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RESEARCH ARTICLE

Metrics for analyzing regional resilience: a bibliographic and cluster analysis approach

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Abstract
The term resilience has begun to proliferate in regional economic literature over the last decade as more and more authors have sought to connect the term to economic shocks. Resilience as a concept is not new, particularly for ecology and engineering, but its use in regional economic analysis is more recent. Many authors have sought to define and measure the resilience of regions to exogenous shocks, utilizing multifaceted interdisciplinary approaches. This paper uses a bibliometric approach to conduct an in-depth critical review of both the definitions and metrics associated with regional resilience. We found 98 unique studies that were reviewed to collate and analyze methods and indicators used to measure regional economic resilience. Our analysis identified 202 unique metrics (e.g., educational attainment) associated with regional economic resilience that can be aggregated into 15 overarching themes (e.g., demographics), and represented in 3 distinct clusters (e.g., community development).

Keywords: Bibliographic analysis; Measurement and metrics; Regional resilience

Introduction

The term resilience has become a buzzword applied across multiple disciplines but notably, its use in regional economics has stemmed from the global financial crisis of 2008-2009. The volume of academic literature concerning economic resilience has increased substantially in just the last decade (e.g., Bristow and Healy, 2014; Martin and Sunley, 2015; Boschma, 2015; Modica and Reggiani, 2015; Courvisanos et al 2016; Di Caro, 2017). However, the broad and continued interest in resilience has resulted in diverse applications in the field without an agreed-upon definition. Resolving this issue is critical for the future development and application of the concept in economics.

Although there exists a lack of clarity in the literature to date, there have been multiple definitions and approaches to studying economic resilience proposed. Rose (2007) provides a useful critique of a lack of clarity by noting that "the presentation of a precise

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definition is important because resilience is in danger of becoming a vacuous buzzword from overuse and ambiguity". Sensier et al (2016) highlights a bigger problem than this, which is how do we measure something that few academics can define consistently? Therefore, studying resilience requires two initial steps: (i) defining the concept and (ii) developing an appropriate method to measure it effectively.

Despite these challenges, various studies have identified factors that shape and influence regional economic resilience. The term resilience comes from the Latin root *resilire*, meaning to rebound or spring back. While the concept is relatively new to regional science, it has been extensively explored in disciplines such as engineering, architecture, psychology, transportation, business administration, emergency response management, and environmental science (Martin & Sunley, 2015).

There is also considerable debate about how to interpret the resilience of a regional economy given the economy is constantly changing (van Bergeijk, Brakman, & van Marrewijk, 2017). The most prevalent approaches within the literature define economic resilience as a measure of economic stability in the case of a crisis with a focus on the economy's ability to return to its original growth pattern. This concept is prevalent in much of the literature. The growth path concept, however, does not paint the full picture. In addition, the work of Mai and Chan (2020) highlight the persistent conceptual ambiguity of resilience, emphasizing that its definition and application vary across disciplines, leading to inconsistencies in how it is understood and measured.

This paper attempts to fill an existing gap in the literature by developing a thorough list of metrics used to assess regional economic resilience. To begin, we endeavor to classify definitions and metrics under common roots, providing characteristics that researchers can utilize to best suit their needs.

The paper is organized as follows. Section 2 presents a brief review on key concepts of economic resilience. This is an important first step given how resilience has evolved from different fields. The next section presents the methodology for our 2-stage bibliographic analysis, where the first stage surveys the literature to identify existing metrics and the second conducts a clusters analysis. Following Van Eck and Waltman (2017), we identify clusters of metrics based on their co-association with each other. The final section summarizes the key findings from this paper and makes recommendations for how resilience could be measured and analyzed in future work.

Concepts of economic resilience

Defining economic resilience

Rose (2007) defines economic resilience in two ways: static and dynamic. Static economic resilience is the ability for the economy to maintain its functionality when shocked, whereas dynamic economic resilience refers to the speed of recovery from the shock. This is an important distinction from other work which inherently looks at interconnectivity and resilience. Briguglio et al. (2006) define resilience in terms of economic vulnerability, i.e., how susceptible economies are to shocks, and conclude that these can be permanent or quasi-permanent features of a nation. The notion of resilience being about an economic trajectory is also evident in the work of Foster (2007), who sees it as the ability to return to the previous growth path after a shock.

