

**SRIWIJAYA INTERNATIONAL JOURNAL OF DYNAMIC
ECONOMICS AND BUSINESS**
<http://ejournal.unsri.ac.id/index.php/sijdeb>

**Measuring Economic Resilience Across Selected economies:
A Multidimensional Entropy Weight Approach
and GIS-Based Spatial Analysis**

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Abstract: This study measures and compares economic resilience across 17 selected economies from 2015 to 2024 by constructing a multidimensional Economic Resilience Index (ERI). The index consists of nine indicators covering seven dimensions: economic, human, labour-market, financial, institutional, structural, and external capacities. Using secondary panel data, the ERI is developed through the Entropy Weight Method (EWM), while GIS analysis visualizes geographical differences and changes in resilience between 2015 and 2024. The results reveal substantial variation in resilience levels and dynamics across economies. Domestic Credit to the Private Sector receives the highest entropy weight, followed by Control of Corruption, Employment to Population Ratio, and Government Effectiveness, indicating the importance of financial, institutional, and labour-market factors. Based on the average ERI for 2015–2024, the United Arab Emirates records the highest resilience, followed by South Korea and Saudi Arabia. However, Saudi Arabia shows the largest improvement over the period, while Brazil experiences the greatest decline. GIS results further highlight clear geographical disparities in resilience. Overall, the findings confirm the multidimensional nature of economic resilience and underline the importance of stronger financial systems, institutions, labour markets, and productive structures for long-term economic adaptability. These results provide useful evidence for policymakers designing resilience-oriented development strategies globally.

Keywords: Economic Resilience Index, Entropy Weight Method, Spatial Analysis, Economic Resilience

Introduction

In recent decades, the global economy has faced increasingly complex forms of pressure, ranging from financial crises, supply chain disruptions, and geopolitical uncertainties to environmental changes. The concept of economic resilience has become increasingly

relevant in explaining the capacity of an economy to withstand, adapt to, and transform in response to both external and internal pressures (Martin and Sunley, 2020).

In its early development, studies on economic resilience were largely associated with the ability of a region to recover after experiencing economic shocks. However, recent perspectives view resilience as a broader capacity, referring to the ability of an economic system to absorb disturbances, adapt to changes, and undertake structural transformation in response to uncertain conditions. This perspective indicates that economic resilience is not solely determined by macroeconomic performance, but is also shaped by various structural factors, including human capital quality, labour market conditions, financial sector capacity, industrial development, and institutional quality (Huang et al., 2023). This broader conceptualization implies that reliance on a single economic indicator is insufficient to capture the multidimensional nature of resilience.

Composite indices provide a useful framework for integrating these different dimensions into a unified measure. Among the available weighting techniques, the Entropy Weight Method (EWM) offers a data-driven approach in which indicator weights are derived from the degree of informational variation observed in the data rather than predetermined subjective judgments. Ouyang et al. (2025) for example, employed EWM to construct a cross-country economic resilience index and demonstrated the relevance of economic scale in countries' responses to international crises. Nevertheless, the objectivity of EWM should be interpreted with caution. A larger entropy weight indicates greater variation and discriminatory information within the sample, but does not necessarily imply greater theoretical importance or a causal effect on resilience. For this reason, the present study uses theoretical and empirical literature to guide indicator selection, while EWM is employed specifically to determine their relative statistical weights within the composite index.

Despite the growing literature, several important gaps remain. First, much of the empirical evidence has been generated at the regional, provincial, or city level, while systematic cross-country analysis remains comparatively limited. Recent studies examining Chinese cities and OECD regions have provided valuable evidence on spatial and temporal variations in resilience, but their subnational focus limits understanding of whether similar patterns arise across heterogeneous national economies. At the cross-country level, Ouyang et al. (2025) provide important evidence based on 47 countries; however, their framework primarily emphasizes resistance and recovery capacities in relation to international crises. There therefore remains scope for a broader multidimensional framework incorporating financial, institutional, human, labour-market, structural, and external capacities.

