

# A SYSTEMATIC BIBLIOMETRIC ANALYSIS TO MEASURE REGIONAL ECONOMIC RESILIENCE

**Evangelos N Dulufakis\***

*Hellenic Mediterranean University, Heraklion Crete, Greece*

**George J Xanthos**

*Hellenic Mediterranean University, Heraklion Crete, Greece*

**Georgios Konteos**

*University of Western Macedonia, Kozani, Greece*

**Nikolaos Sariannidis**

*University of Western Macedonia, Kozani, Greece.*

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## ABSTRACT

*In this article, we review the different methodological approaches of measuring regional economic resilience, conducting a systematic bibliometric analysis. There are various diversified methods ranging from the use of descriptive, interpretative, or simple regression models to sophisticated statistically econometric models. The present research, via a systematic bibliometric analysis, provides insights of the regional and spatial economics' literature in relation to resilience measurement and estimation methods applied, pertaining to economically derived disturbances or shocks, such as recessions. Moreover, it enlightens our knowledge concerning the conceptual framework of regional capacity and ability to confront, and to respond to these shocks.*

*The results of this paper 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. This somehow happens, because the notion of (regional) resilience has not yet been clearly defined conceptually, to conclude to a globally accepted concept and definition.*

**Keywords:** Measuring context, Regional economic resilience, Systematic bibliometric analysis, Nuts II & III regions, Economic disturbances

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

## INTRODUCTION

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; Maru, 2010).

\*Correspondence to: Evangelos N Dulufakis, Hellenic Mediterranean University, Heraklion Crete, Greece, Tel: +306976629762; E-mail: ddk167@edu.hmu.gr

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, 2008). According to another interpretation, regional resilience reflects the ability of an 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, analyses 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).

There is a large variety of diversified methodological approaches to measure resilience. Some of them refer to the construction of simple indices (Martin, 2012; Augustine, 2013) or of composite indices (Psycharis, 2012; Reggiani, 2016). Applications of statistical time series models (Fingleton, 2012) or panel data models (Angulo, 2018). Causal structural models (Doran & Fingleton, 2013; Fingleton & 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). In the current research work, we consider only economic shocks, which are sudden, unexpected and ‘out-of-the-ordinary’ events (such as national recessions and financial crises) at a Nuts II or/and NutsIII level (Martin & Sunley, 2015).

The article is structured as follows: in Section 1, an introduction of the core objectives, the techniques and main results of the research work are outlined, in Section 2 various definitions of resilience presented in the literature are recorded while their interpretations at regional level are analyzed. In section 3 several studies on measurement and estimation methods and applications are reported, emphasizing the different methodologies developed and applied at regional level of NutsII & NutsIII scale. In section 4 the methodological framework of the current research is analyzed; a systematic bibliometric analysis is conducted along with quantitative and qualitative analyses. Supplementary improvements and recommendations for future research are also depicted. In section 5, basic results and conclusions are summarized propounding the need for further study and measurement methodological clarifications.

### **CONCEPTUAL CLARIFICATION**

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, 2004). According to a

'seminal' description of the concept of resilience, it 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, 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, 2008). According to another interpretation, it reflects the ability of a region to anticipate, prepare, respond to, and ultimately recover from a disturbance (Foster, 2007). According to this interpretation, resilience reflects a 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). Moreover, the focus on the concept of resilience must be based on the ability of regions to face economic, technological, and environmental challenges (Wolfe, 2010). According to another conceptual interpretation, 3 main approaches are described (Martin, 2011). The first interprets resilience using engineering/technical science terminology (engineering resilience) and describes the system's ability to return to its initial equilibrium point (before disturbance occurrence). The second approach refers to the level of adaptation, and 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). It concerns the different level of equilibrium that the system driven, after the enforcement of the disorder. The third approach resembles the evolutionary interpretation of resilience called "adaptive" resilience (Martin, 2012). It relates 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. The interpretation of Rose & Krausmann, (2013) on static and dynamic resilience is in the same context. These different interpretations "impose" four interrelated aspects of regions' reactions against disturbances such as: degree of resistance, extent of recovery, extent of re-orientation and degree of renewal (Simmie & Martin, 2010; Kurikka, 2022; Martin, 2012). More 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 & Sunley, 2014; Diodato & Weterings, 2015; Manca, 2017; Baycan & Pinto, 2018).

### **MEASUREMENT METHODOLOGICAL APPROACHES**

The methodological approach to measure resilience ranges from descriptive, interpretative case studies to sophisticated statistically econometric models. According to this approach, several different methodological

approaches to measuring the degree and "type" of regional resilience are found in the literature as described below (Martin & 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 etc.) 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 & 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 that assess the resilience of a region. As an example, we provide the case of 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 (2012). In another research, a broader family of econometric models based on the Dixit–Stiglitz theory of imperfect competition was applied (Doran & Fingleton, 2013). Moreover, a dynamic spatial panel model was used to analyze the effects of disturbances in the regional economies caused by 2008 financial impact (Fingleton, 2015).

