi-regime environment (Simmie and Martin, 2010). This second interpretation of resilience points out the presence of out-of-equilibrium dynamics, permanent losses due to economic crises and the importance of structural changes. It admits the possibility that recessions and jobless recoveries can perpetuate the long-term structure of a particular context, implying that unemployment and output do not re-adjust in the long-run showing hysteresis and path-dependence. In this situation, multiple equilibria models and nonlinear specifications are better candidates to explain the process under observation.

Holling (1996, p.33) introduced a direct comparison between engineering and ecological resilience highlighting that: 'the first definition concentrates on stability near an equilibrium steady state, where resistance to disturbance and speed of return to the equilibrium are used to measure the property […], the second definition emphasizes conditions far from any equilibrium steady state, where instabilities can flip a system into another regime of behaviour. In this case the measurement of resilience is the magnitude of disturbance that can be absorbed before the system changes its structure by changing the variables and processes that control behaviour.' Interestingly, Holling's formulation offers a theoretical guidance for combining the two notions of economic resilience setting out both measurement issues and the importance of regime changes. The empirical strategy discussed in section 3 aims to provide a comprehensive framework to explore Holling's intuition so as to identify whether engineering or ecological resilience is at work in a particular context.

2.2 The determinants of regional resilience

Why territories differ in terms of economic resilience within and across countries is an open-question, and an empirical area of research which is growingly attracting the interest of many researchers. Prior studies on regional resilience have been mostly focused on its descriptive side, resulting in spare systematic evidence on its determinants. Exceptions are the works of Fingleton and Palombi (2013) and Diodato and Weterings (2014). The former contribution explain the different degree of economic resilience showed by the British towns during the Victorian era by means of the sectoral composition of local employment and industrial specialization; the latter one relate the uneven economic resilience of Dutch regions to the interplay of factors like the intra- and inter-industry productive linkages, and the mobility of workers within and across regions.

The explanatory factors used in our analysis are connected to the complex set of locally specific determinants or subsystems of regional resilience suggested by Martin and Sunley (2014): industrial and business structure, labour market conditions, financial arrangements, agency and decision-making.[1] As for the industrial structure, we analyse the relation between economic diversity and regional resilience, admitting the possibility that regional economic diversity can contribute to enhance robustness and adaptability, whereas sectoral specialization may act in the opposite direction; and that more diversified regional systems are likely to be less vulnerable to sector-specific negative events. The adoption of measures capturing economic diversity at a regional level have the merit to consider Jacobs externalities and knowledge spillovers across sectors (Mameli *et al.*, 2012).

Also, we explore the role of trade openness and the influence of specific tradable goods composing the regional export basket (Rowthorn, 2010) for promoting economic resilience. Frankel and Romer (1999) pointed out the relations between export-oriented

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[1] In the same spirit, Modica and Reggiani (2014) have proposed six main categories to group the determinants of regional resilience: socio-economic characteristics, financial resources, infrastructures, community capacity, innovation and technology, natural environment.

activities and economic growth through several channels like specialization from comparative advantages, exchange of ideas and technologies; Boschma and Iammarino (2009) in their study on regional growth in Italy highlighted the interplay of trade openness, regional export baskets, knowledge spillovers and related variety. To evaluate the effect of labour market conditions, we refer to human capital and the skill profile of the labour force. Faggian and McCann (2009) have studied the complex interactions between human capital and regional long-term development, underlying the role of human capital inflows, regional migration, place-specific factors and knowledge spillovers. Gennaioli *et al.* (2013) have emphasized the multiple effects of education on regional development and long-term economic growth favouring the upgrading of skills and abilities of both workers and entrepreneurs, and promoting growth-enhancing externalities.

The negative influence of financial constraints on regional resilience can result relevant given that high interest rates and tight financial markets can act as barriers to investments in high-return activities, reducing the creation of new firms and amplifying the cyclical and structural effects of economic crises. This effect can be magnified during and after financial turmoil like that experienced in 2007-2008, when local differences in financial conditions can be influenced by global- and national-wide elements. We introduce a measure of financial constraints at a regional level in order to find out the asymmetric effects of the credit system on regional evolution across Italian regions. Giannola and Lopes (2012) have found a negative relation between tight regional credit markets and local evolution in Italy.

Within the agency and decision-making subsystem we explore the influence of mutual confidence on resilience. In principle, places endowed with public trust and cooperation may be less vulnerable to adverse events due to the positive consequences on the reduction of transaction costs, the accumulation of physical and human capital, and the improvement of government performance. Capello and Faggian (2005) have discussed the impact of relational capital – a multifaceted set of explicit and implicit cooperation, partnership and relationship – on the performance of Italian firms; Di Giacinto and Nuzzo (2006) have used several indicators of social capital for explaining the Italian North-South divide in terms of total factor productivity.

3. Detecting regional resilience

3.1 Data and preliminary statistics

The first-step of our analysis combines a measure of regional economic activity for each region under observation with an index describing the national business cycle. We use quarterly regional employment data from 1992(IV) to 2012(IV) for the 20 Italian regions (NUTS-2 level) as an indicator of regional economic activity. The choice of this time period is due to the limited availability of regional employment data at quarterly frequency for the Italian case; this issue has been addressed in Di Caro (2014) where the motivations for preferring quarterly employment data rather than annual employment or GDP observations have been discussed. Observe that, moreover, quarterly employment data allows for the consideration of the potential relations between employment and GDP in a given region, and interactions in output and employment among regions, admitting the possibility that such connections are likely to be not fully contemporaneous at quarterly frequency, and it takes time for employment to adjust to its and other regions' dynamics in output (Ball *et al.*, 2013).

The variable describing the national business cycle is the quarterly Italian unemployment rate for the same time period; a graphical representation (level and growth rate) is reported in figure 1. In general, three views about unemployment have been proposed (Papell *et al.*, 2000): i) traditional theories focusing on the non-accelerating inflation rate of unemployment (NAIRU) and the idea that shocks are temporary random fluctuations around the constant natural rate; ii) structuralist approaches studying the implications of major changes or breaks in the NAIRU and the possibility that unemployment may follow mean-shifting dynamics (Bianchi and Zoega, 1998); iii) unit root hysteresis views pointing out the importance that shocks can have permanent effects on a given economy and the path-dependent nature of unemployment (Blanchard and Summers, 1987). The three approaches have different empirical implications.

Insert about here.
Figure 1. Italian unemployment rate, level and growth rate.

Traditional theories claim the stationarity of the unemployment series and its evolution as a mean-reverting process; structuralists mostly look at the identification of single or multiple break(s) in the series, that can be either endogenously or exogenously defined, in order to rule out the presence of the unit root; the hysteresis view highlights the relevance of actual unemployment and the fact that every unemployment level may reflect an equilibrium level (Røed, 1997). We are preliminary interested in exploring the behaviour of the national unemployment rate so as to identify which kind of unemployment view can be applied to the Italian case and how the movements of the aggregate variable shall be interpreted. Yet, it is worth noting that the main focus of the model specification discussed in section 3.2 is to offer a description of regional employment evolution, and that the national unemployment rate is used as an observed variable.

The results of the preliminary tests conducted for assessing the presence of a unit root in the Italian unemployment rate, available upon request, confirms the previous findings described in the existing literature, namely that the Italian unemployment rate probably follows a unit root behaviour (Bianchi and Zoega, 1998).[2] During the time period here considered it results difficult to precisely detect a changing behaviour in the series which can potentially affect the underlying process. The *Lira* crisis at the beginning of the observation period has influenced the average unemployment rate upward; the current recession was not completely over at the time of the last observation at the end of 2012 and, then, the last shock can be partially observed. In what follows, we interpret the movements registering in the level of the actual unemployment rate like a shock or a series of shocks occurring in the national economy, that can configure a different equilibrium level, in line with the hysteresis approach.