Second, existing resilience measures differ considerably in their conceptual dimensions, indicator selection, and weighting procedures. Such methodological heterogeneity may reduce comparability across studies and obscure the relative contribution of the structural capacities represented in a composite index. Although recent entropy-based studies illustrate the value of objective weighting procedures, national-level applications that combine a broad multidimensional structure with explicit financial, institutional, labour-market, human, structural, and external dimensions remain relatively limited.

Third, the geographical dimension of cross-country economic resilience remains underexplored. Increasing integration through trade, investment, financial flows, and global production networks means that national economies operate within an increasingly

interconnected global environment. Differences in resilience may consequently display identifiable geographical patterns, including concentrations of relatively high or low ERI values across regions. GIS-based spatial analysis can complement conventional index measurement by visualizing these geographical disparities and how they evolve over time. In this study, GIS is used as a descriptive spatial tool rather than as a spatial econometric technique, thereby providing geographical context to the cross country ERI comparison.

Against this background, the empirical analysis covers 17 selected economies: the United Arab Emirates, South Korea, Saudi Arabia, Poland, Malaysia, China, Vietnam, Thailand, Hungary, Indonesia, Türkiye, Brazil, Greece, Mexico, the Philippines, India, and Egypt. The sample was purposively selected based on three criteria: (1) the availability of sufficiently complete and comparable annual data for all nine indicators over 2015-2024; (2) geographical representation across Asia, the Middle East, Europe, and Latin America; and (3) sufficient heterogeneity in financial development, institutional quality, labour-market conditions, human development, productive structure, and external sector characteristics to enable meaningful cross-country comparison.

This study contributes to the literature in three respects. First, it develops a multidimensional Economic Resilience Index (ERI) integrating seven complementary dimensions and nine indicators within a cross-country framework. Second, it examines temporal changes in the ERI and evaluates indicator-level contributions associated with these changes, enabling the sources of improvement or deterioration in the composite index to be identified more transparently. Third, it incorporates GIS-based spatial analysis to visualize geographical disparities and changes in economic resilience between 2015 and 2024. By integrating multidimensional measurement, temporal comparison, indicator-level decomposition, and geographical visualization, the study provides a comprehensive framework for assessing economic resilience across heterogeneous economies.

Literature Review

Conceptual Foundations of Economic Resilience

Economic resilience has emerged as an increasingly important concept in understanding how economies respond to various external shocks, including financial crises, geopolitical tensions, supply chain disruptions, and environmental challenges. While early studies primarily viewed resilience as the ability of an economy to absorb disturbances and return to its pre-shock equilibrium, more recent literature emphasizes resilience as a dynamic process involving adaptation, learning, and structural transformation (Briguglio et al., 2009; Sensier et al., 2016).

The conceptual foundation of resilience originates from ecological studies introduced by Holling (1973) who defined resilience as the capacity of a system to maintain its fundamental functions when exposed to disturbances. This concept was subsequently adopted in regional economic literature to explain how regions or countries respond to various shocks and changes that influence economic activities.

The development of resilience studies was further influenced by the emergence of the evolutionary resilience perspective introduced by Martin and Sunley (2015). Unlike the earlier approach that focused on the ability of an economic system to return to its previous condition after a crisis (bounce back), this perspective emphasizes the ability of an economy to adapt, adjust its structure, and create new growth pathways (bounce forward). Therefore, economic resilience is viewed as a continuous and dynamic process that changes along with the development of the economic environment.

In the evolutionary resilience perspective, economic resilience consists of four main dimensions: resistance, recovery, adaptation, and transformation (Martin and Sunley, 2015, 2020). Resistance refers to the ability of an economy to reduce the impact of shocks and avoid a large decline in economic performance. Recovery describes the ability of an economy to return to growth after facing disruption. Adaptation refers to the ability to adjust to changes by using available resources and responding to new conditions. Transformation refers to the ability to make structural changes, develop new economic sectors, and create a stronger foundation for future growth. These four dimensions show that economic resilience is not only about surviving economic shocks but also about improving and developing through adjustment, innovation, and structural change.

