MEASUREMENT APPROACHES OF REGIONAL ECONOMIC RESILIENCE: A LITERATURE REVIEW

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Abstract

In this article, we review the different methodological approaches of measuring regional economic resilience conducting a literature review. Methodological approaches to measure resilience range from the use of descriptive, interpretative, or simple regression models to sophisticated statically econometric models.

Given these premises, the present research, provides insights of the regional and spatial economics in relation to resilience measurement and estimation methods and enriches the knowledge of the measurement methodological context and applications from diversified literature sources. Our research focuses on economically derived disturbances or shocks, such as recessions, and the resistance capacity or ability of a regional economy to respond to these shocks. The core results of this article are summed up in one main inference, that the methodological context for measuring regional economic resilience is undefined and basically empirically developed using either resilience indices or statistically based econometric models to assess the resilience of a region.

Keywords: regional economic resilience, conceptual approach, measurement context, economic disturbance, literature review

JEL classification: R11 Regional Economic Activity: Growth, Development, Environmental Issues, and Changes

1. A brief literature review

In recent years, the concept of resilience has become a "popular" term in various multidisciplinary fields. In the case of economics, resilience is "interpreted" as the ability of an economy to return in equilibrium conditions, those that prevailed before the occurrence of the disturbance [Kallioras (2012), Adger (2000), Van Breda (2001), Janssen (2007), Swanstrom (2008) and Maru (2010)]. As regards to regional science, the resilience of a region is described as its ability to successfully recover from of a shock strike its economy that either "throw it off its growth path or have the potential to throw it off its growth path" [Martin (2011), Hill et al. (2008)]. According to another interpretation, regional resilience reflects the ability of a regional economy to anticipate, prepare, respond to, and ultimately recover from a disturbance or disruption [Foster (2007)].

A useful classification pertaining to the types of resilience, provides the notion of resilience in a 4 dimensional framework according to: a) the degree of sensitivity (or depth of reaction) of regional economy to a recessionary shock interpreted as resistance, b) the speed and degree of recovery of regional economy from a recessionary shock interpreted as recovery, c) the extent to which regional economy renews its growth path (resumption of pre-recession path or hysteretic shift to new growth trend) interpreted as renewal and d) the extent of re-orientation and adaptation of regional economy in response to recessionary shock interpreted as re-orientation [Martin (2012)]

The methodological approaches to measure resilience range from use of descriptive, interpretative, or simple regression models to sophisticated statically econometric models.

Some of them refer to the construction of simple indices [Martin (2012) or Augustine et al. (2013)] or of composite indices [Psycharis et al (2012), Reggiani et al (2016)],

applications of statistical time series models [Fingleton et al. (2012)], panel data models [Angulo et al (2018)], causal structural models [Doran and Fingelton (2013), Fingleton and Palombi (2013)], Shift-share and an input-output analysis models [Giannakis & Bruggeman (2015)], or other methodological approaches for measuring the impact of a shock and the ability to recover, using measured indices [Lapuh (2016)]. Our focus in this paper is on economic shocks. Economic shocks originate globally to national or local level, are sudden, unexpected and 'out-of-the-ordinary' events (such as national recessions and financial crises) [Martin and Sunley (2015)].

Given these premises, the present article, provides insights of the regional and spatial economics literature in relation to resilience measurement and estimation methods applied and proposed so far, enrich the knowledge of the measurement methodological context and applications from several different sources, including other reviews or bibliometric analyses of resilience measurements. Our research focuses on economically derived disturbances or shocks (such as recessions) and the resistance capacity or ability of a regional economy to respond to these shocks.

The article is structured as follows: In section 2, different conceptual definitions and approaches of regional resilience encountered in the literature, enriched with several studies on measurement and estimation methods and applications are reported, emphasizing to the different methodologies applied at regional level of NutsII & NutsIII scale. In section 3 additional improvements and recommendations for future research are presented whether section 4 concludes the article summarizing the extracted results, highlighting the need for further studies and clarification on measurement methodological approaches' aspects of regional economic resilience.

2. Regional economic resilience: conceptual & measurement approaches

The conceptual approach to the notion of resilience, as well the interpretation of its magnitude changes varies, depending on the science in the light of which it is examined and evaluated. The origin of the concept of resilience stems from the environmental, health and social sciences and describes the (biological) ability of an (eco)-system or an organism to adapt and thrive under adverse environmental conditions following a disturbance [Holling (1973), Holling & Gunderson (2002), Walker et al. (2004)]. A 'seminal' description of the concept of resilience, is described as the ability of a social-ecological system to absorb disturbance and re-organize while undergoing change to still retain essentially the same function, structure, identity, and feedback, that prevailing before the occurrence of disturbance [Walker et al (2004), Holling's (1973)].

