Testing and explaining regional resilience

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Motivation (1)

- ✓ In the past five-plus years the idea of economic resilience (Reggiani *et al.*, 2002; Martin, 2012), that is, the way local economies resist to and recover from shocks rebalancing their long-run development path, has stimulated further investigation on the spatial patterns of economic crises and adverse events (Modica and Reggiani, 2014);
- ✓ From a theoretical point of view, the evolutionary approach to the study of resilience (Pike *et al.,* 2010; Boschma, 2014) allows for the consideration of the place-specific consequences of aggregate shocks in a more general way, encompassing the two concepts of economic resilience, the engineering and ecological one, initially proposed by the early contributors in the resilience literature (Holling, 1973 and 1996; Pimm, 1984);
- ✓ Yet, we need to throw some light on the key issues in regional economic resilience (Martin & Sunley, 2014) like measurement aspects and the correct identification of common shocks in order to understand the specific 'value-added' provided by the concept of resilience to the regional science literature, and to the definition of policy proposals.

Motivation (2)

- ✓ On the empirical side, the majority of works – mostly using statistical indices and econometric techniques - has focused on the description of economic resilience, and the detection of different regional responses to aggregate shocks (Fingleton *et al.*, 2012 and 2014; Cellini & Torrisi, 2014; Di Caro, 2014a, forthcoming);
- ✓ An increasing number of researchers is investigating the determinants of regional economic resilience and the reasons justifying the presence of uneven spatial reactions to common shocks (Fingleton & Palombi, 2013; Di Caro, 2014b; Diodato & Weterings, 2014);
- ✓ Martin & Sunley (2014) and Modica & Reggiani (2014) pointed out the importance of looking at the determinants of regional resilience as a complex set of factors interacting in a time- and spatial-specific context. These factors can be grouped in macro-categories such as the industrial structure, financial and governance arrangements, infrastructures, labour market conditions, etc.;
- ✓ Therefore, it becomes crucial to assess what explains resilience, when and where, and how to combine the determinants of resilience with those factors driving regional long-term development (Mameli *et al.*, 2014).

Research questions

Basic Idea: searching for a robust empirical framework that is able to take into account some features of regional economic resilience in a unified modelling environment, identifying aggregate shocks, addressing measurement issues, including spatial interactions, and exploring the determinants of resilience.

1. Can the smooth-transition autoregressive (STAR) model represent a good candidate for studying regional resilience?
2. Are differences in economic resilience explained by place-specific or spatial factors, or both?
3. How to reconcile the results on resilience with those on regional growth and development?

Modelling resilience: the STAR framework (1)

- The nonlinear Smooth-Transition Autoregressive (STAR) model (Granger & Teräsvirta, 1993; van Dijk *et al.*, 2002) is increasingly attracting the interest of researchers analysing regional issues in a multi-regime environment (Kang *et al.*, 2012; Lambert *et al.*, 2014; Pede *et al.*, 2014);
- A general representation of the STAR model is:

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

where $y_t^{(p)} = (1, \tilde{y}_t^{(p)})'$, $\tilde{y}_t^{(p)} = (y_{t-1}, \dots, y_{t-p})'$, $\phi_i = (\phi_{i0}, \phi_{i1,} \dots, \phi_{ip})'$, $i = 1{,}2$ and ε_t is a white-noise error process with mean zero and variance σ^2. The transition function $G(s_t; \gamma, c)$ can have the following logistic form $G(s_t; \gamma, c) = \left\{1 + exp\left[-\gamma \prod_{k=1}^{N}(s_t - c_k)\right]\right\}^{-1}$. In this case, the resulting specification is the logistic STAR or LSTAR model;

- The transition variable s_t determines the regime-shifting behaviour of the variable y_t, and the parameter γ captures the speed at which these regime changes occur.