3.2 Methodology

To be workable, the original intuition proposed by the early contributors in the resilience literature like Holling and Pimm needs an empirical strategy which is able to provide a flexible and quite robust way for distinguishing between engineering and ecological resilience. We need a specification that combines most of the featuring aspects of regional economic resilience as discussed in section 2: the link between national business cycle and regional economic activity, the place-specific effects of aggregate shocks, the separation between linear and nonlinear dynamics, the presence of multiple equilibria and

[2] The presence of a unit root in the Italian unemployment series has been preliminary tested by applying the Augmented Dickey Fuller (ADF) test, the Perron and Vogelsang (1992) test based on Perron (1989), which allows for a one-time unknown break, the Bai and Perron (1998) test which allows for multiple structural breaks. The presence of a unit root has not been rejected at the 5% level of significance. Testing the unit root hypothesis in the presence of a single or multiple unknown break(s) rather than adopting different procedures relying on the Chow split test and the *ex-ante* selection of known structural breaks (Bianchi and Zoega, 1998), is justified by the short time span in our sample and by fact that during the period here considered the precise identification of one or multiple structural change(s) is results difficult.

structural changes. One way of addressing these issues in combination can be the Smooth-Transition Autoregressive (STAR) model discussed in Granger and Teräsvirta (1993) and van Dijk *et al.* (2002).

Nonlinear STAR models have been mostly used in the existing literature for analysing the asymmetric behaviour of the business cycle during booms and busts (Teräsvirta and Anderson, 1992), studying the occurrence of multiple equilibria and smooth regime changes in the evolution of output measures (Van Dijk and Franses, 1999), detecting the presence of nonlinear smooth error correction adjustments in monetary models and exchange rates (Kılıç, 2011). More recently, the STAR framework has been applied to address spatial economic issues: Lambert *et al.* (2012) and Pede *et al.* (2014) have proposed a spatial version of the STAR model for studying local economic growth in the US, by incorporating neighbouring interactions in the transition function; Kang *et al.* (2012) have adopted the STAR specification for describing the impact of aggregate oil price changes on the US economy at a state level. Our contribution is related to the latter line of research, being interested in explaining regional economic resilience by looking at the place-specific evolution of economic activities in response to variations in the aggregate economy.

For a univariate time series y_t a general representation of the STAR model is:

$$y_t = \phi_1' y_t^{(p)}\big(1 - G(s_t;\gamma,c)\big) + \phi_2' y_t^{(p)} G(s_t;\gamma,c) + \varepsilon_t \qquad (1)$$

where $y_t^{(p)} = (1, \tilde{y}_t^{(p)})'$, $\tilde{y}_t^{(p)} = (y_{t-1}, \dots, y_{t-p})'$, $\phi_i = (\phi_{i0}, \phi_{i1,} \dots, \phi_{ip})'$ are parameters to be estimated, $i = 1,2$ and ε_t is a white-noise error process with mean zero and variance σ^2. The transition function $G(s_t;\gamma,c)$ is continuous and bounded between 0 and 1, and the following logistic version has been adopted:[3]

$$G(s_t;\gamma,c) = \{1 + exp[-\gamma \prod_{k=1}^{N}(s_t - c_k)]\}^{-1}, \qquad \gamma > 0 \qquad (2)$$

[3] The choice of the logistic transition function and the LSTAR model can be motivated by the specific interpretation of the regime-switching pattern induced by the transition function in our case, as pointed out by Van Dijk *et al.*, (2002). Also, the LSTAR specification has been preferred on the basis of the results of the testing procedure suggested by Teräsvirta (1994) for discriminating between the LSTAR and other nonlinear models.

with γ denoting the speed of transition between regimes, N the total number of transition points, s_t the transition variable and c_k the threshold(s) value(s) indicating the level of the transition variable at which a transition point occurs. The parameter γ has three characteristics: $\gamma > 0$ as identifying restriction; when $\gamma \to 0$ the model in (1) becomes linear; when $\gamma \to \infty$ the logistic function in (2) approaches a Heaviside function, assuming the value 0 for $s_t < c$ and 1 for $s_t > c$. The transition variable s_t can be a lagged endogenous variable, a linear/nonlinear representation of lagged endogenous variables, a linear trend or an exogenous variable (Teräsvirta, 1994).

The logistic STAR (LSTAR) model obtained by combining (1) and (2) represents, at any given point in time, the evolution of the variable y_t as a weighted average of two different linear autoregressive *AR(p)* processes. The transition variable s_t determines the magnitude of the weights, while the parameter γ captures the speed at which these weights change when s_t varies. This model can be interpreted as a continuum of regimes depending on the different values of the transition function (between 0 and 1), or, alternatively, as a two-regime switching model where the transition from one regime $(G(s_t; \gamma, c) = 0)$ to the other $(G(s_t; \gamma, c) = 1)$ is smooth (van Dijk *et al.*, 2002). Hence, in this framework the output variable y_t follows a given regime according to the particular dynamic of the transition variable s_t, implying that variations of the latter are able to influence the regime-switching pattern of the former.

The LSTAR modelling procedure follows the sequential steps indicated by Teräsvirta (1994), namely: i) specifying a linear autoregressive model; ii) testing linearity against LSTAR nonlinearity for different values of the transition function by performing a LM-test based upon a *n*-order Taylor approximation of the underlying process; iii) if linearity is rejected in favour of LSTAR nonlinearity, estimating the LSTAR model by applying maximum likelihood estimator or conditional least squares; iv) conducting post-estimation robustness checks. Deschamps (2008) has explored the properties of the LSTAR model in comparison with those of the Markov-switching nonlinear specification, pointing out the ability of the former to incorporate strong available information derived from observed data.

The idea of regional economic resilience can be investigated by means of the LSTAR modelling procedure if we consider the variable y_t as an index of regional economic activity like regional employment, and the transition variable as a measure of aggregate output such as the national unemployment rate. In this case, testing linearity versus LSTAR nonlinearity means providing insights on the specific evolution of the regional context under observation in response to the dynamic of the national economy. A linear evolution may imply that the regional system is influenced by a particular national-wide shock, but a structural change is not likely to occur and the regional economy experiences bounce-back trajectories in line with the concept of engineering resilience. In this case, variations in the national unemployment rate have temporary consequences on regional employment growth, which is likely to return to its pre-shock path.

Alternatively, the presence of nonlinearity and regime shifting represents a situation where the regional system is subject to structural changes and its evolution follows a persistent and switching pattern as claimed by the ecological resilience concept. Aggregate shocks trigger different evolutionary paths of regional employment that does not return to its pre-shock regime. In reality, the distinction between engineering and ecological resilience can be more complex and the two notions of economic resilience can be observed in the same area during different time periods or when taking into account shocks of different nature (Martin and Sunley, 2014). Metcalfe *et al.* (2006) have sustained the view that whether an economic environment show multiple equilibria and structural changes or not is an *ex-post* empirical issue, which is difficult to be pre-specified.