According to Bruneau et al. (2003), Simmie & Martin (2010), Martin (2012), and Di Caro (2017), there are three primary definitions associated with economic resilience: engineering resilience, ecological resilience, and adaptive resilience. Di Caro (2017) defines engineering resilience as an economy's ability to maintain a stable long-term growth

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trajectory despite the influence of a shock. Ecological resilience, adapted from the natural sciences, utilizes the concept of hysteresis, or the altering of a response based on reactions to preceding events (Martin, 2012). Martin (2012) defines adaptive resilience as a system's ability to (i) reorganize its structure to minimize the extent of the system-affecting disturbance and/or (ii) take advantage of a shock to renew itself.

Although there is variety in the definition of resilience, Webber et al. (2018) suggest that the concept of regional resilience has begun to converge to a broad definition in economics, noting that "regional economic resilience may be defined as the capacity of a regional or local economy to withstand, recover from, and reorganize in the face of market, competitive, and environmental shocks to its developmental growth path." We use this last definition as a starting point in our work.

Measuring economic resilience

Although the topic of measuring economic resilience is relatively new, older work has dealt with how regions evaluate and respond to economic shocks without using the term resilience. For example, Conroy (1975) shows that the industrial diversification of a region affects the way the economy of the region responds to economic disturbances. In addition, Groot et al. (2011) found that private service industries are less sensitive to business cycle fluctuations than manufacturing and construction but more sensitive than public sector industries.

Many recent studies quantify resilience using unemployment and regional output. This makes for a simplistic approach, as seen in Sensier et al. (2016), who calculate a business cycle and use regional employment and output data to calculate the speed with which the economy recovers.

The use of "standard" employment statistics has been common for measuring resilience (Hill et al., 2008) but some have questioned the simplicity and one-dimensional nature of such metrics (e.g., Dawley et al., 2010; Holm and Østergaard, 2015; Faggian et al., 2018). As a result, more complex methods that integrate the simultaneous use of multiple metrics have increased in popularity (see for example the work of Tsiotas, 2022).

Employment growth across a business cycle is a common proxy for resilience (see Fawson et al 1998; Gabe 2017). Lu and Dudensing (2015) make use of time series and relative growth position methods by comparing and modeling quarterly sales data at an industrial level. Retail sales data is also a useful metric for exploring resilience, as it provides insight into consumer spending patterns and the overall stability of economic activity following a shock (e.g., Rose and Krausmann, 2013). By analyzing fluctuations in retail sales, researchers can assess how quickly a region's economy rebounds, the extent of demand recovery, and the adaptability of businesses to changing conditions. More complex econometric approaches use time series data to explore the effect of regional characteristics on maintaining growth or employment during recessionary periods have (e.g., Hill et al (2012); Diodato and Weterings (2014) Di Caro (2017); and Dinh et al (2017)).

The disconnect of measurement and definition

A single definition of resilience does not currently exist, thereby resulting in a potential disconnect across studies with respect to how economic resilience should be measured. With this in mind, it is useful to consider the work of Rose (2007) in which resilience is measured at a microeconomic, mesoeconomic, and macroeconomic level. This type of approach borrows from multiple definitions of resilience. The microeconomic definition is concerned with the way in which individual firms, households, and organizations behave. The mesoeconomic definition is concerned with the behaviors of economic sectors,

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individual markets, and cooperative groups. Finally, the macroeconomic definition embodies the sum of all individual units, markets, and their interactions (Rose, 2007). In practice, Rose's work emphasizes the importance of relative spatiality in the understanding of resilience. This type of approach is also found in a more general form in the earlier work of Briguglio et al (2006) who created an index for national economic resilience by finding the average of the four components of resilience: macroeconomic stability (GDP), microeconomic market efficiency (microdata), good governance (qualitative data), and social development. Martin (2012) also calculates regional resilience using regional employment data and measures it against national employment data.