These theoretical perspectives provide the conceptual basis for the multidimensional framework adopted in this study. Resistance and recovery are reflected in dimensions related to economic performance, labour-market stability, financial capacity, and external conditions, while adaptation and transformation are associated with human development, institutional quality, and productive structure. Accordingly, the seven dimensions used in this study are treated as complementary capacities that collectively shape economic resilience rather than as independent causal determinants.

Briguglio et al. (2009) identified four main components in the index, namely macroeconomic stability, microeconomic market efficiency, good governance, and social development. Their framework argues that resilience depends not only on economic performance but also on institutional effectiveness and social capabilities. However, the framework was developed primarily for small states and therefore may not fully capture the broader structural characteristics influencing resilience in larger and more diverse economies. Subsequent studies have expanded the resilience concept by incorporating labour market conditions, financial development, industrial structure, and external sector performance (Martin & Sunley, 2020; Pascariu et al., 2021).

Taken together, the literature suggests that economic resilience is a multidimensional and evolving concept that extends beyond economic stability alone. Despite growing consensus regarding its key dimensions, there remains considerable variation in how resilience is measured and operationalized. This lack of standardization highlights the need for a more comprehensive framework that integrates economic, social, institutional, financial, and structural capacities into a unified measure of resilience.

Construction of the Economic Resilience Index

In line with the evolution of the economic resilience concept, its measurement has shifted from single-indicator approaches toward multidimensional frameworks. Existing studies suggest that the complexity of economic systems cannot be adequately captured by a single indicator because resilience involves multiple interrelated capacities that jointly influence the ability of an economy to withstand, recover from, and adapt to disturbances (Martin & Sunley, 2020; Rose & Krausmann, 2013). Consequently, composite indices have increasingly been used to integrate economic, social, institutional, financial, and structural dimensions within a unified measurement framework.

Several composite indices have subsequently been developed. Briguglio et al. (2009) proposed a resilience framework based on macroeconomic stability, market efficiency, governance, and social development. More recent studies have expanded the scope of resilience measurement by incorporating labour market conditions, financial sector development, industrial diversification, and external sector vulnerability (Di Tommaso et al., 2023; Pascariu et al., 2021). Despite these advances, no universally accepted framework currently exists. Different studies employ different dimensions and indicators depending on data availability, geographical coverage, and theoretical perspectives. This inconsistency creates difficulties when comparing resilience performance across countries and time periods.

Another limitation in the existing literature concerns the overemphasis on either economic indicators or institutional factors. Some studies focus heavily on macroeconomic stability while neglecting human capital and labour market conditions. Others prioritize governance quality but pay limited attention to financial and structural capacities. Consequently, resilience assessments may provide only a partial understanding of the different capacities that support an economy in responding to shocks.

The weighting procedure also represents an important methodological issue in composite index construction. The Entropy Weight Method (EWM) provides a data-driven alternative to subjective weighting because indicator weights are determined by their informational variation within the observed data. Recent studies have increasingly applied entropy-based approaches to construct multidimensional resilience indices (Hou et al., 2023; Ouyang et al., 2025). However, a higher entropy weight should not be interpreted as evidence that an indicator is theoretically or causally more important. Rather, it indicates that the indicator provides greater statistical differentiation within the sample. Therefore, theoretically grounded indicator selection remains necessary, while EWM is used in this study specifically to determine relative informational weights.

This distinction is important because the use of EWM does not eliminate the need for a theoretically justified indicator framework. Instead, the method complements theory-based indicator selection by assigning weights according to the amount of information contained

in each indicator. In this way, the construction of the ERI combines theoretical relevance with a relatively objective weighting procedure.

Recent Empirical Evidence on Economic Resilience

Recent empirical studies indicate that economic resilience varies considerably across geographical scales and methodological approaches. At the subnational level, Huang et al. (2023) documented substantial spatial and temporal variation in economic resilience across Chinese cities and highlighted the importance of structural and institutional conditions in explaining differences in resilience performance. Similarly, Hou et al. (2023) constructed a multidimensional regional economic resilience index for 283 Chinese cities using an entropy-based method and found that financial development can strengthen resilience through improved capital allocation, innovation, and consumption channels. These studies demonstrate the usefulness of multidimensional measurement but remain primarily focused on regional and city-level contexts.