When the occurrence of nonlinearity is supported by the testing procedure and ecological resilience seems more suited to describe the process under observation, the threshold parameter c obtained from the estimation of the LSTAR model assumes particular importance. Indeed, it can be interpreted as the degree of tolerance showed by a given area before switching to a different evolution as a reaction to shocks occurring in the common national variable. The relations between the transition variable s_t and the threshold c characterize the adjustment of a region in this multi-regime environment: for $s_t > c$ the process (smoothly) approaches the regime $G(s_t; \gamma, c) = 1$, while for $s_t < c$ the variable y_t is moving towards the opposite regime $G(s_t; \gamma, c) = 0$. Noteworthy, the threshold parameter resembles the measure of ecological resilience indicated by Holling for identifying the 'magnitude of disturbance that can be absorbed before the system changes its structure.' Therefore, a high value of c will indicate a more ecological resilient region in the sense that it is able to bear larger aggregate changes before a regime-switching in this area will occur; conversely, regions with low threshold values are triggered to different regimes for smaller variations registering in the national transition variable.

3.3 Estimation results

The empirical strategy is applied to throw some light on the economic resilience of Italian regions in terms of employment evolution over the period 1992-2012. As a primary objective, we test for the presence of linearity versus nonlinearity in each region; test results are reported in table 1. The optimal length of the dependent variable, the regional employment growth rate, has been selected according to the AIC/SBIC information criteria. A maximum length of eight quarters has been imposed for the common observed transition variable, the Italian unemployment rate, resulting in a maximum delay parameter $d=8$ in s_{t-d}. The value of the parameter d denotes the delay in the regional economy's response to changes in the level of the national unemployment rate and it is generally determined from the data (Skalin and Teräsvirta, 2002). The last three columns in table 1 represent: the *p*-values of the test statistics estimated for the null hypothesis of linearity against LSTAR non-linearity (H_0), the *p*-values of the test statistics used for the selection of the LSTR2-type non-linearity (H_1), and the resulting non-linear specification LSTAR1 or LSTAR2. For two regions, Toscana and Marche, the LSTR2 specification with two threshold values has been preferred; in this case, the transition may occur at two different points ($c_2 > c_1$) and the highest one has been selected as the measure of resilience.[4]

Insert about here.
Table 1. Test results for ecological resilience.

The presence of nonlinearity has not been found out for three regions, namely Lazio, Molise and Basilicata, suggesting that the concept of engineering resilience is probably more appropriate for describing resilience in these areas. During the time period here considered these regions do not seem to have experienced a structural change caused by variations in the national economy, being affected in a temporary way from aggregate disturbances and showing bounce-back patterns. This result can be explained by looking at the structural composition of these economies. Lazio, the region where the Italian capital Rome is located, is highly characterized by the influence of public activities and public employment on the overall economy; Molise and Basilicata are the two smallest Italian regions registering a high public employment share: from 1992-2012, the share of public

[4] This selection reflects the fact that that over the sample period the Italian unemployment rate has been on average 9.14, well above the lower threshold point of both Toscana and Marche. The preference for the model with one threshold(s) point(s) (LSTR1) or two (LSTR2) has been operated by adopting the sequential test procedure indicated by Teräsvirta (2006).

employment on total employment in Molise and Basilicata was about 0.28 and 0.29 well above that registered in the other two smallest Italian regions Valle d'Aosta and Trentino A.A.. The buffering role of public activities has likely to be at work in the three regions so as to contribute to maintain the stability of these local economies (Martin and Sunley, 2014).

Next, the LSTAR model has been estimated for the remaining 17 regions; table 2 reports the estimation results for the speed of transition (γ), the threshold(s) parameter(s) C_1 and C_2, the adjusted R^2, and the impact coefficients of the aggregate unemployment rate on regional employment growth calculated as the sum of the statistically significant coefficients of both the linear and the nonlinear part. Graphs reported in figure 2 illustrate the smooth transition function against the transition variable for each region. The threshold parameter - the measure of economic resilience - represents the value of the national unemployment rate in percentage points at which the transition occurs in every region. The impact coefficients capture the overall effect of the Italian unemployment rate on the region-specific employment evolution when taking into account the possibility of regime switching.[5]

Insert about here.
Table 2. LSTAR estimation results.

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Figure 2. Smooth transition functions.

Three main aspects are worth discussing. Firstly, regions show significant differences in terms of degree of tolerance with a standard deviation of about 1.39. Emilia Romagna and Toscana, for instance, move to another employment evolution when the national unemployment rate stands at about 11.37% and 11.17%; while in Sicilia and Calabria a similar movement is likely to be in place when the Italian unemployment rate registers 7.41% and 7.95%, respectively. Hence, the latter two regions experience structural changes and negative dynamics for lower equilibrium levels of the aggregate unemployment. Secondly, the spatial dimension of regional resilience across Italy seems to reflect the presence of neighbouring effects, with more resilient regions mostly located in the Centre and in the North of the country and less resilient areas in the South. The average impact

[5] The robustness of the final version of the LSTAR specification adopted has been checked by applying the LM test for serially uncorrelated errors, the test for checking residual nonlinearity, the test for parameter constancy, the ARCH-LM test and the Jacque-Bera test for residuals. All test results are available upon request.

coefficients in the four Italian macro areas (North-West, North-East, Centre, South)[6] are -0.019, -0.009, -0.003 and -0.035, respectively. This pattern is confirmed after performing an ANOVA F test on equality of the mean level of resilience across the four macro-areas resulting in a rejection of the null of equality: F-statistics = 4.75, p = 0.0189. The presence of neighbouring interactions is supported by the results of the Moran's *I* index of spatial correlation across the 17 regions with a positive relation of 0.353 (p-value 0.001) when considering a spatial weight matrix equals to the inverse distance of the five closest regions.

The resilience narrative acts in favour of the view that regional economic inequalities in Italy have been mostly driven by place- and macro area-specific aspects. Regions in the North-East outperformed the other Italian regions in terms of economic resilience; with few exceptions, high resilient regions are located along the Adriatic belt where the combination of the explaining factors that will be discussed below has played a relevant role. To clarify this point, the two graphs in figure 3 compare the dynamic of the transition function for two Northern (left-hand side) and two Southern (right-hand side) regions, showing a quite similar delay parameter. Observe that, within the same macro area the regions located along the Adriatic belt, namely Veneto and Puglia, show higher resilience – i.e. in these areas, a structural break occurs for higher levels of the national unemployment rate – than their counterparts.

Insert about here.
Figure 3. Smooth transition functions – selected comparisons.

Thirdly, looking at the impact of the Italian unemployment rate on regional employment growth it can be observed that less ecological resilient regions having lower degree of tolerance show the highest total negative effects. This relation implies that the disturbances in the national-wide unemployment rate have place-specific consequences in terms of both the robustness to structural changes and the evolution of regional employment growth. Let's consider Piemonte and Campania, experiencing a smooth regime-change when the Italian unemployment rate is above 9.74% and 7.93%, respectively. When a regime change occurs, the negative response of employment growth in Piemonte is about 2.34%, while in Campania is about 3.56%. Also, note that regions show differences when considering the speed of transition, that is, the parameter γ which

[6] The four macro-areas are defined by the Italian Statistical Office ISTAT as follows: i) North-West: Piemonte, Lombardia, Liguria, Valle d'Aosta; ii) North-East Trentino A.A., Friuli V.G., Veneto, Emilia Romagna; iii) Centre: Toscana, Marche, Lazio, Umbria; iv) South: Abruzzo, Calabria, Molise, Puglia, Campania, Basilicata, Sardegna, Sicilia.

captures the velocity of adjustment experienced by a given area when a regime-switching takes place. A negative correlation of about -0.23 links the speed of transition and the degree of tolerance observed across Italian regions.

3.4 The effects of regional interactions

The previous results have been obtained by studying employment on a regional level in combination with an index of national economic activity: we have looked at the direct impact of an aggregate shock on each regional economy, but the complex set of the propagation mechanisms behind the shock itself has not been explicitly investigated. Now, our main interest is to introduce regional interactions like domestic trade linkages and to assess the effect of such spatial interdependencies in terms of regional resilience. This implies finding out to what extend the economic resilience showed by a particular region depends on its specific ability to react to shocks or by regional spillovers. The explicit introduction of spatial connections allows us to consider that the common shock can affect regional employment either directly or indirectly through the effects on linked regions.