A somewhat different approach that still utilizes spatial techniques was applied in Lu and Dudensing (2015) that separates out the effects of the recession when studying the impact of Hurricane Ike on the regional economies of Texas. The resilience of each county is measured by considering the effect of the Hurricane on quarterly sales within the industries of each sector (public administration, services, hotel/restaurant, entertainment, and health services). Resilience for each sector is measured in the difference (in number of quarters) between when the county shows negative QoQ (quarter-on-quarter) growth and when the sector itself shows negative QoQ growth.

Holm and Ostergaard (2015) start with the notion of "evolutionary resilience" but also cite the importance of spatial metrics when measuring the employment growth rate in the information and communications technology sector as a proxy of resilience. A great deal of recent literature following the 2020 pandemic has embraced a recasting of evolutionary as transformative resilience. The work of Trippl et al (2024) argues that there are two distinct approaches of scholars that would fundamentally use different metrics: one that focuses on bouncing back after an economic shock and the other that focuses on bouncing forward, that is, a region adopting a new approach to development.

Methods

This paper adopts a two-stage bibliometric analysis to identify the metrics used for assessing regional resilience as well as modify an existing clustering approach to identify the co-association between different metrics. Constructing metrics clusters draws a link between how definitions of resilience might be associated with different metric groups.

For our first stage, we build a database of relevant articles through the following process (see Figure 1). First, we search *Google Scholar* and *Web of Science* using the terms "Economic Resilience" and "Regional Economics". We then eliminate any paper that is duplicating a method already recorded or that is qualitative, which does not allow easy quantification to a consistent metric. Third, we analyze the scientific publications in the field using the Scopus Elsevier database, together with Science Citation Index Expanded. This results in a database of 98 publications that were published between 1990 and 2024 (Appendix A). Next, we analyze different aspects of each publication, such as publication type, major research areas, journals, citations, affiliations, and keyword occurrence frequency. A key aspect of this analysis is identifying explicit resilience metrics rather than control variables used by authors. Therefore, we note data sources as well as the construction of measures in the database. Based on this, we compile a data set with broad categories (e.g., demographics) and specific metrics (e.g., population growth) associated with regional resilience, allowing us to compare metrics across multiple papers.

In the second stage, we use the Visualizing Scientific Landscapes application developed by Center for Science and Technology Studies at Leiden University[1] to quantify the

[1]https://www.vosviewer.com

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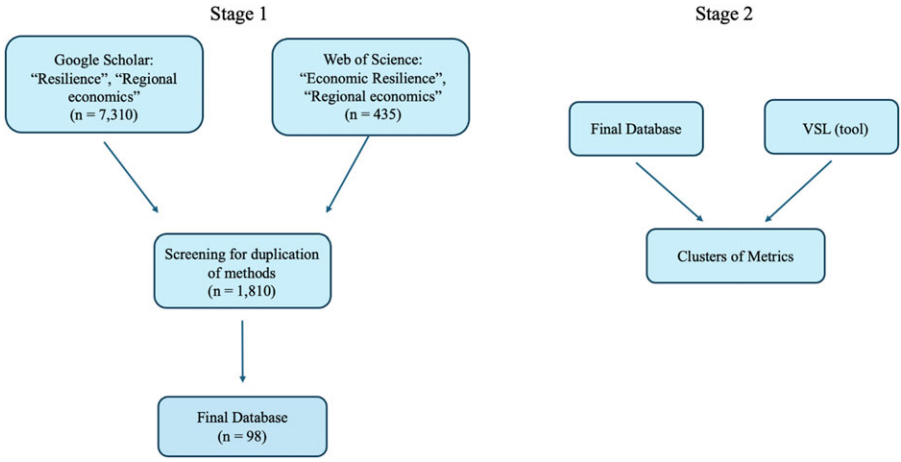


Figure 1. Bibliographic approach to analysis.