Recent evidence also emphasizes the importance of productive structure and spatial configuration. Giannakis et al. (2024) show that sectoral interconnectedness contributes to regional economic resilience across European regions, indicating that the structure of economic linkages can influence the ability of regions to respond to negative shocks. Likewise, Kim & Kim (2025) find that spatial structures and urban core configurations are associated with heterogeneous resilience outcomes across OECD regions. These findings reinforce the view that resilience is not evenly distributed across space and that geographical and structural characteristics provide additional information beyond conventional macroeconomic indicators.

At the cross-country level, Ouyang et al. (2025) construct economic resilience measures for 47 countries using an entropy-based framework and distinguish between resistance and recovery capacities in response to international crises. Their findings provide important evidence that economic scale and structural characteristics are associated with differences in national resilience. However, their framework primarily focuses on crisis-related resistance and recovery, while broader dimensions related to human, institutional, labour-market, financial, structural, and external capacities remain less explicitly integrated.

Taken together, recent empirical studies support the use of multidimensional and spatial approaches to economic resilience. However, the existing evidence remains fragmented across different geographical scales, indicator systems, and methodological frameworks. Much of the literature continues to focus on regional or city-level analyses, while cross-country studies frequently emphasize specific crisis-response capacities. This provides an empirical basis for constructing a broader national-level ERI that integrates multiple structural capacities and complements the index with GIS-based spatial analysis.

Selection of the Seven Dimensions of Economic Resilience

To address these limitations, this study develops an Economic Resilience Index (ERI) based on seven complementary dimensions: economic capacity, human capacity, labour market capacity, financial capacity, institutional capacity, structural capacity, and external capacity. These dimensions were selected based on three considerations: their theoretical relevance to economic resilience, their recurrent use or empirical support in previous studies, and the availability of comparable annual cross-country data over the study period (Briguglio et al., 2009; Martin and Sunley, 2020; Pascariu et al., 2021).

Economic capacity is represented by GDP growth, reflecting the ability of an economy to maintain output performance and recover from adverse economic conditions. Although GDP growth alone cannot capture resilience comprehensively, it remains relevant for evaluating short-term economic performance and recovery capacity. Human capacity is measured using the Human Development Index (HDI), which captures the role of education, health, and income in enhancing adaptive capacity and supporting long-term resilience (Afolabi and Raifu, 2025). Labour market capacity is measured through the unemployment rate and employment-to-population ratio, as labour market stability is frequently associated with economic resistance and recovery processes (Kim and Kim, 2025).

Financial capacity is represented by domestic credit to the private sector (% GDP), which reflects the ability of the financial system to support productive investment and facilitate economic adjustment during periods of disruption. Nguyen & Su (2021) highlight the role of financial development in reducing the adverse effects of economic shocks. More recent evidence also indicates that financial development can contribute to economic resilience by improving capital allocation and supporting innovation and productive activity (Hou et al., 2023).

Institutional capacity is captured through government effectiveness and control of corruption. According to Pascariu et al. (2021) these indicators reflect the quality of governance and the ability of public institutions to design and implement policies that support economic stability and resilience. Structural capacity is measured using industry value added (% GDP), representing the contribution of the industrial sector to economic activity and long-term transformation. Di Tommaso et al. (2023) argue that a strong industrial base can enhance a country's capacity to sustain production and adapt to economic change. External capacity is represented by the current account balance (% GDP), which indicates a country's ability to cope with external economic pressures and reduce dependence on foreign financing. Briguglio et al. (2009) suggest that stronger external balances contribute to greater resilience against global economic shocks.

Taken together, these seven dimensions provide a multidimensional framework for assessing economic resilience. The framework incorporates short-term economic performance as well as the financial, human, labour market, institutional, structural, and external capacities that support resistance, recovery, adaptation, and transformation. Importantly, these indicators are not treated as independent causal determinants of resilience; rather, they represent complementary components used to construct the composite ERI.