In economics, resilience is "interpreted" as the ability of an economy to return in equilibrium conditions, for example those that prevailed before the manifestation of the disturbance [Kallioras (2012), Adger (2000), Van Breda (2001), Janssen (2007), Swanstorm (2008), Maru (2010)].

As regards regional science, the resilience of a region is described as its ability to successfully recover from a shock which either throw it off or had the power to throw it off its development path [Martin (2011), Hill et al. (2008)]. According to another interpretation, resilience reflects the region's ability to anticipate, prepare for, respond to, and ultimately recover from a disruption. Regional resilience is intertwined with the ability of a region to cope with external pressures, its ability to react positively to external changes, its adaptability, and the ability of regional structures to cooperate and implement the appropriate kinds of planning, action, and social learning [Davies (2011)]. More specifically, resilience represents the process of preparing a region to become (or to be) resistant to a disorder begins before the manifestation of the disorder itself [Foster (2007)].

Using a different approach, resilience interpretation is based on 3 main approaches [Martin (2011)]. The first interprets resilience using engineering/technical science terminology (engineering resilience) describing it as the ability of a system to return to the initial equilibrium point it was before the disturbance occurred.

According to the second approach, the resilience of a system is related to the level of adaptation after a disturbance, or more precisely to the level of equilibrium to which the system will return after a disturbance (multiple levels of equilibrium). In this case, the concept of "ecological" resilience is referred to, which was first presented by Holling (1973) and

concerns the different level of equilibrium that the system driven, after the enforcement of the disorder.

The third approach and interpretation resemble the evolutionary interpretation of resilience called “adaptive” resilience. According to this, it is related to region’s ability to reorganize its operation, redefine its development goals and redefine its infrastructure to maintain an acceptable growth path in output, employment, and wealth over time, responding to the effects that any disturbance may cause whenever it occurs [Martin (2012)].

These different interpretations “impose” four interrelated aspects of regions’ reactions against economic shocks [Simmie & Martin (2010), Kurikka (2022), Martin (2012)].The first aspect is that of resistance, which corresponds to the sensitivity of a regional economy to disturbances. The second aspect is that of the speed and extent of recovery from disruptions. The third aspect relates to the extent regional economy undergoes structural re-orientation in accordance to growth path. The fourth type concerns the degree of renewal or resumption of the growth path prior to the shock. Recent literature revisions, define resilience as the multidimensional capacity of regional and local economy to absorb shocks, adapt or transit to new sustainable development path [Martin and Sunley (2014), Diodato and Weterings (2015), Manca et al. (2017), Baycan and Pinto (2018), Martin (2012)].

As far as the methodological approaches to measure resilience is concerned, these range from descriptive, interpretative case studies to sophisticated statically econometric models. Several different methodological approaches to measuring the degree and "type" of regional resilience are found in the literature as described below [Martin and Sunley (2015)]:

- Use of simple case studies incorporating descriptive statistical data and questionnaires among the main "players" shaping regional policies
- Use of resilience indices - simple or composite - that measure relative resilience and recovery using time-specific variables.
- Use of time series statistical models (impulse response models, errors correction models) through which the time required to absorb the effect of a disturbance is calculated, in other words the size of the effect of the disturbance that is gradually eliminated in the unit of time.
- Random structural models that incorporate regional resilience into regional economic models predict the "imaginary" position that the system under consideration would have in the absence of the imposed disturbance.

Each of the above approaches has its own characteristics, advantages, and disadvantages and in a general perspective, researchers see no reason why these different approaches cannot be combined with each other. The concept of resilience in regional science is assessed based on a region's ability to maintain a successful growth path after a disturbance, regardless of whether “success” is evaluated in terms of a traditional index (for example: change in employment rate) or a more complex indicator (for example: change in Resilience Capacity Index - RCI). In any case, regional resilience is assessed by measuring the change in a state at the initial period (before the disturbance) and the change in the state at the final period (after the disturbance), or by assessing the initial and final state (of a variable or an indicator for example) of a region [Chapple and Lester (2010)].