relationships among specific economic resilience metrics gleaned from our bibliographic analysis. The tool in its general form uses a clustering technique based on direct citation relations utilizing a quality function introduced in Van Eck and Waltman (2017). The technique has been reviewed and used in thousands of academic articles[2]. Our approach modifies the input data and changes some parameters to move from the co-citation of papers to the relatedness of metrics. This relatedness of metrics allows the establishment of clusters. The formation of this relatedness is established from equation (1):

$$a_{ij} = \frac{c_{ij}}{\sum_{k=1}^{n} c_{ik}} \tag{1}$$

where a_{ij} denotes the relatedness of metric $_i$ with metric $_j$, that is these two metrics are used together in a publication. The variable c_{ij} is an indicator variable that equals 1 if a metric $_i$ is also used with a metric $_j$ otherwise it is simply given a 0. The variable $_k$ ranges from 1 to n, and is the number of metrics to be assigned to clusters. Effectively the measure is a ratio of the relatedness of metrics over the total number of metrics in the sample. This cluster analysis provides valuable insights into how different resilience metrics have been used together in the literature. An important caveat is that because many of the 202 metrics found are used once, we only cluster metrics that have appeared more than 5 times (i.e., those greater than the mean number of occurrences).

Results

Overall findings

Our final sample includes 98 unique studies that directly reference regional economic or socio-economic resilience published in 41 journals between 1990 and 2024 (Appendix A). Table 1 summarizes the names and foci (via the InCites JCR Classifications) of the journals that are published on the topic. The top 3 journals in terms of publication frequency are *Regional Studies* (n = 10), fol lowed by *The Annals of Regional Science* (6) and the

[2]For a full list of publication see https://www.vosviewer.com/publications

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Cambridge Journal of Regions, Economy and Society (5). Papers featuring economic and regional resilience have also been published in several journals outside of mainstream economics (n = 32), such as geography (37), and regional and urban planning (37), highlighting the diverse application and audience of the topic (Table 1). These include environmental studies (n = 31), development studies (10), geosciences (5), and sustainability science (4). Plotting out the year that studies have been published highlights the surging interest in regional resilience over the past decade (Figure 2a). While the first known publication occurred in 1990 (Sherwood-Call, 1990), 94% of the studies we evaluated have been published since 2008 and more than 60% of regional economic resilience papers we compiled have been published since 2015.

Looking at where studies are conducted, geography is important as not all nations collect or maintain the same types and quality of data. A majority of the published studies focused on Europe (n = 50) followed by North America (17), Asia (10), the globe (8), Oceania (7), Africa (2), and South America (2) (Appendix A). This can be largely explained not only by the high frequency and relatively high quality of the available data but also by the great recession of 2008-2009 having had a significant effect on the EU, where most European nations experienced long downturns and long recovery periods. With this as the backdrop, regional economic resilience analysis was driven in Europe by the need of policymakers and others to understand what makes one location more resilient than another. US studies, however, took much longer to emerge, and those that did emerge initially evolved from more disaster and ecological resilience standpoints as opposed to location comparison standpoints.

This distinction between economic and social resilience compared to physical or structural resilience shaped the way in which authors sought to consider and measure the concept of resilience. Indeed, we find a distinction between emerging papers from the US that were born out of other fields, such as ecology, disaster management, environmental studies, business, and those that have cited European work as a starting point. This dichotomy has in some instances created the diversity of metrics that are included in these studies. The challenge this has often presented is marrying the use of different proxy measures from different authors who are trying to capture the same underlying aspect of resilience.

Researcher-classified resilience metrics

We identified 202 unique metrics used within the 98 publications (Appendix B). For tractability, we aligned the 202 metrics to 15 specific groupings (Table 2) that varied in frequency over time (Figure 2b). Initial seminal work on resilience focused on output and employment (over 30 different indicators purported to measure this economic dimensions of resilience), demonstrating the breadth of the way in which different authors tried to study the topic. For example, skill mismatch (i.e., the skill makeup of a region not aligning with the jobs most in demand) is a forward looking, outward focused metric, yet some researchers have focused on the relative measure of skills in a region as an indicator of resilience.

Growth and Trade are grouped together as an Economic Output category, as it was clear that Gross Domestic Product (GDP) and Gross Regional Product (GRP) was used in some form by a significant number of papers (29 of the 98 publications reviewed) and was the "go to" especially as the research area was emerging. However, these metrics have waned over time, and other metrics have taken their place, particularly on the socio demographic side. Demographics is our largest group of metric types containing 34 unique indicators. Of these, there are metrics covering a wide number of characteristics from educational attainment, food security, and even religion.