Table 1. **Conceptual Framework and Measurement Indicators of ERI**

Dimension	Indicator	Measurement	Direction	Data Source
Economic Capacity	GDP Growth	Annual %	+	WDI
Human Capacity	Human Development Index (HDI)	Index	+	UNDP
Labour Market Capacity	Employment-to-Population Ratio	% Population Age 15+	+	ILO
Labour Market Capacity	Unemployment Rate	% Total Labor Force	-	ILO
Financial Capacity	Domestic Credit to Private Sector	% GDP	+	WDI
Institutional Capacity	Government Effectiveness	Score	+	WGI
Institutional Capacity	Control of Corruption	Score	+	WGI
Structural Capacity	Industry Value Added	% GDP	+	WDI
External Capacity	Current Account Balance	% GDP	+	IMF

Methods

This research seeks to evaluate and illustrate the dynamics of economic resilience among Selected economies over the period 2015-2024 by developing an Economic Resilience Index (ERI). The index integrates seven dimensions that represent different aspects of resilience, including economic capacity, human development, labour market conditions, financial capacity, institutional strength, economic structure, and external sector capacity.

The ERI is calculated using the Entropy Weight Method (EWM), which assigns indicator weights based on the level of information and variation provided by each indicator in the dataset. This method helps reduce the influence of subjective judgments commonly found in conventional weighting approaches. Moreover, EWM has been widely adopted in composite index studies, particularly in the areas of economic resilience and sustainable development, due to its ability to provide a more objective representation of multidimensional characteristics.

The construction of the ERI consists of three main stages: data normalization, entropy weight calculation, and composite index development. Since the selected indicators have different measurement units and value ranges, all variables are first standardized using the Min-Max normalization method. To ensure comparability across countries and over time, the minimum and maximum values for each indicator are determined from the entire pooled sample of 170 country year observations, covering 17 economies over the 2015-2024 period, rather than being calculated separately for each year. This procedure places all observations on a common reference scale over the study period.

For indicators that have a positive relationship with economic resilience, the normalization process is conducted using the following equation:

$$Z_{ij} = \frac{X_{ij} - X_{jmin}}{X_{jmax} - X_{jmin}} \quad (1)$$

where X_{ij} represents the original value of indicator j for country-year observation i , while X_{min} and X_{max} denote the minimum and maximum values of indicator j observed across the entire pooled sample. The normalized value Z_{ij} ranges from 0 to 1, with higher values representing relatively stronger resilience capacity for the respective indicator.

In contrast, the unemployment rate is treated as a negative indicator because higher unemployment reflects weaker labour market resilience. Its normalization is therefore reversed:

$$Z_{ij} = \frac{X_{jmax} - X_{ij}}{X_{jmax} - X_{jmin}} \quad (2)$$

This transformation ensures that all normalized indicators have the same directional interpretation, such that a higher normalized value consistently represents a more favorable condition for economic resilience. After normalization, the proportion of each country year observation for indicator (j) is calculated as:

$$P_{ij} = \frac{Z_{ij}}{\sum_{i=1}^n Z_{ij}} \quad (3)$$

The entropy value of each indicator is subsequently calculated using:

$$e_j = -\frac{1}{\ln(n)} \sum_{i=1}^n P_{ij} \ln P_{ij} \quad (4)$$

where n represents the total number of country-year observations in the pooled dataset ($n=170$). When $P_{ij} = 0$, the term $P_{ij} \ln P_{ij}$ is conventionally treated as zero. The degree of diversification, which represents the information utility of each indicator, is then obtained as:

$$d_j = 1 - e_j \quad (5)$$

The entropy weight assigned to indicator j is calculated as:

$$\omega_j = \frac{d_j}{\sum_{j=1}^s d_j} \quad (6)$$

$$ERI = \sum_{j=1}^s Z_{ij} \omega_j \quad (7)$$

where ERI represents the Economic Resilience Index for country year observation, Z_{ij} denotes the normalized value of indicator j , and ω_j represents the entropy derived weight assigned to indicator j . Here, (s) denotes the total number of indicators included in the index ($s=9$). The same set of entropy weights, estimated from the full pooled sample, is applied consistently to all country year observations. Consequently, the resulting ERI values are comparable across countries and over time, with higher values indicating relatively stronger economic resilience (Huang et al., 2023).