In international literature, the most widespread composite resilience index is the RCI Index (Resilience Capacity Index) (Foster, 2011; Foster, 2012). RCI incorporates 12 equally weighted variables reflecting economic, socio-demographic, and social cohesion characteristics. Another attempt of constructing a composite index considers 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, 2006). In Greek literature, dominates the construction of the CIRRR composite index which incorporates a range of ten economic, social, demographic, and structural variables. GDP per capita is the

most frequently used statistical indicator of growth, despite the weaknesses attributed to it (Psycharis,2012). Another attempt of constructing a composite index to assess the resilience of Greek regions includes variables such as population changes, export value, savings, new constructions, etc. (Psycharis, 2014). In another attempt to evaluate spatial performance of the Greek regions, GDP per capita is used as 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 (Petraikos & 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. had previously used (Petraikos & Artelaris, 2008). The resilience of 79 Slovakia regions were measured, applying the Resilience Capacity Index (RCI), in the context of 2007-2008 economic crisis, combined with the use of an index of regional vulnerability (Reggiani 's, 2016). A series of indicators were also created to measure economic resilience and vulnerability of US counties relative to other counties (Miller, Johnson & Dabson, 2016). Moreover, regional resilience to economic disturbances was measured based 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 (Bruneckiene, 2018). Furthermore, a Composite Weighted Index of Regional Resilience - CWIRR index -was constructed 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 (Stanickova & Melecky, 2018). The resilience and the recovery index were also used, using a spatial general equilibrium model (Di Pietro, 2021).

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, 2 different variables are used (Sensier, 2016). Often, empirical approaches examine the degree of correlation of measured resilience with specific factors (or determinants) that influence 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, before and after the



occurrence of the disturbance at a regional or/and at sectoral level (Martin, 2012; Kitsos & Bishop, 2018; Athanasopoulos, 2022). A simple way of measuring a region's resilience to recession is the ratio of the decrease in regional 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 at regional level, either manually or by using descriptive methods such as the Shift Share Analysis method (Sensier 's, 2016; Angulo, 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 in 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 the equation (3):

$$RS_{ij} = \frac{\Delta J_i - \Delta J_n}{|\Delta J_n|} \quad (3)$$

where  $\Delta J_i$  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  $\Delta J_n$  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).

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. Based on Martin's, (2012) interpretation of resilience, regional resilience and resistance components were calculated. The same researcher, investigating interrelations between "resilience" and "regional competitiveness", applied the Multi-Factors Partitioning method (MFP), to capture the effects of sectoral and regional specialization and the corresponding productive sectors on the resilience of Italian regions. A simple resilience index was also applied to compare the expected values of employment's changes in relation to the actual ones (Martin, 2016). A measurement for both types of "resistances" (resistance and recovery) is also performed. To investigate the relationship between resistance and recovery indices, researchers 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 association of measured resilience with governance quality was then tested combined European Governance Quality Index [European Quality of Government Index (EQI)] and a linear regression model. The calculation of simple Resilience ( $R_{\text{resistance}}$ ) and Recovery ( $R_{\text{recovery}}$ ) indices are evolved by using regional EU27 GDP,  $t-1$  as the initial calculation period of the analysis which for the resistance index was 2008 and for the recovery index was 2009, and  $t$  as the final/ending point of the examination period which was respectively the years 2009 for the resistance index and 2011 for the recovery index (Opera, 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  $E_r$  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, 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, 2013). Other researchers use local knowledge networks to interpret regional resilience (Crespo, Suire, & 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, 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 (Sensiers, 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, 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 empirically 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, 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,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, 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 (OLS method) (Oprea, 2020). 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, 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, 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, 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 & 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, (2018; Giannakis & 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 (i.e., 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.

### **DATA COLLECTION & RESEARCH FRAMEWORK**

Literature reviews play an essential role in academic research to gather existing knowledge and to examine the state of a field (Cropanzano, 2009; Kunisch, 2018). However, a literature review that only offers an arbitrary selection of evidence is often not fully representative of the state of existing knowledge, and the selection of some studies over others, ultimately leads to what is known in statistical analysis as a sample selection bias - a type of bias caused by choosing a non-random sample of data for further analysis.