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Table 1. Summary of regional resilience papers by journal title and JCR classification category

Journal	n	Journal Cat #1	Journal Cat #2	Journal Cat #3	Journal Cat #4
Regional Studies	10	Economics	Env. Studies	Geography	Reg & Urb Plan
The Annals of Regional Science	6	Economics	Env. Studies	Geography	Reg & Urb Plan
Cambridge Journal of Regions, Economy and Society	5	Develop. Studies	Economics	Geography	
European Planning Studies	4	Env. Studies	Geography	Reg & Urb Plan	Urban Studies
Sustainability	4	Sustainability Sci.	Env. Sciences		
Environment and Planning A: Economy and Space	3	Env. Studies	Geography		
International Journal of Disaster Risk Reduction	3	Geosciences	Met. and Atmos. Sci	Water Resources	
Papers in Regional Science	3	Economics	Env. Studies	Geography	Reg & Urb Plan
Global Environmental Change	2	Env. Sciences			
Journal of Economic Geography	2	Economics	Geography		
Natural Hazards	2	Geosciences	Met. and Atmos. Sci	Water Resources	
Social Indicators Research	2	Social Sciences	Sociology		
Regional Science Policy & Practice	2	Geography			
Spatial Economic Analysis	2	Economics			
Annals of Regional Science	1	Economics	Env. Studies	Geography	Reg & Urb Plan
Applied Geography	1	Geography			
Computers, Environment and Urban Systems	1	Dev. Studies	Geography	Reg & Urb Plan	
Entrepreneurship & Regional Development	1	Dev. Studies	Business		
Environmental Hazards	1	Env. Studies			

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Table 1. (*Continued*)

Journal	n	Journal Cat #1	Journal Cat #2	Journal Cat #3	Journal Cat #4
Geography Compass	1	Geography			
Growth and Change	1	Dev. Studies	Reg & Urb Plan		
International Journal of Critical Infrastructure Protection	1	Comp Sci	Engineering		
Journal of Homeland Security and Emergency Management	1	Public Admin.			
Journal of International Development	1	Dev. Studies			
Urban Studies	1	Env. Studies	Urban Studies		
World Development	1	Dev. Studies	Economics		
Journal of Regional Science	1	Economics	Env. Studies	Reg & Urb Plan	
Networks and Spatial Economics	1	Op. Res.& Mgmt	Trans. Sci & Tech.		
Oxford Development Studies	1	Dev. Studies			
The American Journal of Economics and Sociology	1	Economics	Sociology		
International Review of Financial Analysis	1	Business	Finance		
Journal of Public Administration	2	Political Science	Public Administration		
Land	1	Environmental Studies			
Applied Economics	1	Economics			
*Other Publications**	27	n/a			
Total	**98**				

*Studies published in books or journals not tracked in InCites JCR Classifications.