Relating the employment path of a region to that of its trade partners can have two main implications for economic resilience. The employment dynamic of the trade partners may act through the demand channel, that is, regional interactions influence the domestic demand of final and intermediate goods. Be connected with high resilient regions registering more favourable employment growth trajectories can have positive consequences for a given regional system: the demand coming from domestic trade partners contributes to partly smooth the impact of aggregate adverse conditions. In addition, trade linkages can represent one of the different channels of transmission of the national-wide shock across the space according to the specific origins and propagation mechanisms of the shock itself (Di Giacinto, 2012). In this case, regional connections can be considered as additional sources of instability for a particular regional economy contributing to amplify the impact of the national disturbances.

To explore these issues, we introduce a variable representing domestic trade linkages among Italian regions on the right-hand side of the relation (1) above, with $\tilde{y}_t^{(p)} = (y_{t-1}, \dots, y_{t-p})$ now becoming $\tilde{y}_t^{(p)\prime} = (y_{t-1}, \dots, y_{t-p}; y_{t-1}^{trade}, \dots, y_{t-p}^{trade})$. For a given region j, the variable y_t^{trade} has been constructed as the weighted average of the employment growth rates for its three main intraregional trade partners, where the weights have been calculated as the share of intraregional goods transported on road from region j to each trade partner.[7] This variable provides a description of regional interactions on the basis of economic arguments, it incorporates time-varying spatial linkages, and it approximates intraregional trade linkages across Italian regions in a quite satisfying way given that goods transported on road are a significant share of total domestic trade flows in Italy (SRM-Prometeia, 2014). As before, we have preliminary conducted the tests on linearity versus nonlinearity for all the 20 Italian regions, and for the 17 regions for which the presence of linearity has been rejected we have estimated the LSTAR model; test results and estimates are given in the Appendix.

In general, estimation results obtained with the introduction of regional spillovers confirm the previous findings. The spatial patterns of economic resilience remain significant: the null of equality of the mean level of the measure of resilience across the four Italian macro-areas has been rejected at the 5% level of statistical significance after performing the ANOVA F test; the Moran's *I* index of spatial correlation across the 17 regions gives a positive relation of 0.248 (p-value 0.007). A negative correlation of about -0.20 has been found between the speed of transition and the degree of tolerance; and Southern regions continue to register the highest negative impact coefficients associated to the effect of the national unemployment rate on regional employment.

There has been a reduction of the degree of tolerance in most of the regions, the average threshold parameter has decreased from about 9.40 to about 8.80, supporting the view that regional resilience is potentially affected by both place-specific aspects and the consequences of the interactions among regions. Comparing the measure of economic resilience before and after the introduction of regional spillovers provides interesting insights. In the North, the degree of tolerance in Piemonte has decreased from 9.74 to 8.36 and in Veneto from 9.04 to 8.44; in the South, Abruzzo and Puglia registered a degree of tolerance of 8.61 and 8.50 before taking into account trade linkages, and 7.73 and 8.24 after it. These differences can be interpreted as a higher influence of regional interactions on the resilience of Piemonte and Abruzzo in comparison with Veneto and Puglia. In other words, the latter two regions show a more robust place-specific ability to cope with

[7] Data on intraregional goods transported on road with the indication of the region of origin and destination are collected by the Italian Statistical Office ISTAT on annual basis. The variable y_t^{trade}, that is observed at a quarterly frequency, has been obtained by using the annual share of goods transported on road for each quarter of the same year.

national adverse events than that of the former two ones where the resilience of trade partners plays a relevant role.

4. Explaining regional resilience

4.1 Data description

Differences in economic resilience across Italy are explained by using a set of variables connected to the determinants discussed in section 2.2. To define economic diversity we have adopted the relative diversity index presented in Duranton and Puga (1999), $RDI_j = 1/\sum_h |e_{jh} - e_h|$, where e_{jh} is the employment share of industry h in region j and e_h the employment share of the same industry at country level. Employment data are taken from the Italian Census of Industries and Services and include 46 two-digit manufacturing and service sectors. Similar results have been found when using other measures of diversity like the Herfindahl index and its modifications (Mameli *et al.*, 2008). The relevance of external trade and export propensity has been captured by the *EXPY* index, which is an inverse of the Balassa revealed index obtained by weighting the export basket of a given region by the implied productivity of each traded good (Hausmann *et al.*, 2007). This index contains 38 product categories exported by the Italian regions to the rest of the world and it offers a detailed representation of trade openness: a high level of *EXPY* denotes regions exporting high productive goods. Also, we have constructed the variable *MADEITALY* for 17 product categories like machineries and mechanicals representing the traditional 'Made in Italy' activities.

For human capital, the average years of educational attainment of the population in a given region have been taken into account.[8] As in Barro and Lee (2013), this measure has been obtained by weighting the educational attainment achieved by a fraction of the total population in schooling years for the corresponding duration in years of the specific educational level. The average interest rate paid by obtaining a specific financing operation used by firms (i.e. *operazioni a revoca*) has been used as a proxy for financial constraints. This variable covers the entire time horizon and it does not include the interest rate attached to non-performing credits; the data source is the Bank of Italy. The electoral participation to referenda has been used as a proxy for social capital and cooperation; it was one of the indicators used by Robert Putnam in his study on the *civicness* of Italian regions and it has

[8] We have used Census data which are available for the years 1991, 2001 and 2004 – 2011. Missing observations (1991 – 2001; 2001 – 2004) have been filled through linear interpolation. Similar results have been obtained when using different measures of human capital as in Gennaioli *et al.* (2013).

been selected given its availability for the time period under observation. Summary statistics and data sources are in the Appendix.

4.2 Empirical results

Table 3 reports Pearson correlation indexes between the measure of regional resilience obtained in section 3.3 and the determinants of resilience. Similar results have been found when using the measure of resilience including domestic trade linkages as in section 3.4. Two time horizons have been adopted: the initial year of the time period under observation following the convergence-based approach *à la* Barro; the average over the years 1992 – 2012 in order to consider time-varying aspects. Table 4 shows the OLS regression results including a constant (columns 1-3), together with the t-statistics and the R-squared; these results are almost identical to those computed from White's consistent estimator of the covariance matrix allowing for heteroscedasticity. Due to the limited number of degrees of freedom, we have performed separate regressions for each explanatory variable.

The final column of table 4 reports the Spearman's rank-correlation coefficient (Siegel, 1956) and the *p*-value of the null hypothesis of no correlation. It represents a non-parametric rank-order correlation having the merit to be less sensitive to extreme point estimates than regression results, and provide support on the robustness of our findings. To check whether the significance of our results can be affected by the underlying relations between output growth and explaining factors, we have run separate regressions with the regional GDP growth rate over the time horizon here considered as a control variable. These additional estimates, available upon request, sustain the validity of the set of determinants used for explaining regional resilience.

Insert about here.
Table 3. Correlation between resilience and explanatory factors.

Insert about here.
Table 4. Cross-regional regressions and rank correlations.