Modelling resilience: the STAR framework (2)

- This model represents a continuum of regimes depending on the different values of the transition function (between 0 and 1); or, alternatively, 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;
- The LSTAR modelling procedure is as follows (Teräsvirta, 1994): i) specifying a linear autoregressive model; ii) testing linearity against LSTAR nonlinearity for different values of the transition function; 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;
- This specification is able to combine most of the features of regional resilience like the connections 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 structural changes;
- Let's consider the variable y_t as an index of regional economic activity (e.g. regional employment), and the transition variable as a measure of aggregate output (e.g. the national unemployment rate); in this case, testing linearity versus LSTAR nonlinearity means providing insights into the specific evolution of a regional system in response to the dynamic of the national economy;
- Important aspects: economic interpretation of the common transition variable and shocks – different approaches related to the aggregate unemployment rate (Papell *et al.*, 2000) –; specific time horizon under observation; relevance of employment or GDP data for studying resilience (Cellini *et al.*, 2014).

Modelling resilience: the STAR framework (3)

- A linear evolution may imply that regional employment is influenced by a particular nationwide 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; alternatively, the presence of nonlinearity and regime shifting configures 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;
- The distinction between engineering and ecological resilience can be more complex and the two notions can be observed in the same area during different time periods or when taking into account shocks of a different nature; Metcalfe *et al.* (2006) sustained the view that whether an economic environment shows multiple equilibria and structural changes or not is an ex-post empirical issue, which is difficult to pre-specify;
- Observe that, some regions can show linear evolutions while others may record nonlinear dynamics – for the Italian case, 3 out 20 regions registered linear patterns -; this can be explained by the occurrence of particular factors like the buffering role of public sector employment and activities (Martin & Sunley, 2014) that maintain the stability of the economy of particular places during shocks;
- In the presence of nonlinearity, the threshold parameter c obtained from the estimation of the LSTAR model can be interpreted as the degree of tolerance shown by a given area before switching to a different evolution as a reaction to shocks occurring in the common national variable: it resembles the measure of economic (ecological) resilience suggested by Holling for identifying the 'magnitude of disturbance that can be absorbed before the system changes its structure;'
- A high value of c indicates a more resilient region that it is able to bear larger aggregate changes before regime-switching in this area will occur; a low value implies that (low resilient) regions are triggered to different regimes for smaller variations recorded in the national transition variable.

Results (1)

- The table below 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 for Italian regions over the period 1992(IV)-2012(IV).

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: * implies statistical significance at 10%, ** at 5%, *** at 1%.

Results (2)

Interpretation:

- ✓ Italian regions show significant differences in terms of degree of tolerance – the measurement of economic resilience - with a standard deviation of about 1.39;
- ✓ 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 and less resilient areas in the South: the average impact coefficients in the four Italian macro areas (North-West, North-East, Centre, South) 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);
- ✓ Low resilient regions show the highest total negative effects. Regions show differences when considering the speed of transition, that is, the parameter γ which 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.

Robustness:

- ✓ Results have been obtained by estimating the LSTAR model for each region by applying conditional maximum likelihood;
- ✓ For each region, the final version of the LSTAR specification has been selected according to the following tests' results: the LM test for serially uncorrelated errors, the test for checking residual non-linearity, the test for parameter constancy, the ARCH-LM test and the Jacque-Bera test for residuals.

Results (3)

- To further explore the spatial dimension of resilience, regional interactions like domestic trade linkages have been introduced, with $\tilde{y}_t^{(p)}$ becoming $\tilde{y}_t^{(p)\prime} = \left(y_{t-1}, \dots, y_{t-p}; y_{t-1}^{trade}, \dots, y_{t-p}^{trade}\right)$. For each region, 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;
- Two main implications: i) demand channel: employment growth in trade partners can influence the domestic demand of final and intermediate goods; ii) trade connections represent one of the various channels of transmission of the nationwide shock across space according to the specific origins and propagation mechanisms of the shock itself (Di Giacinto, 2012);
- Results confirm most of the previous findings: the null of equality of the measure of resilience across the four Italian macro-areas has been rejected at the 5% level of statistical significance (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);
- In addition, the view that regional resilience is potentially affected by both place-specific aspects and the consequences of interactions among regions is supported. For some regions (e.g. Piemonte in the North and Abruzzo in the South) the influence of regional interactions in terms of resilience is higher than for other regions (Veneto in the North and Puglia in the South), which show a more robust place-specific ability to cope with nationally adverse events.