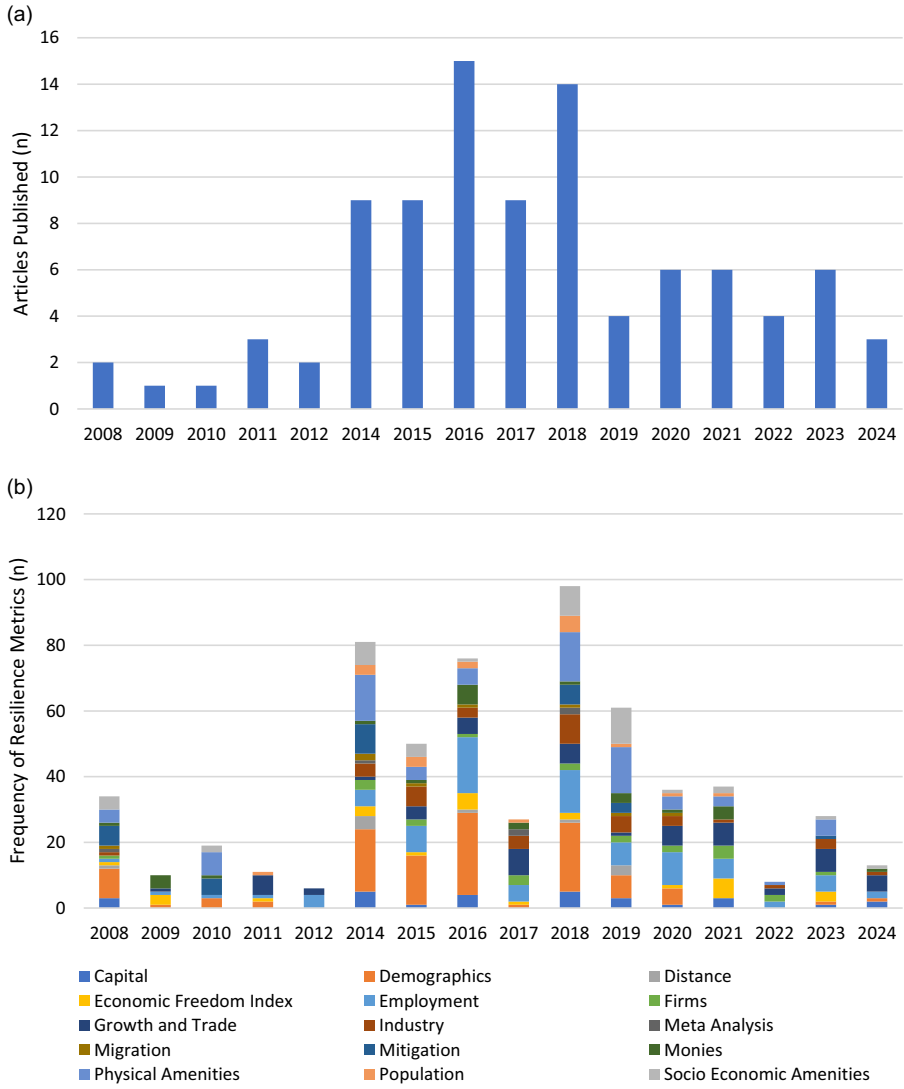


Figure 2. Frequency of (a) regional and economic resilience studies published and (b) use of key resilience metric categories in study analysis, 2008–2024.

Many of the studies that are compiled in our analysis focus on explaining how a region dealt with a major shock ex post. Most metrics were used as explanatory variables in a regression model. Similarly, there is a significant conjecture in the literature over whether certain industry metrics imply a region is more or less resilient to a shock. A good example of this is the work of Hill et al (2010) that suggests regions with a higher proportion of their employment in durable goods manufacturing are likely to experience more downturns and thus be less shock resistant. On the contrary, Eraydin (2016) implies that only manufacturing businesses will be dependent on strategic imports, thereby making a region

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Table 2. Frequency of aggregate resilience indicator references from studies included in regional and economic resilience analysis (n = 98)

Aggregate Resilience Category	N
Capital	34
Demographics	108
Distance	10
Economic Freedom Index	31
Employment	90
Firms	24
Growth and Trade	63
Industry	42
Meta Analysis	7
Migration	6
Mitigation	32
Monies	32
Physical Amenities	76
Population	18
Socio Economic Amenities	43
Total	**615**

less resilient. This suggests these metrics are important for providing researchers with a compendium to deploy in order to capture resilience. However, the causation or correlation between the metrics and resilience is beyond the scope of our work.

Another clear distinct group of metrics is broadly connected under the theme of amenities. From a regional economic perspective Graves (1980) and more recently Partridge (2012) acknowledged that amenities led to migration and growth a clear link to the resilience of a place. The work of Beynon et al (2016) finds that amenities can be broken into physical and social to better understand the rurality of a region. We identify 57 amenity metrics that can be further classified into physical and social. Beynon et al (2016), noted that it is possible to see changes in social amenities however physical amenities are slow if not impossible to change. Therefore, these metrics often provide limited help in measuring impacts or change as a result of shocks but could still provide longer term explanations of resilience.

Cluster analysis-based resilience metrics

The bibliographic cluster analysis identified 3 distinct groups of metrics (Figure 3). The associated descriptive details of these configurations can be found in Table 3. Cluster 1 encompasses various aspects related to demographics, economics and infrastructure, collectively referred to as "community development". Cluster 2, "economic development", includes economic activities, research and development, and employment dynamics. Cluster 3, "economic performance", largely includes metrics linked to macroeconomic conditions and governance.