Consequently, narrative reviews often offer no comprehensive background for theory development and testing (Sternberg, 1991; Sutton & Staw, 1995). An important distinction between narrative and systematic reviews is that the latter adopt a replicable, scientific and transparent process, in other words a detailed technology, that aims to minimize bias through exhaustive literature searches of published and unpublished studies and by providing an audit trail of the reviewer's decisions, procedures and conclusions (Tranfield, 2003).

As a first step to this direction, this article identifies the knowledge development and knowledge gaps in measuring regional economic resilience. The bibliographic searching software (Harzing, 2007). Publish or Perish, available from <https://harzing.com/resources/publish-or-perish>, was used for the analysis. Publish or Perish is a software program that retrieves and analyzes academic citations. It uses various publicly available data sources to obtain the raw citations, then analyzes these and calculates a series of citation metrics. The currently freely available data sources used in our research were: Crossref, Google Scholar, PubMed and Scopus databases (Using Harzing, 2007). Publish or Perish, we generated a bibliographic pool of analyzed citations referred to article searches and records of scientific publications and research work on measurement methodological framework (methods, applications, approaches) of resilience in regional science and generally in the field of spatial economy. Publish or Perish software revealed their interrelations, identified their theoretical justifications and their contributions to clarifying resilience capacity measurement and estimation at NutsII and NutsIII regional level as well.

Findings from the review show that neither a comprehensive systematic bibliometric analysis have so far been conducted, nor a journal article investigating the methodological framework of measurement and estimation of regional economic resilience have been published globally. The only systematic bibliometric analysis published is registered on a conference proceeding which aims to map the research area with the topic of economic resilience (measurement) and disturbance between 2015 and 2020 (Purwandari, 2021). Furthermore, a few journal articles and scientific papers found in the literature (26 articles and papers) to apply a methodological approach or a method to measure and estimate regional economic resilience at a NutsII and NutsIII regional level. We once remind that one of our research prerequisites, as the origin of disturbance is concerned, is that the disturbance should be of economic origin exclude other forms of distortions such as environmental and technological distortions or physical disasters. The results revealed that the most popular, favorite, and dominant measuring approach of regional economic resilience is the construction of a simple index, comparing changes of a statistical variable (mostly used variable is regional employment) before and after the occurrence of a disturbance. In some cases, 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. Often, empirical approaches examine the degree of correlation of measured resilience (resilience index) with specific factors (or determinants) that influence it. To achieve this, researchers supplementarily apply econometric or statistical models such as panel data models, time series models, or simple regression models and correlation analysis models to

identify and reveal the correlation between the measured (estimated) index and regional determinants. The determinants that mainly affect regional resilience capacity and performance are industrial and business structure, labor market conditions, financial and governance arrangements, agency, and decision-making (Martin & Sunley, 2015).

In the few cases where composite indices were constructed and applied to measure and estimate regional economic resilience at NutsII and NutsIII level, no further correlation investigation was performed. A possible explanation could be the fact that, construction of a composite index incorporates differentiated variables reflecting various economic, socio-demographic, entrepreneurial and social cohesion characteristics which in some extent reflect social, business, and economic characteristics of a region. Another reason that explains or justifies the limited use of composite indices is that their application requires a correct and clear knowledge of the conditions prevailing in the regional economy under consideration, the current economic conditions and the parameters that might limit the reliability of their usage. Concluding, in few cases, econometric or statistical models such as data panel models, time series models or simple regression analysis and SSA methods were used to empirically assess regional economic resilience, in combination with complementary correlation analysis to identify and estimate the correlation bonds between resilience capacity and regional determinants.

Data collection obtained from Crossref, Google scholar, Scopus, and PubMed through bibliometric analysis, namely the author, the title of the paper, the title of the journal, the year of publication from 2005 to 2022. The bibliography reaches were limited to the following aspects: the type of bibliography was only journals, scientific articles and conference papers/proceedings-articles, the title and keywords were four (4) words: regional economic resilience and measuring, the year was limited up to the end of 2022.

The initial searching retrieved 1253 results-from all data sources-applying specific searching criteria (terms) such as:

- Retrieval results include journal articles, scientific papers, and conference proceedings-articles / minutes.
- Exclude any article included in handbooks or books or nonscientific paper (e.g. newspaper).
- Include only economic/financial driven disturbances, distortions, or chocks.
- Exclude other types of shocks (even if they have financial effects or influences) such as physical disasters, technological shocks, local labor disturbances, transitory technology etc.
- Include only NutsII and NutsIII regions.
- Exclude cities, communes, communities, businesses, firms, urban or rural areas.
- Include results combining the 4 search words: “measuring economic regional resilience” either in their title or their key words field or at both fields resulted in totally 86 records.