These measurements may involve either the use of a simple statistical measurement index, or a more complex index, or the application of empirical measurements and data extraction applications through regional analysis techniques. An indicative example coresponds to the empirical assessment of regional resilience using a dataset of quarterly employment series for 12 UK regions for the period 1971–2010, applying a Seemingly Unrelated Regression (SUR) model to examine the relevance of UK (engineering) resilience and regional employment [Fingleton et al. (2012)]. A broader family of econometric models based on the Dixit–Stiglitz theory of imperfect competition has also been used [Doran & Fingleton (2013)]. Moreover, a dynamic spatial panel model to analyze the effects of disturbances in the regional economies caused by 2008 financial impact was also used [Fingleton et al. (2015)].

In international literature, the most widespread composite index is that of RCI Index (Resilience Capacity Index) [Foster (2011); Foster (2012)]. RCI is a composite index incorporating 12 equally weighted variables reflecting economic, socio-demographic, and social cohesion characteristics. Another attempt of constructing a composite index considers the following 4 components: 1) the macro-economic stability component, 2) the micro-

economic adequacy of the market component, 3) the good governance component and the 4) the social development component [Briguglio et al. (2006)]. In another research work, a Resilience Capacity Index (RCI) of 79 Slovakia regions was measured, in the context of 2007-2008 economic crisis, combined with the use of an index of regional vulnerability [Reggiani 's et al. (2016)]. A series of indicators to measure economic resilience and vulnerability of US counties relative to other counties were also implemented [Miller, Johnson, & Dabson (2016)]. Regional resilience to economic shocks as well, based on 6 groups of parameters consisting of 65 indicators determined using Pearson's correlation coefficient and Kendall's correlation coefficient Rank, the knowledge capacity index, the regional governance capacity index, the knowledge and innovation capacity index, the learning capacity index, and the infrastructure capacity index have been also presented [Bruneckiene et al (2018)]. Furthermore, a composite resilience index-using principal component analysis-based on five factors, such as public relations, human infrastructure in urban areas, labor market and performance of economic innovation in science and research resulting into the creation of CWIRR index (Composite Weighted Index of Regional Resilience for the r region) were constructed [Stanickova and Melecky (2018)]. Another researcher, analyzing the resilience of the European Union based on regional vulnerability, resilience, and recovery, used the resilience index and the recovery index. Using a spatial general equilibrium model, the researcher investigates the resilience of EU regions under three alternative recessionary shocks, each triggering different economic adjustments and mechanisms [Di Pietro et al. (2021)].

In Greek literature, dominates the construction of a composite index (CIRR index) which incorporates a range of ten economic, social, demographic, and structural variables [Psycharis et al. (2012)]. According to the researcher, GDP per capita is the most frequently used statistical indicator of growth. A composite index to assess the resilience of Greek regions including variables such as population changes, export value, savings, new constructions, were also created [Psycharis et al. (2014)]. In another attempt to evaluate spatial performance of the Greek regions, GDP per capita is used as an independent variable together with a series of structural variables such as trade index, the degree of public investment per region, the percentage of regional GDP produced in the protected sector of the economy, etc. [Petrakos and Psycharis (2016)]. A more complex growth and prosperity index consisting of 21 variables, including data related to welfare and quality of life such as declared income, sectoral GDP, urbanization, centrality index, etc. has been presented as well [Petrakos and Artelaris (2008)].

Apart from attempts to create composite indices, empirical research works measuring regional resilience have also been recorded in the literature. In this case, the change in “key” regional variables such as GDP, employment, and unemployment (percentages) measured and evaluated [Martin & Gardiner (2019); Kakderi & Tasopoulou (2017); Giannakis & Bruggerman (2015, 2017); Kitsos & Bishop (2018)]. In some cases, two different variables are used [Sensier et al. (2016)]. Often, empirical approaches examine the degree of correlation of measured resilience with specific factors (or determinants) affecting it. The logic of this approach follows the assumption that regional economies consist of economic factors that produce changes within the economy and determine the overall resilience of regional economies [Bristow & Healy (2014)]. The determinants that mainly affect regional resilience capacity and performance are categorized in 5 main groups such as Industrial Business Structure, Labor Market Conditions, Financial Arrangements, Governance Arrangements, and Agency and Decision-Making [Martin & Sunley (2015)]. Thus, quite often, researchers apply econometric models or statistical methods to assess and identify in detail the degree of correlation of the measured resilience with these determinants.