To complement the composite index analysis, this study employs a Geographic Information System (GIS) based spatial approach using ArcGIS to visualize the geographical distribution and temporal changes in economic resilience. ERI values are mapped for two benchmark years, 2015 and 2024, allowing the spatial distribution of economic resilience at the beginning and end of the study period to be compared. This approach facilitates the identification of cross-country disparities and geographical patterns in economic resilience and provides a visual assessment of how resilience levels evolved over the study period. GIS based visualization has been widely applied in economic development and regional resilience research because it provides an effective means of identifying geographical patterns that may be less apparent from conventional tabular or statistical analysis alone (Xie et al., 2021).

Findings

Entropy-Based Weighting and Ranking of Economic Resilience Indicators

The entropy weighting results indicate that each indicator contributes differently to the formation of the Economic Resilience Index (ERI). The variation in indicator weights reflects differences in the amount of information provided by each indicator. Indicators with higher weights contain greater information variability, making them more influential in distinguishing differences in economic resilience levels across countries (Karagiannis and Karagiannis, 2020).

Based on the estimation results presented in Table 2, DCPS receives the largest entropy weight 0.2833, indicating that it provides the greatest statistical differentiation across the pooled observations. This finding highlights the relevance of financial capacity in differentiating economic resilience across the selected economies. The relatively large entropy weight assigned to financial capacity in the present study is broadly consistent with Sun & Chen (2025), who demonstrate that financial development plays an important role in strengthening regional economic resilience. Their study similarly employs the Entropy Weight Method to construct a multidimensional resilience index, providing further empirical support for incorporating financial capacity into resilience measurement.

Table 2. Entropy-Based Weights and Ranking of Economic Resilience Indicators

Indicator	Entropy (ej)	dj =1-ej	Weight	Rank
DCPS	0,9351	0,0649	0,2833	1
Control of Corruption	0,9630	0,0370	0,1616	2
Employment-to-Population Ratio	0,9724	0,0276	0,1205	3
Government Effectiveness	0,9747	0,0253	0,1102	4
HDI	0,9771	0,0229	0,1000	5
Industry Value Added	0,9783	0,0217	0,0946	6
Current Account Balance	0,9863	0,0137	0,0600	7
GDP Growth	0,9904	0,0096	0,0420	8
Unemployment	0,9936	0,0064	0,0278	9

Control of Corruption receives the second-largest entropy weight 0.1616, followed by the Employment to Population Ratio 0.1205 and Government Effectiveness 0.1102. These results indicate that institutional and labour market dimensions also provide substantial statistical differentiation in economic resilience across the selected economies. The relatively prominent role of institutional indicators is consistent with Beirne and Panthi (2025) who find that stronger institutional quality supports macro financial resilience during periods of elevated financial stress. This relationship is further supported by Khan et al. (2022), who show that institutional quality promotes financial-sector development across emerging and developing economies, particularly through improvements in control of corruption and government effectiveness. Together, these studies support the present finding that financial and institutional dimensions are closely associated with differences in economic resilience across economies.

Meanwhile, the Employment to Population Ratio indicates that resilience is not solely determined by macroeconomic stability but also by the capacity of an economy to generate employment opportunities. A stronger labour absorption capacity provides a more stable social foundation, enabling economies to better withstand economic volatility.

HDI obtain weights of 0.1000, indicate that higher human development strengthens economic flexibility. This finding is consistent with Ye et al. (2025) who find that human capital significantly enhances economic resilience and technological innovation serves as an important mechanism through which human capital contributes to resilience. Furthermore, Industry Value Added, with a weight of 0.0946, highlights the contribution of the industrial sector in promoting economic diversification and reducing vulnerability to external changes. This finding is broadly consistent with Tan et al. (2020), who demonstrate that industrial structure is an important component of regional economic resilience and find that industrial diversification can strengthen resilience in resource based economies. Although their analysis is conducted at the regional level, the evidence supports the inclusion of productive structure as an important dimension of economic resilience.