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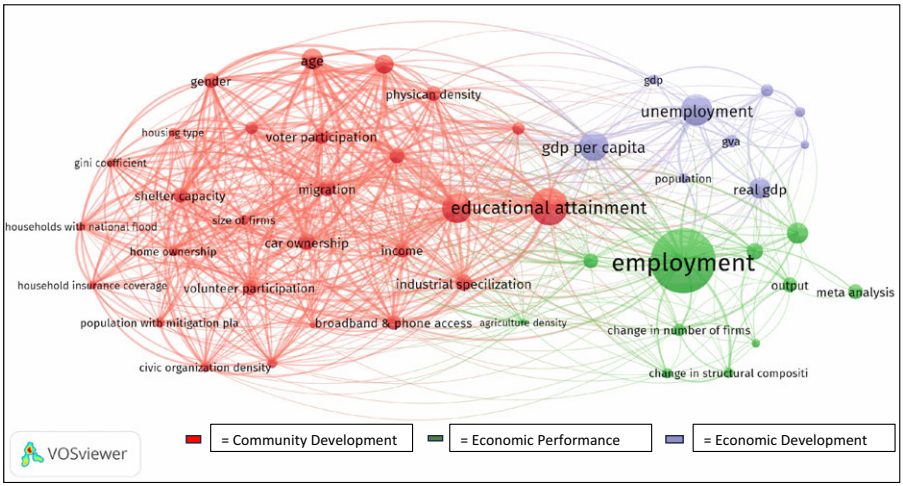


Figure 3. Clusters of unique metrics associated with resiliency.

This relatively novel clustering exercise has allowed us to break the traditional ad hoc approach of linking what appear to be like-for-like metrics together and instead allow the co-association of metrics from existing studies to be identified (see table 3). Each of the clusters are multidimensional in terms of the metrics having spatial and temporal aspects present in the different scales of data. For example, the community development cluster contains physical metrics such as "housing type" but also migration dynamics. The commonality, albeit identified from metrics being utilized together in studies, provides us with the opportunity to rethink how to link the definitions and metrics of resilience. Taking the definitions in the work of Martin (2012) it is possible to link the identified clusters to three distinct definition, engineering, ecological and adaptive resilience. The economic performance cluster very much aligns to the concept of engineering resilience, that is macroeconomic metrics that have the ability to measure how a region can withstand shocks. The community development cluster links well to the idea of ecological resilience, metrics that cover multiple domains from the physical to the social that focus on stability. Finally, the economic development cluster, with its metrics on entrepreneurial culture, change in firms and research and development neatly supports the adaptive definition of resilience.

Conclusions

Studying regional economic resilience has grown in popularity, with the volume of new papers on the topic that we identified reaching a peak in 2018. However, defining the concept of resilience is still a source of debate. We address this head on by tracing the roots of the subject back to both an economic and ecological and disaster management perspective. Our approach identified resilience metrics, rather than simply a single definition, with a goal of providing a comprehensive compendium of regional economic resilience measures. After significant sorting and filtering our analysis of the final 98 papers identified 202 unique metric that we then classified into 15 broad groups to highlight the connectedness across the sphere of categorizing and measuring resilience.

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Table 3. Summary of metrics from cluster analysis

Metric	Resilience Category	Cluster	Number of Papers Including Metric	Weight of Links[a]	Total Link Strength[b]
Educational Attainment	Demographics	Community Development	18	42	111
Industrial Employment	Industry	Community Development	14	36	109
Age	Demographics	Community Development	10	32	108
Labor Force Participation	Employment	Community Development	9	35	99
Car Ownership	Capital	Community Development	8	32	101
Industrial Specialization	Industry	Community Development	8	36	81
Migration	Migration	Community Development	8	32	96
Voter Participation	Demographics	Community Development	8	33	91
Broadband & Phone Access	Physical Amenities	Community Development	7	34	82
Gender	Demographics	Community Development	7	30	83
Income	Demographics	Community Development	7	34	74
Physician Density	Socio-Economic Amenities	Community Development	7	31	67
Population by Area	Population	Community Development	7	33	77
Shelter Capacity	Shelter Capacity	Community Development	7	30	95
Volunteer Participation	Demographics	Community Development	7	31	86
Accessibility and Quality of Road Networks	Physical Amenities	Community Development	6	26	49
Population Growth	Population	Community Development	6	30	65
Civic Organization Density	Socio-Economic Amenities	Community Development	5	29	57
Home Ownership	Capital	Community Development	5	30	82