In some research works, resilience is assessed based on the calculation of variables’ change in absolute values (between the periods of the disturbance year), for instance before and after the occurrence of the disturbance at a regional or/and at sectoral level [Martin (2012); Kitsos and Bishop (2018); Athanasopoulos (2022)]. A simple way of measuring a region’s resilience to recession is the ratio of the decrease in employment or production to the corresponding decrease at national (country) level: that is, the respond of national economy is used as reference against which the relative resistance or resilience of the regions is measured

[Martin (2012)]. This researcher used data on employment changes to assess the resilience of UK regions over three UK crisis time periods: 1979-1982, 1990-1992 and 2008-2010.

Other researchers assess regional resilience by calculating the percentage change of statistical variables before and after the occurrence of a disturbance, either manually or by using descriptive methods such as the Shift Share Analysis method [Sensier et al. (2016); Angulo et al. (2018); Cainelli, Ganau, & Modica (2019); Giannakis & Bruggeman (2015; 2020)].

A combination of two econometric methods was used, the technique of the classical Shift Share Analysis method and the input-output method to evaluate employment's changes in 13 Greek regions in (2001-2006) and (2008-2013) period investigating the effects of 2007-2009 financial crisis [Giannakis & Bruggeman (2015)]. A simple regional resilience index was also used, upon the proposal of Lagravinese (2015), which calculates resilience based on the change of employment in European countries [Giannakis & Bruggeman (2017)]. As point of reference, it takes the average employment of the EU 28 countries and resilience is estimated from equation (1):

$$\beta_{res}^{EU} = \frac{\frac{E_t^R - E_{t-1}^R}{E_{t-1}^R} - \frac{E_t^{EU} - E_{t-1}^{EU}}{E_{t-1}^{EU}}}{\left|\frac{E_t^{EU} - E_{t-1}^{EU}}{E_{t-1}^{EU}}\right|} \quad (1)$$

where E_t^R is employment at the regional level and E_t^{EU} employment in the 28 EU Member States, t -1 the initial period of the analysis and t the final period of the analysis (year after the disturbance). Additional analysis was also carried out at national level according to equation (2):

$$\beta_{res}^{N} = \frac{\frac{E_t^R - E_{t-1}^R}{E_{t-1}^R} - \frac{E_t^N - E_{t-1}^N}{E_{t-1}^N}}{\left|\frac{E_t^N - E_{t-1}^N}{E_{t-1}^N}\right|} \quad (2)$$

where E_t^R is employment at national level. Another empirical approach to assessing regional resilience measures the changes of regional variables after the year of imposition of the disturbance, in other words after the occurrence of the disturbance (with or without the use of Shift Share Analysis Method or other techniques for measuring statistical variables' changes) to construct a simple resilience index using equation (3):

$$RSij = \frac{\Delta Ji - \Delta Jn}{|\Delta Jn|} \quad (3)$$

where ΔJ_i is the change of regional variable J of region i in the time interval [t -1, t] referring to a time after the imposition of the disturbance and ΔJ_n corresponds to the change of variable J of region i in time interval [t -1, t] at national level [Lagravinese (2015); Martin, Sunley; Gardiner & Tyler (2016); Giannakis & Bruggeman (2017)].

Several empirical approaches separate resilience into two forms, resistance resilience and recovery resilience. Often in the literature the interpretation of these two terms is also found as "performance" resilience and "ability" resilience. "The concept of resilience can be divided into two forms, performance (resistance) and capacity (recovery)" [Sutton & Arku (2022)]. Similar terms have been given by other researchers describing regional resilience as resistance and recovery capacity after disruption.

Performance refers to the outcome of regions' response to perturbations (for example assessment of regions' resilience), while capacity refers to the underlying process of regions' adaptation to a perturbation (for example short-term and sudden perturbations) [Bristow & Healy (2014); Evenhuis (2017)]. Both forms of resilience are important, as the former shows whether areas are resilient, and the latter explains why they are resilient. While conceptually both forms of resilience have been recognized in the resilience literature, resilience capacity is rarely examined empirically, remaining a "black box" in need of further investigation [Hill et al. (2012)]. Most of the empirical research has focused on the performance of regional economies against disturbances, examining particularly whether regions were resilient or not,

exploring the general determinants of resilience [Brown & Greenbaum (2017), Courvisanos et al. (2016), Martin. (2012)].