The determinants of resilience (1)

- Differences in economic resilience across places can be due to several factors and their interplay; selecting some of these factors becomes necessary from a practical point of view and given data availability, even if this implies partly reducing the spectrum of all the possible determinants of economic resilience. Yet, the selection of particular explaining variables can be motivated by looking at their effects on regional development, remembering that regional economic resilience contributes to combine the place-specific responses to shocks with local developmental patterns (Martin & Sunley, 2014);
- Specifically, the following factors have been used in our analysis:
  - *Economic diversity:* a more diversified economic base may improve regional robustness and adaptability, more diversified regional systems are likely to be less vulnerable to sector-specific negative events, it allows for the consideration of Jacobs externalities and knowledge spillovers across sectors;
  - *Export propensity:* trade openness and the specific composition of regional export baskets can improve knowledge spillovers and the diffusion of related variety;
  - *Human Capital:* the education of workers and entrepreneurs may reinforce the ability of a given system to recover from shocks; human capital inflows act in the same direction;
  - *Social Capital:* mutual confidence and cooperation bolster the economic environment through their effects on the reduction of transaction costs; the accumulation of physical capital; the improvement of government performance;
  - *Financial constraints:* financial markets' inefficiencies hamper investments, reduce the creation of new firms and increase the cyclical and structural effects of adverse events.

The determinants of resilience (2)

- ✓ The significance of these factors is confirmed after adopting different techniques: Pearson correlation indexes, cross-regional regression estimates, Spearman rank correlation coefficients;
- ✓ Of particular importance, such factors operate at both place- and macro-area- level, remaining valid after the introduction of macro-areas' dummies;
- ✓ The spatial concentration of economic resilience can be explained by the geographical distribution of its determinants.

Variable	Initial Year	Average time period
DIVERSITY	+	+
EXPY	+	+
MADEITALY	+	+
SOCIAL CAPITAL	+	+
FINANC	-	-
HUMCAP	+	+

Comments on the Italian case

- The resilience perspective allows for the reconsideration of Italian regional inequalities, by assessing the link between uneven regional development and asymmetric responses to common shocks; for the UK, Fingleton *et al.* (2012) have provided a similar relationship to interpret the differences among British regions;
- The rooted North-South divide is confirmed also when looking at the economic resilience of Italian regions: high resilient regions are mostly located in the Centre and in the North of the country, while less resilient ones are located in the South; however, territorial exceptions and regional variations suggest that the understanding of resilience across Italy requires more in depth observations on the peculiar characteristics of reactions to shocks;
- As discussed elsewhere (Di Caro, 2014c), the Italian *Mezzogiorno* is progressively becoming more vulnerable to aggregate shocks and less able to recover from unexpected events, experiencing a negative lock-in pattern since the early 1990s;
- Initially, in Italy the Great Recession had quite homogenous consequences – Northern regions experienced the negative impact on their financial sector more than Southern ones -; subsequently, the jobless recovery had a major impact in the South, where labour demand is decreasing and new outflows migration are climbing.

Conclusions

➢ Three main insights:

1. The STAR framework helps to investigate regional economic resilience by anchoring empirical evidence with theoretical aspects;
2. The link between place-specific reactions to shocks and local developmental patterns has been analysed;
3. Regional differences have been explained by the interplay of regional interactions and context-dependent determinants.

Next steps:

1. Assessing the fruitfulness of adopting nonlinear time series (STAR, STVECM, etc.) for analysing regional resilience and the links between manufacturing dynamics and economic resilience;
2. Studying the interactions between place-specific determinants and regional spillovers;
3. Extending the analysis to different time horizons and more countries in order to obtain more general policy proposals.

Thank you for your attention!