Taken together, these results support the view that the explanation of resilience requires to look at a complex set of locally specific elements and spatial interactions (Martin and Sunley, 2014). The positive and significant influence of having a more diversified economy and a good external trade performance on economic resilience is worthwhile noting. A region with a diversified and export-oriented economic base is probably better equipped to sustain an adaptive economic path in the long-run. The endowments of human and social capital act in favour of the creation of a resilience-enhancing regional environment where the presence of skilled labour force and the diffusion of mutual confidence make it possible to actively respond to external pressures. Financial and credit constraints seem to operate in the opposite direction hampering investments from domestic and external firms, reducing the availability of financial resources for the productive sector and slowing the recovery pattern. The fact that our regression results remain significant after the introduction of macro-areas' dummies can contribute to explain some territorial exceptions, like the level of resilience showed by Abruzzo and Puglia, higher than that of the other Southern regions, and that of Liguria, lower when compared to the other Northern regions, with the occurrence of context-dependent factors.

Of particular importance, it can be noted the geographic concentration of these factors in some areas, which can throw further light on the spatial distribution of regional resilience across Italy. In the Centre and in the North-East, the favourable combination of such forces has shaped the ability of these areas to rebalance the negative consequences arising from national and international adverse events. The opposite has been true for the South, where the lack of industrial diversification, low export performance, outflow migration of skilled workers and entrepreneurs and the inefficient allocation of financial resources have sustained a lock-in pattern of persistent vulnerability and inability to react to aggregate shocks. Other factors not explicitly considered here, that are part of the subsystem 'Governance Arrangements' (Martin and Sunley, 2014), can have played a role on the way economic resilience is spread across Italy. The low resilience of the South can have been amplified by the weaknesses of its institutional environment and the ineffectiveness of national economic measures and support policies aimed at reducing territorial disparities in Italy.

5. Concluding remarks

Paraphrasing Romer and Romer (1994), this paper has been developed around the following research question: where and why national recessions end (or not) at a regional level? Building on the idea of regional economic resilience, it has been presented a two-steps non-linear empirical framework for analysing the place-specific consequences of aggregate shocks and the way regions react to variations in the national business cycle in the presence of structural changes. Temporary and persistent effects of common shocks on regional employment have been distinguished by testing for the presence of engineering versus ecological resilience. Regional economic resilience has been measured and the importance of regional interactions and spatial linkages has been discussed. Differences in resilience across places have been explained by a comprehensive set of factors, finding out the positive influence of economic diversity, export propensity, human and social capital, and the negative impact of financial constraints.

The application of this strategy to the Italian case has provided further evidence on the asymmetric regional evolution spread across this country. Italian regions show differences in economic resilience both in terms of robustness to variations in the national business cycle and total impact of aggregate shocks on regional employment growth. The rooted North-South divide is confirmed though the occurrence of regional exceptions. More resilient regions are concentrated in the Centre and in the North-East of the country, where the combination of place-specific attributes and macro-areas' elements has been found to be complementary. Our results shall be read as warning signals for national policymakers in Italy: the worsening of aggregate economic conditions may cause long-lasting and regional-specific negative effects, with implications on the within country distribution of wealth, population, employment and economic activities.

Two final comments can link our analysis to future research questions in this area. In the presence of significant differences in regional economic resilience as we have documented in this paper, it can be interesting to further assess the place-specific effects of countercyclical fiscal and monetary policies (Barca *et al.*, 2013) in order to evaluate whether common stabilization policies are able to smooth regional reactions to shocks and contribute to sustain a more even recovery pattern across the space. The relevance of regional interactions for explaining the economic resilience of particular areas requires additional investigation on the spatial dimension of resilience and the linkages among regions for clarifying which complex set of forces shape the ability of some places to adaptively rebalance their economies in the long-run.

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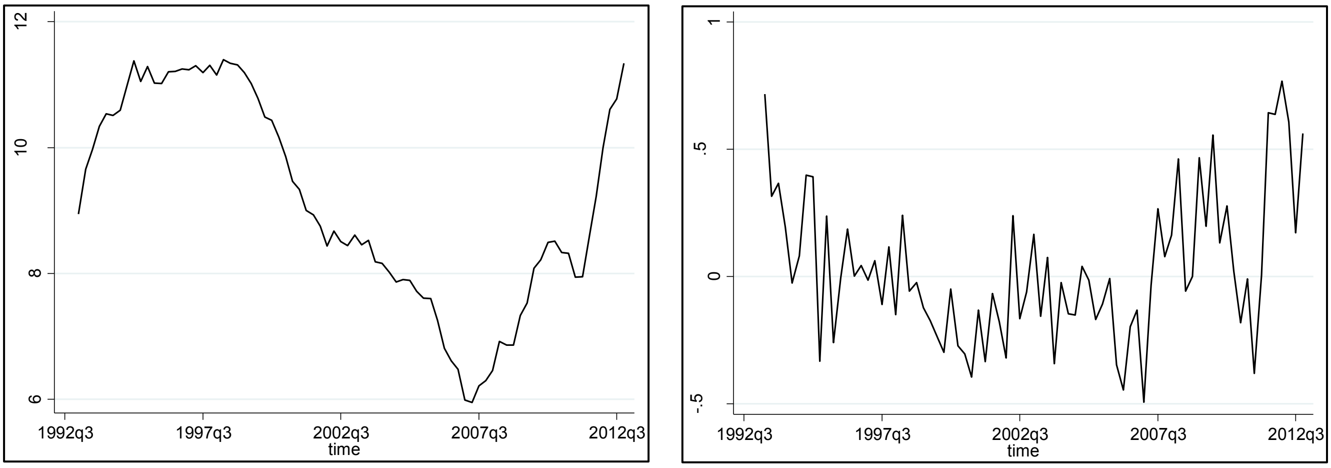
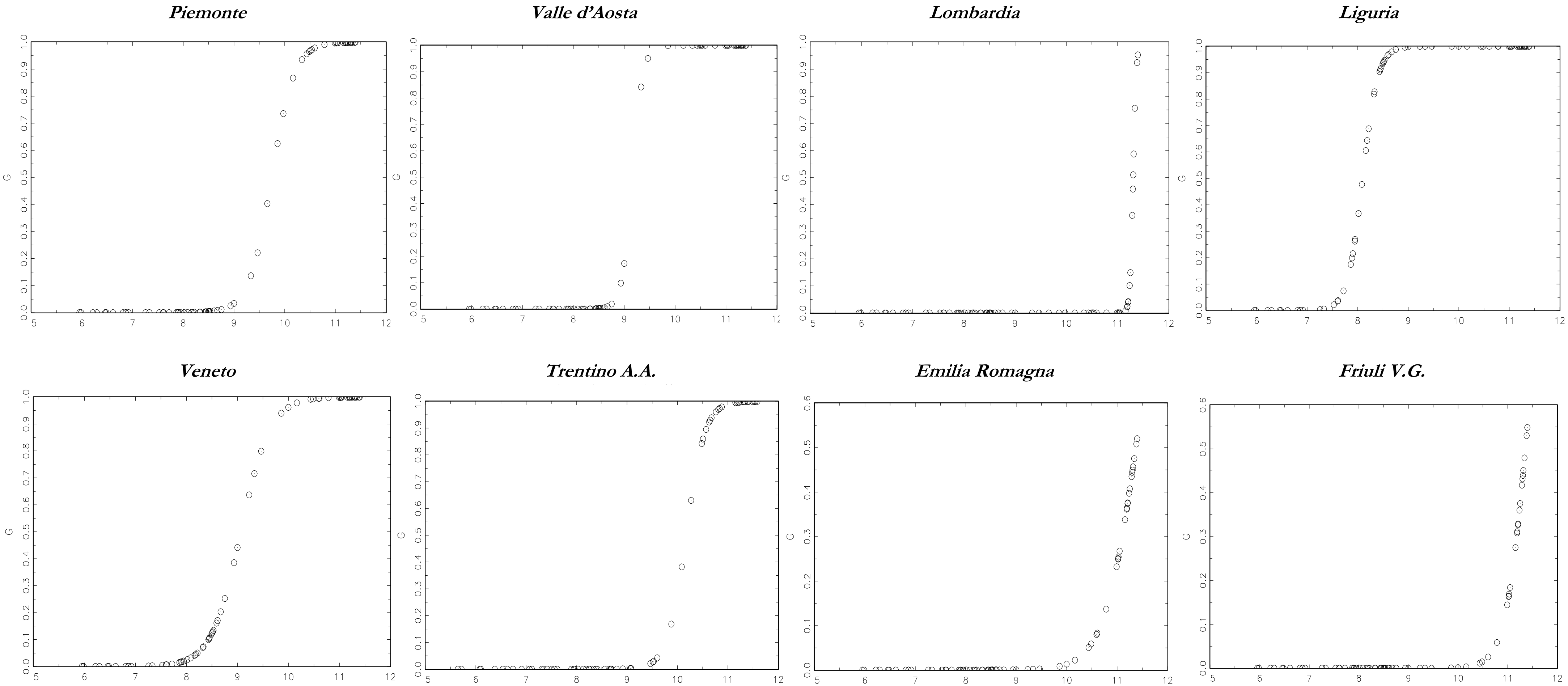
Figures and Tables