Considering a general categorization of disturbances that take place and affect spatial economic resilience of an area or region, one can distinguish two main categories: a) disasters, that are usually of anthropogenic origin or coming from extreme weather conditions [Rose and Krausmann (2013)] and b) recessionary disturbances [Martin (2012)]; In a more detail interpretation of shocks, seven broad types are referred: economic, institutional, organizational, environmental, and technology [Holm & Østergaard, (2015)], man-made shocks, and epidemic shocks [Sutton, & Arku, (2022)]. Considering the spatial origin of shocks, these could be either regionally or globally, isolated or globally occurrences (Martin & Sunley, (2015)].

In literature, the construction of a simple resilience index is mainly based on the measurement of employment rates. Employment's changes better reflect social effects of disturbances and especially economically originated disturbances, such as the financial crisis of 2007-2009 [Giannakis & Bruggeman (2017)]. Apart from employment, other indicators of economic growth such as GDP or GDP per capita or GVA are also important in capturing the effects of disturbances on society. The use of employment as a statistical variable is applied to calculate regional resilience index according to equation (3) [Lagravinese (2015)]. The researcher studied the period 1970-2011 and the effects of the economic recession on the Italian regions. To investigate the relationship between resistance and recovery indices, they used the Dynamic Shift Share Analysis Method to analyze how sectoral specialization and regional factors affect employment changes.

Another empirical analysis of the relationship between regional innovation capacity and resilience to crises in the European region uses cluster analysis [Bristow & Healy, (2018)]. Another indicative research work investigates the relationship between regional resilience of European regions and the quality of governance during the period of the great economic crisis of 2008 [Ezcurra & Rios (2018)]. Using equation (3) they calculated the regional resilience index for 255 NUTSII regions in the EU of 27 Member States in the period 2008–2013 applying regional employment as the measured value of corresponding index. The calculation of simple Resilience (Resistance) and Recovery (Recovery) indices are evolved by using regional EU27 GDP, from 2008 to 2009 for the resistance index and to 2011 for the recovery index [Opera et al. (2020)]. To examine the effect of the various factors (affecting regional resilience) on the formation of the resistance and recovery indices, the researchers examined two multiple linear regression models in which dependent variables were Resistance and Recovery Indices and independent variables were several influencing parameters selected and determined by the researchers. These parameters were: income from agricultural production, industrial processing and services, public administration activities, entrepreneurship data and higher education data, gross capital formation, urban population concentrations.

Another methodological approach to calculate a simple index, uses the employment Er in region r of the corresponding country c, at t =2008 and T=2009...2012. The survey sample was 209 NUTS II regions in 16 European countries [Cainelli et al (2019)]. Employment data were also used to measure regional resilience and economic diversification, income equality and the prevailing business environment to interpret economic resilience (or resistance) to various shocks [Augustine et al. (2013)]. Other researchers, use local knowledge networks to interpret regional resilience [Crespo, Suire, and Vicente (2013)]. At another research paper, assessment, and identification of the impact of the economic crisis of 2011–2013 in Greek urban areas through the deterioration of the labor market and welfare is presented [Palaskas et al. (2015)]. Different ways of measuring evaluation found in literature and the different methodological approaches that have been developed such as empirical examinations, case studies of econometric or statistical models are also presented [Martins & Sunley (2015)]. Additional issues of assessment of regional resilience which relate to issues such as whether resilience is measured in absolute terms or relative to the national average or if it is compared with the resilience of other regions to a sudden disturbance are also examined [Sensier et al. (2016)]. In another research, an attempt to econometrically test the performance and the determinants that influence NUTS III regions during the economic crisis of 2007-2009 is performed [Petrakos & Psycharis (2016)].