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Table 3. (*Continued*)

Metric	Resilience Category	Cluster	Number of Papers Including Metric	Weight of Links[a]	Total Link Strength[b]
House Age	Capital	Community Development	5	30	61
Population with Mitigation Plans	Mitigation	Community Development	5	27	50
Size of Firms	Firms	Community Development	5	31	76
Gini Coefficient	Socio-Economic Amenities	Community Development	4	27	64
Household Insurance Coverage	Mitigation	Community Development	4	26	58
Households with National Flood Protection	Mitigation	Community Development	4	26	58
Housing Type	Physical Amenities	Community Development	4	28	60
Pervious Surface Density	Physical Amenities	Community Development	3	30	51
Employment	Employment	Economic Development	31	39	78
Industrial Specialization	Industry	Economic Development	10	18	29
Trade	Growth and Trade	Economic Development	8	15	22
Meta Analysis	Meta Analysis	Economic Development	7	3	4
Output	Growth and Trade	Economic Development	7	17	21
R&D Intensity/ Expenditure	Industry	Economic Development	7	34	43
Change in Number of Firms	Firms	Economic Development	6	19	28
Change in Structural Composition of Employment Change	Employment	Economic Development	5	9	16
Employee Skill Level	Employment	Economic Development	5	17	22
Entrepreneurial Culture	Firms	Economic Development	4	9	11
Agriculture Density	Physical Amenities	Economic Development	3	33	35

(*Continued*)

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Table 3. (*Continued*)

Metric	Resilience Category	Cluster	Number of Papers Including Metric	Weight of Links[a]	Total Link Strength[b]
Unemployment	Employment	Economic Performance	15	25	52
GDP Per Capita	Growth and Trade	Economic Performance	14	34	63
Real GDP	Growth and Trade	Economic Performance	10	914	22
GVA	Growth and Trade	Economic Performance	6	12	16
Inflation	Monies	Economic Performance	6	11	20
GDP	Growth and Trade	Economic Performance	5	14	17
Government Effectiveness	Economic Freedom Index	Economic Performance	5	12	16
Population	Population	Economic Performance	5	12	17
Policy Support & Policy Interference	Economic Freedom Index	Economic Performance	4	10	13

*The link strength is determined by the number of times the metrics are used with each other while the weight of the links is determined by the total number of times the metric is used.

We found that the metrics employed in a study vary greatly depending on whether a researcher starts from an economic viewpoint or whether they take an engineering or ecology perspective. However, regardless of the starting point, each study links specific metrics to broader, more overarching concepts of resilience. Output and employment were found to be the cornerstones of metrics used in early literature, while demographics and amenities have become more widely used in more recent studies. Amenities have also become a more prominent metric for comparing resilience in multiple locations although we note that not all amenities are necessarily the same.

The compilation and presentation of various definitions, categories, and metrics associated with resilience is useful for anyone wishing to study regional economic resilience. While the 202 unique metrics identified are not necessarily the only measures available, we argue that there are a much smaller group of core metrics that can support the analysis of different concepts of resilience. Our cluster analysis identified a unique subset of 47 metrics that fit into 3 separate categories (community development, economic development, economic performance). Going forward, further research should better understand what actually drives economic resilience and how it can be measured dynamically (e.g., Zhang et al, 2021 and Agnani et al, 2024).

A significant element not directly addressed in this paper is the multi-dimensionality of some resilience metrics. For example, metrics thought to be predictors of resilience in some studies are found not to in others (recent work by Tsiotas, 2022 goes into more detail on

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this issue). One important next step for resilience analysis would be to explore multiple conjunctional causal configurations of variables, using qualitative/quant techniques such as fuzzy set Qualitative Comparative Analysis (fsQCA).

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/age.2025.10010

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