Figure 1. Italian unemployment rate, level and growth rate



Note: Figure 1 reports the Italian unemployment rate in level (left) and growth rate (right) for the period 1992(IV)-2012(IV).

Figure 2. Smooth transition functions



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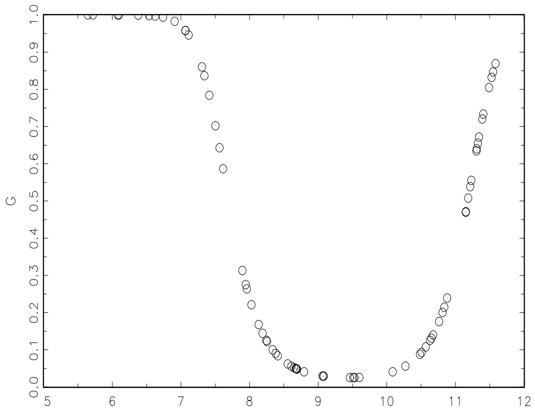
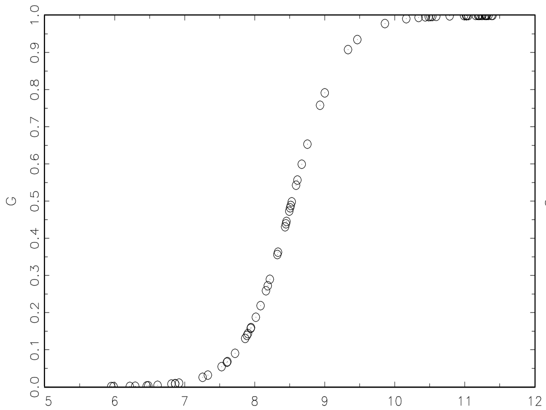
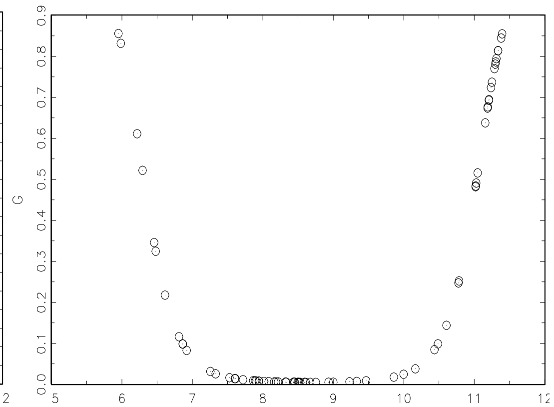


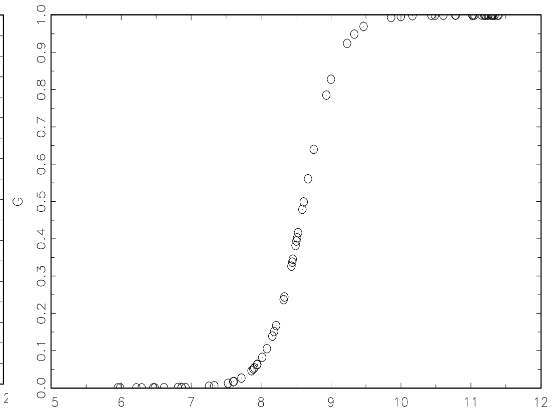
Umbria



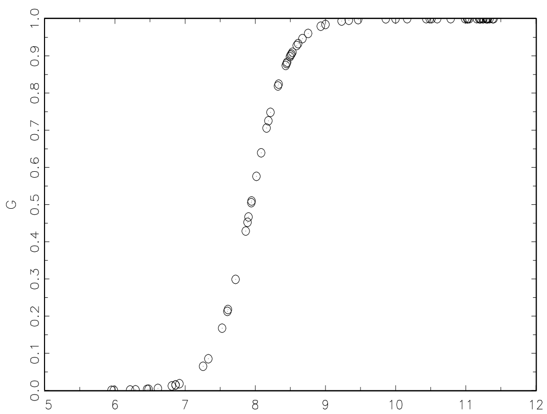
Marche



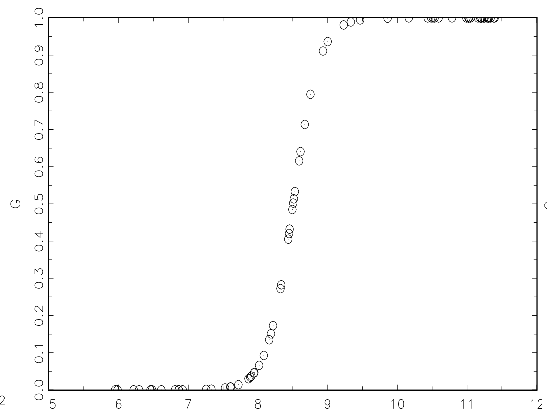
Abruzzo



Campania



Puglia



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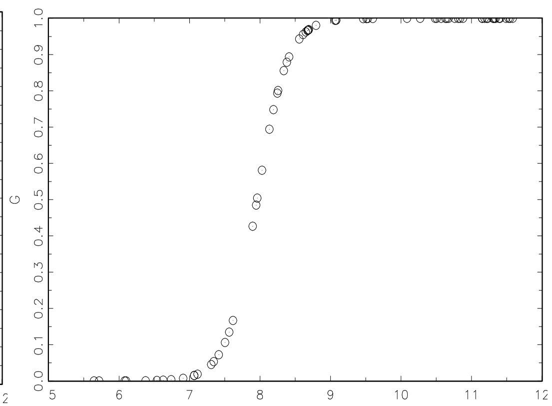
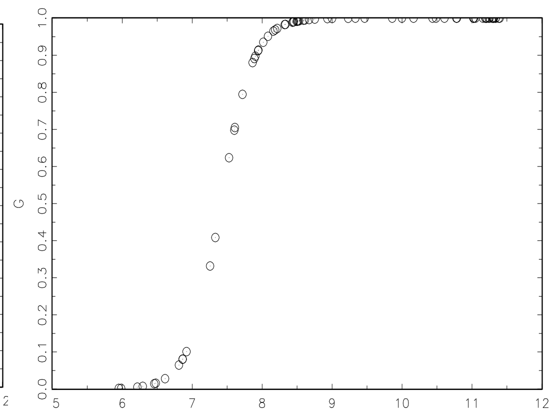
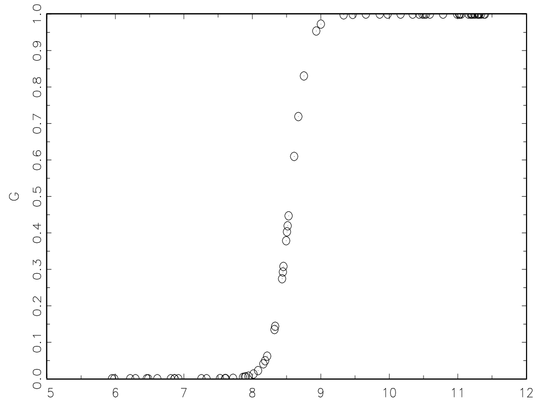