Various other research works on the measurement and assessment of regional resilience are recorded. Such as, is the study of regional economic resilience for 20 Italian NUTS 2 regions analyzing regional employment changes over the period 1992-2021 using a non-linear smooth transition regression model [Di Caro (2017)]. The investigation of 2002–2007 period (before the financial crisis) and how determinants affected regional resilience based on changes in employment over the period 2008–2013, in 268 NUTSII regions of EU-28 countries, performed using a multilevel linear regression model [Giannakis & Bruggeman (2017)]. The assessment of the resistance of Spanish regions to the economic crisis, has been investigated under three main concepts of resilience: "Adaptive", "Engineering" and "Ecological" [Angulo et al. (2018)]. "Adaptive" resilience is measured through the application of the Shift Share Analysis method to calculate employment change, while "Engineering" and "Ecological" resilience emphasize on the path of development and the overall level of employment, in a period before and after crisis. An examination and empirical investigation of the relationship between industrial affinity and economic resilience during the crisis period 2008-2012 on a sample of 209 NutsII EU regions in 16 countries has also been performed [Cainelli et al. (2019)]. A two-dimensional quantitative measurement using the observed differences between expected (counterfactual) and actual employment in a region after a shock at US county-level developed to quantify regional resilience [Ringwood et al. (2018)]. Researchers attempted to distinguish the response to the shock from a random variation in the disturbance. Another empirical investigation of economic resilience of NutsII regions, examines the correlation between regional and structural factors and the degree of their influence upon resilience [Giannakis & Bruggeman (2020)]. A more comprehensive analysis provides, again for European NutsII regions, the application of an OLS regression model to measure unemployment resilience for the period 2008–2016 using a set of explanatory variables such as human capital [Cappelli et al. (2020)]. In another measurement of regional resilience of seven Eastern European countries during 2008 crisis, the construction (using GDP variable) of a resistance and a recovery index is used as dependent variable on a regression analysis model [Oprea et al. (2020)]. Using the OLS method, the researchers investigate the effect of specific factors on the resilience index (in terms of resistance and recovery) such as: agriculture, constructions, services, public administration, entrepreneurship, higher education, natural capital, and the urban population. The importance of human capital on labor market resilience in a sample of seven Portuguese NutsII regions over the period 1995–2018 based on different regional business cycles (and therefore various disruptions) has also been investigated [Simoes et al. (2022)].

According to a recent research paper, a different methodological approach was used to evaluate and rank the economic resilience of 17 Spanish regions, by observing the evolution of the components of the profit rate from 1975 to 2011 [Navines et al. (2022)]. For this purpose, researchers measured and analyzed the differential evolution of the two components of the rate profits: (i) the productivity of capital and (ii) the share of gross operating surplus in national income. In this research paper, the profit rate component is used instead of the "classical" components of measuring regional resilience such as employment. In another research paper, the role of regional industrial embeddedness (the share of regional industrial activity located in a region) on regional resilience is studied [Kitsos et al. (2022)]. Resilience is captured as the difference between pre- and post-crisis employment during the 2008 EU recession and the NutsII regions of the United Kingdom. Using Martin and Sunley's (2014) equation, they measure the resilience resistance (Res) for each region r and period t from 2008 to 2011. Using the local input-output tables, researchers try to interpret the industrial integration in the local regional systems and, by using regression models, to look for their correlation to regional economic resilience between 2008 and 2011.

In another research paper, an attempt is made to analyze the economic resilience of 284 Chinese cities at county and district levels using the equation that have already been used by Faggians et al. (2018); Giannakis and Bruggeman (2020, 2021); Lagravinese (2015) [Wang & Li (2022)]. They calculate regional resilience based on national employment changes. Moreover, they applied logistic multiple regression to assess the determinants of regional economic resilience and the variation in resilience caused by interprovincial disparities. In a more contemporary approach to assess resilience, it is examined through the investigation of the changes in a system (ie, structural and functional) resulting from the reactions to the

disturbances of the economic factors that constitute it [Sutton & Arku (2022)]. The methodological approach of evaluation-investigating a system-argues that the overall resilience is determined by the economic factors that constitute the region and by examining the changes of the system due to various disturbances. By examining system changes, research can determine the type of resilience regions exhibit during various perturbations.

3. Proposed improvements

Pertaining to the measurement and estimation of regional economic resilience, the analysis' results revealed the domination of the simple indices in measuring and evaluating regional economic resilience combined with correlation analyses applications to identify interrelations between resilience indices and regional determinants. This approach must be modelized and standardized under a unified and globally accepted context of investigation towards the production of comparable, scientifically reliable, accepted, and replicable measurement results and data.

Another point of intervention is correlated to the two (2) forms of resilience capacity, the resistance resilience (performance) and the recovery resilience (capacity) of a region. The former shows whether regions are resilient, and the latter explains why they are resilient. Both forms of resilience have been conceptually recognized in the resilience literature, while resilience capacity or recovery is rarely examined empirically remaining the need of further investigation. Most of the empirical research has focused on the performance of regional economies against disturbances, examining particularly whether regions are resilient or not, and not why they are resilient.