Search Engines' Results using "Key words" and "title" keys such as: "measuring regional economic resilience" and applying the restrictions listed above (1 to 7) in retrieval process (prerequisites conditions for return a search result as "accepted result") concluded 86 records. From those 86 records, we conducted an examination and exploration of their abstract using as guidance the words: "measuring regional economic resilience" and excluding duplicated records, 35 results were returned. Peer review of thirty-five (35) results returned twenty-one (21) results. One (1) bibliometric review added, and ten (10) records also manually added from other sources. Other sources are journal articles, scientific paper and conference proceedings articles that reviled and come across to our sight upon the literature investigation process as regards the concept and notion of regional resilience. These records do not include either in their title nor in the "key words" field any of the four (4) words: "measuring regional economic resilience" that were used at the Publish or Perish software. On the contrary, these records appear in their article's body text: a methodological approach, a method or a measuring process which is described, applied, or evaluated pertaining to regional economic resilience. Given these premises, total results encountered were: thirty-two (32) from journal articles, scientific/working papers, and conference/proceeding articles (minutes) from conferences/congresses.

A qualitative analysis of these publications resulted in different methodological approaches and methods of estimation or measurement of regional economic resilience as follows:

- a) As regards the application of statistical variables to construct a simple or composite index we summarize the following results:

One article which includes a systematic bibliometric analysis of measuring regional economic resilience and disturbance.

One article addresses questions on the meaning and explanation of regional economic resilience (conceptualization context and definitions) and among others, outlines and identifies the methodological framework of measuring and estimation of regional resilience: what is measured and how is measured.

22 articles out of 31, construct a simple index to estimate and measure regional resilience using various statistical variables such as: employment (15 cases), GDP variable (6 cases), GDP per capita (2 cases), unemployment (1 case), gross income (1 case).

6 articles out of 31 construct a composite index to estimate and measure regional resilience using various indicators such as human capital, sociodemographic structure, labor market, economic performance and innovation, science, and research etc.

1 article applies the regional business cycle method and various macroeconomic time-series variables such as GDP, consumption, investment, export, import etc.

1 article applies the "resilio" model which comprise factors that determine regional resilience divided into six groups involving 65 subgroups of indicators.

In cases of construction of simple indices, measurements of variables used in the construction of the resilience index referred to absolute changes in only 2 articles. The rest of the cases consider (%) changes of statistical variables compared mainly to national changes. In one case the traditional shift share analysis method is used to estimate variable changes over time and the input-output method as well. Furthermore, in three (3) articles, regional resilience is measured by comparing the counterfactual (projected) annual rate of a pre-defined variable in the absence of the economic crisis with the actual value occurred. Moreover, the construction and measurement of a simple or composite resilience index is complemented with econometric or statistical models' implementation, which correlate the measured indices to regional determinants such as labor market, socio-demographic characteristics, human capital, structure of regional economy, innovation and R&D activity, economic performance of the region etc.

- b) Regarding the use / application of supplementary and / or supporting econometric or statistical models to better estimate and correlate regional resilience to regional determinants, we identify the following cases:

Three (3) articles in which, researchers use the panel data models such as dynamic fixed-effect (FE) panel data, the spatial autoregressive (SAR) model and the dynamic fixed-effect SAR model, endogenous spatial lag, and spatially autoregressive Errors panel data model.

One (1) article in which a time series model is used and more specifically the vector error-correction model (VECM).

Nineteen (19) articles in which other statistical models are used such as the simple harmonic motion and regime switching model, simple or multi regression analyses, SUR and STAR regression models, the medium-scale DSGE model, Pearson correlation coefficient and Kendall rank correlation coefficient, factor analysis and entropy method, business cycle and complexity measurement method, a descriptive model following the four-phase adaptive cycle model.

As regards the various aspects of regional resilience under investigation, "engineering", "ecological", "evolutionary", the research resulted in 22 articles measuring and estimating the general notion of resilience at regional level, four (4) articles focused on the "engineering" type of resilience and three (3) on the "ecological" type of regional resilience. Moreover, in 3 articles, resilience capacity is measured in relation to resistance resilience and to recovery resilience of the region.

Pertaining to measurement and estimation of regional economic resilience, 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 modeled 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. 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.

### **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, 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) (Chapple & Lester, 2010).

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. 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.

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 before and after the occurrence of the disturbance. Other researchers calculate 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 or input-output method. Another empirical approach measures the changes of regional variables after the year of imposition of the disturbance, measuring 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. 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.

The use of simple or composite indices, do 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, 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 national changes and in some cases, counterfactual or estimated values (in the absence 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. This somehow happens because regional resilience has not yet been clearly defined conceptually, to conclude to a globally accepted concept and definition. Till then, fussiness and multi directional approaching methods will prevail in the field of regional and spatial economics.

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