Sicilia

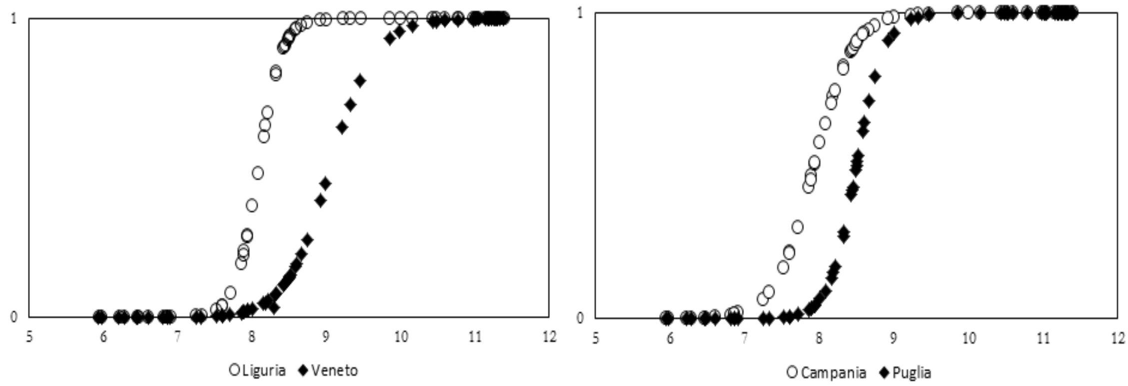


Sardegna



Note: Graphs in figure 2 report the smooth transition function G (y axis) and the variation of the transition variable (x axis) for the Italian regions, obtained by estimating LSTAR.

Figure 3. Smooth transition functions – selected comparisons



Note Graphs in figure 3 report the smooth transition function G (y axis) and the variation of the transition variable (x axis) for selected Italian regions, obtained by estimating LSTAR models.

Table 1. Test results for ecological resilience

Region	Lags	Transition variable (s_{t-d})	H_0	H_1	Model
Piemonte	2	t-7	0.0031		LSTR1
Valle d'Aosta	3	t-5	0.0040		LSTR1
Lombardia	2	t-7	0.0010		LSTR1
Liguria	2	t-1	0.0012		LSTR1
Veneto	1	t-2	0.0025		LSTR1
Trentino A.A.	3	t-8	0.0003		LSTR1
Friuli V.G.	4	t-2	0.0024		LSTR1
Emilia Romagna	3	t-2	0.0004		LSTR1
Toscana	3	t-7	0.0026	0.0003	LSTR2
Umbria	2	t-5	0.0027		LSTR1
Marche	2	t	0.0018	0.0009	LSTR2
Lazio		Linear			
Abruzzo	3	t	0.0012		LSTR1
Molise		Linear			
Campania	2	t-3	0.0014		LSTR1
Puglia	1	t-4	0.0026		LSTR1
Calabria	2	t-7	0.0024		LSTR1
Basilicata		Linear			
Sicilia	2	t	0.0040		LSTR1
Sardegna	2	t-7	0.0025		LSTR1

Note: H_0 refers to the null hypothesis of linearity (p-value); H_1 reports test results (p-value) on the null hypothesis of LSTR2 model (Teräsvirta, 2006). The transition variable is the Italian unemployment rate and a maximum delay of eight quarters, $d = 8$, has been imposed.

Table 2. LSTAR estimation results

Region	γ	C_1	C_2	adjusted-R^2	impact coefficients
Piemonte	7.66*	9.74***		0.64	-0.0234
Valle d'Aosta	11.69*	9.05***		0.44	-0.0230
Lombardia	12.67*	11.34***		0.74	-0.0098
Liguria	11.36***	8.09***		0.64	-0.0209
Veneto	5.70*	9.07***		0.74	-0.0104
Trentino A.A.	9.48*	10.17***		0.83	-0.0115
Friuli V.G.	8.26*	11.33***		0.53	-0.0116
Emilia Romagna	5.33***	11.37***		0.67	-0.0011
Toscana	3.72**	7.96***	11.17***	0.87	-0.0029
Umbria	4.87**	8.53**		0.69	-0.0013
Marche	2.82*	6.30***	11.03***	0.51	-0.0052
Abruzzo	6.93**	8.61***		0.69	-0.0209
Campania	6.64**	7.93***		0.65	-0.0356
Puglia	9.26*	8.50***		0.54	-0.0185
Calabria	8.24*	7.95***		0.78	-0.0363
Sicilia	7.57**	7.41***		0.66	-0.0497
Sardegna	13.71**	8.55***		0.68	-0.0479

Note: Estimation results obtained by applying LSTR1 and LSTR2 specifications. For every region the impact coefficients have been obtained as the sum of the linear and non-linear statistically significant coefficients of the Italian unemployment rate. * implies statistical significance at 10%, ** at 5%, *** at 1%.

Table 3. Correlation between resilience and explanatory factors

Variable	Correlation Index	
	Time period:	
	initial year	average period
DIVERSITY	0.5548	0.5121
EXPY	0.5334	0.5064
MADEITALY	0.6458	0.5779
FINANC	-0.4980	-0.7022
SOCIAL	0.5985	0.7283
HUMCAP	0.6025	0.4898

Table 4. Cross-regional regressions and rank correlations

Dependent variable	const (tstat)	β (tstat)	R^2	ρ [p-value]
DIVERSITY_1	0.0641 (5.30)	0.0252 (2.39)	0.28	0.53 [0.0280]
DIVERSITY_2	0.0644 (4.54)	0.0245 (2.14)	0.24	0.56 [0.0197]
EXPY_1	-1.0495 (-2.22)	0.1202 (2.42)	0.28	0.64 [0.0052]
EXPY_2	-1.0304 (-2.07)	0.1130 (2.25)	0.25	0.65 [0.0050]
MADEITALY_1	-0.1214 (-1.50)	0.0238 (2.66)	0.32	0.64 [0.0054]
MADEITALY_2	-0.0870 (-1.10)	0.0194 (2.29)	0.26	0.67 [0.0033]
HUMCAP_1	-0.2208 (-2.07)	0.1532 (2.96)	0.37	0.65 [0.0051]
HUMCAP_2	-0.4323 (-1.81)	0.2396 (2.21)	0.25	0.52 [0.0328]
SOCIAL_1	-0.1584 (-1.86)	0.0584 (2.97)	0.37	0.48 [0.0510]
SOCIAL_2	-0.1317 (-2.33)	0.0596 (3.99)	0.51	0.78 [0.0002]
FINANC_1	0.4921 (2.72)	-0.1354 (-2.20)	0.24	-0.58 [0.0139]
FINANC_2	0.3091 (5.45)	-0.0943 (-3.80)	0.49	-0.80 [0.0001]

Note: The n. of observations in each regression is equal to 17. Variables are referred to the initial year (_*1*) and the average period (_*2*). OLS t-statistics are in parentheses (). The coefficient ρ is the Spearman's rank correlation coefficient, *p*-values under the null hypothesis of independence are in parentheses [].