Moreover, further investigation should be conducted upon regional determinants that mainly affect regional resilience capacity and performance towards the evolution of another unified and unbiased identification and measurement framework, which could be applied and performed at any regional level within Europe and globally.

Before these interventions are practiced, there is a prerequisite and unnegotiable condition as regards the concept and notion of regional economic resilience: a concrete conceptualized clarification and adaptation of a common accepted definition of the term "resilience" should be adopted, especially in regional and spatial economic science.

4. Conclusions

The concept of resilience in regional science is assessed based on a region's ability to maintain a successful growth path after a disturbance, regardless of whether "success" is evaluated in terms of a traditional index (for example: change in employment rate) or a more complex indicator (for example: change in Resilience Capacity Index - RCI). In any case and according to Chapple and Lester (2010), regional resilience is assessed by measuring the change in a state at the initial period (before the disturbance) and the change in the state at the final period (after the disturbance), or by assessing the initial and final state (of a variable or an indicator for example) of a region.

The methodological approach to measure resilience ranges from the use of descriptive or interpretative models, simple or multi regression analyses to sophisticated statically econometric models. According to the results of this paper, several different methodological approaches to measuring the degree and "type" of regional resilience are found in the literature. These measurements may involve either the use of a simple statistical measurement index, a more complex index, or the application of empirical measurements and data extraction applications through regional analysis techniques that assess the resilience of a region.

Composite indicators present several advantages, mainly the ability of their adaptation in different economic conditions, the easy and direct classification and comparison of the examined economies as well as the ease of drawing conclusions compared to the use of simple indicators. Nevertheless, the safest and most efficient way to exploit the results of measurements using composite indicators is to use them in combination with other data that consider social, technological, and business characteristics of the economies under examination. Explicit care is required in the process of compiling such an index, which requires a correct and clear knowledge of the conditions prevailing in the regional economy

under consideration, the current economic conditions and the parameters that may limit the reliability of the applied indicators.

Apart from attempts to create a composite index, empirical research works measuring regional resilience have also been recorded where in most cases, the change in key regional variables such as GDP, employment, and unemployment (percentages) are measured and evaluated. In some research works, resilience is assessed based on the calculation of variables' change in absolute values (between the periods of the disturbance year), for instance before and after the occurrence of the disturbance at a regional or even at sectoral level. Other researchers calculate the percentage change (%) of statistical variables before and after the occurrence of a disturbance at regional level, either manually or by using descriptive methods such as the Shift Share Analysis method or input-output method. Another empirical approach is related to the measurement of the changes of regional variables after the year of imposition of the disturbance, in other words after the occurrence of the disturbance measuring the two types of resilience named and distinguished in the literature as resistance resilience and recovery resilience. The former shows whether areas are resilient, and the latter explains why they are resilient. In several research works as well, measured changes of statistical variables, are used to construct a simple resilience index. The construction of a simple resilience index is mainly based on the measurement of employment rates. Apart from employment, other indicators of economic growth such as GDP or GDP per capita or GVA are also important in capturing the effects of disturbances on regional economies.

In most of the research, the use of a simple or composite index does not provide researchers with solid and adequate information upon region's resistance performance and behavior. This derives from the fact that regional economies are composite complex systems, which are composed of numerous heterogeneous components such as firms, workers, and institutions. Each of these components have various complex interrelations and interconnections between each other and with external influences, presenting each of them with different absorption and responses to adverse shock and various disturbances. Moreover, regional economic structures are considered dynamic operating entities, and this is where time and evolution are involved as well. In such economic systems, there are numerous possible factors (determinants) that determine their operation and performance against possible disturbances and distortions. Thus, quite often, researchers apply econometric models or statistical methods to assess and identify in detail the degree of correlation of the measured resilience with these determinants.

Finally, regional changes of specific variables are compared to the corresponding national changes and in some cases, counterfactual, or estimated values in the absence of the occurrence of a disturbance, are compared to the real values occurred due to the existence of the disturbance.

Concluding, the methodological context for measuring regional economic resilience at NutsII or/and NutsIII level is undefined and basically empirically developed using either resilience indices or statistically based econometric models to assess resilience of a region. This somehow happens because regional resilience has not yet been clearly defined conceptually, to conclude to a globally accepted concept and definition. Until then, fussiness and multi directional approaching methods will prevail in the field of regional and spatial economics.

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