Appendix

Table 1. Summary statistics – section 3

Employment growth	Mean	Stand. Dev.	Min	Max
Piemonte	0.0004	0.0062	-0.0140	0.0132
Valle d'Aosta	0.0008	0.0212	-0.0424	0.0523
Lombardia	0.0013	0.0054	-0.0129	0.0141
Liguria	-0.0002	0.0075	-0.0203	0.0191
Veneto	0.0020	0.0083	-0.0181	0.0224
Trentino A.A.	0.0027	0.0126	-0.0316	0.0461
Friuli V.G.	0.0007	0.0167	-0.0486	0.0442
Emilia Romagna	0.0016	0.0052	-0.0129	0.0109
Toscana	0.0009	0.0122	-0.0338	0.0295
Umbria	0.0016	0.0078	-0.0142	0.0179
Marche	0.0014	0.0054	-0.0104	0.0173
Lazio	0.0018	0.0069	-0.0114	0.0220
Abruzzo	0.0009	0.0111	-0.0235	0.0273
Molise	-0.0017	0.0161	-0.0453	0.0333
Campania	-0.0015	0.0085	-0.0210	0.0159
Puglia	-0.0008	0.0098	-0.0541	0.0169
Basilicata	-0.0006	0.0169	-0.0422	0.0446
Calabria	-0.0015	0.0183	-0.0493	0.0390
Sicilia	-0.0008	0.0069	-0.0156	0.0134
Sardegna	-0.0001	0.0150	-0.0663	0.0634
Italian unemp. rate	9.1398	1.6807	5.9496	11.3969

Table 2. Test results for ecological resilience with regional interactions – section 3.4

Region	Lags	Transition variable (s_{t-d})	H_0	H_1	Model
Piemonte	2	t-8	0.0015		LSTR1
Valle d'Aosta	3	t	0.0009		LSTR1
Lombardia	2	t-7	0.0010		LSTR1
Liguria	2	t-1	0.0006		LSTR1
Veneto	1	t-6	0.0048		LSTR1
Trentino A.A.	3	t-7	0.0015		LSTR1
Friuli V.G.	4	t-7	0.0021		LSTR1
Emilia Romagna	3	t-3	0.0045	0.0001	LSTR2
Toscana	3	t-7	0.0020	0.0002	LSTR2
Umbria	3	t-7	0.0013		LSTR1
Marche	2	t	0.0033	0.0008	LSTR2
Lazio		Linear			
Abruzzo	3	t-4	0.0006		LSTR1
Molise		Linear			
Campania	2	t-7	0.0032		LSTR1
Puglia	1	t-1	0.0028		LSTR1
Calabria	2	t-1	0.0033		LSTR1
Basilicata		Linear			
Sicilia	2	t	0.0006		LSTR1
Sardegna	2	t-1	0.0001		LSTR1

Note: H_0 refers to the null hypothesis of linearity (p-value); H_1 reports test results (p-value) on the null hypothesis of LSTR2 model (Teräsvirta, 2006). The transition variable is the Italian unemployment rate and a maximum delay of eight quarters, $d = 8$, has been imposed.

Table 3. LSTAR estimation results with regional interactions – section 3.4

Region	γ	C_1	C_2	adjusted-R^2	impact coefficients
Piemonte	15.63*	8.36***		0.71	-0.0264
Valle d'Aosta	9.93*	8.03***		0.65	-0.0304
Lombardia	3.34**	10.65***		0.82	-0.0098
Liguria	11.51**	7.93***		0.68	-0.0350
Veneto	10.42*	8.44***		0.76	-0.0181
Trentino A.A.	10.87***	11.36***		0.88	-0.0200
Friuli V.G.	10.85*	8.34***		0.78	-0.0311
Emilia Romagna	8.17**	7.97***	11.08***	0.88	-0.0019
Toscana	8.98**	7.80***	11.00***	0.87	-0.0123
Umbria	7.70**	9.22***		0.79	-0.0009
Marche	8.17*	7.79***	8.59***	0.82	-0.0016
Abruzzo	13.43***	7.73***		0.74	-0.0305
Campania	2.27**	7.62***		0.84	-0.0501
Puglia	15.48*	8.24***		0.77	-0.0161
Calabria	10.81*	7.14***		0.87	-0.0369
Sicilia	6.15**	7.37***		0.78	-0.0267
Sardegna	20.43*	8.38***		0.74	-0.0269

Note: Estimation results obtained by applying LSTR1 and LSTR2 specifications with the introduction of the variable y_t^{trade} in the relation (1). For every region the impact coefficients have been obtained as the sum of the linear and non-linear statistically significant coefficients of the Italian unemployment rate. * implies statistical significance at 10%, ** at 5%, *** at 1%.

Table 4. Definition of variables – section 4

Variable	Definition	Data Source
DIVERSITY	Relative diversity index	Istat
EXPY	*EXPY* for 38 product categories	Coeweb Istat
MADEITALY	*EXPY* for 17 product categories	Coeweb Istat
HUMCAP	average years of educational attainment	Istat
SOCIAL	% electoral participation to referendum	Istituto Cattaneo
FINANCIAL	average interest rate at regional level	Bank of Italy

Table 5. Summary statistics – section 4

Variable	Mean	Stand. Dev.	Min	Max
DIVERSITY_1	3.3835	0.8991	1.8257	4.8784
DIVERSITY_2	3.4615	0.8795	1.8795	5.0244
EXPY_1	9.5152	0.0613	9.3644	9.5924
EXPY_2	9.9475	0.0618	9.7889	10.028
MADEITALY_1	9.0534	0.3311	8.0989	9.3243
MADEITALY_2	9.4447	0.3639	8.3779	9.7476
HUMCAP_1	2.0542	0.0550	1.9586	2.1471
HUMCAP_2	2.1964	0.0287	2.1471	2.2449
SOCIAL_1	4.3199	0.1446	4.0040	4.4715
SOCIAL_2	3.7872	0.1673	3.4164	4.0289
FINANC_1	2.9390	0.0507	2.8690	3.0335
FINANC_2	2.2802	0.1031	2.0893	2.4681

Note: Variables are referred to the initial year (_*1*) and the average period (_*2*).

Table 6. Product categories – regional export basket

Code	Product description	Code	Product description
AA01	Agricultural goods	CG22	Rubber and plastics
AA02	Forestry goods	CG23	Other non-minerals goods
AA03	Fishing goods	CH24	Steel and steeling goods
BB05	Coal (excl. peat)	CH25	Metal goods (excl. machinery)
BB06	Oil and gas	CI26	Computer. optic and electronics
BB07	Minerals	CJ27	Electrical machinery and other machineries
BB08	Other minerals	CK28	Machineries
CA10	Food and taste	CL29	Cars and trailers
CA11	Drinks	CL30	Other transport goods
CA12	Tobacco	CM31	Furniture and design
CB13	Textiles	CM32	Other manufacturing goods
CB14	Cloths	DD35	Energy and gas
CB15	Leather goods (excl. clothes)	EE38	Wasting activities
CC16	Wood and wood products (excl. Furniture)	JA58	Editing goods
CC17	Paper and paper goods	JA59	Video. TV. Music and Cinema
CC18	Printed materials	MC74	Scientific and professional goods
CD19	Coke and refining goods	RR90	Arts and entertainment
CE20	Chemicals	RR91	Libraries. archives and museums
CF21	Pharmaceuticals	SS96	Other personal services

Note: the 17 product categories of *MADEITALY* are: CA10, CA11, CB13, CB14, CB15, CE20, CF21, CI26, CJ27, CK28, CL29, CM31, CM32, JA58, JA59, RR90, RR91.