In contrast, GDP Growth receives a relatively low entropy weight 0.0420, while Current Account Balance and Unemployment Rate receive weights of 0.0600 and 0.0278, respectively. These relatively low weights indicate that these indicators provide less statistical differentiation across the pooled observations compared with financial, institutional, and labour market indicators. Therefore, the results should not be interpreted as implying that economic growth or macroeconomic conditions are unimportant for resilience. This interpretation is consistent with Ouyang et al. (2025), who conceptualize economic resilience as a multidimensional phenomenon encompassing resistance and recovery capacities and construct a composite resilience index using a broad set of economic and structural indicators. Recent cross-country evidence also shows that economic resilience is associated not only with output dynamics but also with external and financial conditions, including trade openness, exchange-rate flexibility, current-account positions, and financial development.

This further supports a multidimensional interpretation of economic resilience that extends beyond short-term economic performance.

Cross-Country Comparison of Economic Resilience Index (ERI)

Table 3 presents the Economic Resilience Index (ERI) performance of the 17 selected economies based on their ERI values in 2015 and 2024, average ERI over the 2015-2024 period, changes between the two benchmark years, and rankings based on the average ERI. The results reveal considerable heterogeneity in both the level and dynamics of economic resilience across the selected economies. Based on the average ERI, the United Arab Emirates ranks first with the highest average value of 0.5264, followed by South Korea 0.4195 and Saudi Arabia 0.3885. This pattern is broadly consistent with previous empirical evidence emphasizing the importance of financial, institutional, and structural capacities in strengthening economic resilience. In the cases of Saudi Arabia and the UAE, economic diversification and institutional reforms have been identified as important elements of resilience to external and oil-related shocks (Almutairi et al., 2024). Similarly, South Korea highlights the importance of sustained investment in human capital, technological innovation, and industrial development in building stronger economic resilience (OECD, 2023).

The change in ERI between 2015 and 2024 provides an additional perspective on the dynamics of economic resilience. Saudi Arabia recorded the largest improvement, with an increase of 0.1223, followed by Greece 0.0648 and the United Arab Emirates 0.0554. South Korea 0.0419, Vietnam 0.0312, and India 0.0283 also experienced notable improvements. These findings demonstrate that the level of resilience and the pace of improvement represent two distinct aspects of economic resilience. For example, while the UAE records the highest average ERI over the study period, Saudi Arabia exhibits the largest improvement between 2015 and 2024. Similarly, Greece ranks relatively low in terms of average ERI (13th) but records the second-largest increase, indicating a substantial improvement from its initial resilience level.

In contrast, Brazil experienced the largest decline in ERI, decreasing by 0.0670 between 2015 and 2024, followed by Thailand -0.0257, Türkiye -0.0222, Egypt -0.0163, and the Philippines -0.0057. These declines indicate that resilience trajectories are not uniform across economies and that relatively favorable performance in some dimensions may not necessarily compensate for weaknesses in others. Brazil, for example, ranks 12th based on its average ERI despite having a relatively higher ERI in 2015, reflecting a deterioration in its resilience position over the study period. Thailand similarly maintains a comparatively higher average ERI (ranked 8th) but exhibits a declining trajectory between the two benchmark years. This condition suggests that economic growth alone does not necessarily lead to stronger resilience unless it is supported by institutional improvement, policy stability, and greater production diversification.

Meanwhile, Indonesia recorded a moderate increase in ERI from 0.2683 in 2015 to 0.2843 in 2024, representing an improvement of 0.0160, and ranks 10th based on its average ERI of 0.2838. China and Hungary also show relatively stable resilience levels, with comparatively small changes of 0.0074 and 0.0026, respectively. Overall, the results indicate that a high average level of economic resilience does not necessarily correspond to the largest improvement over time. Therefore, the average ERI provides an indication of the overall resilience level maintained during 2015-2024, while the change in ERI captures the direction and magnitude of resilience dynamics between 2015 and 2024. This distinction provides a more comprehensive assessment of cross-country differences in economic resilience.

Table 3. **Economic Resilience Performance, Changes, and Country Rankings**

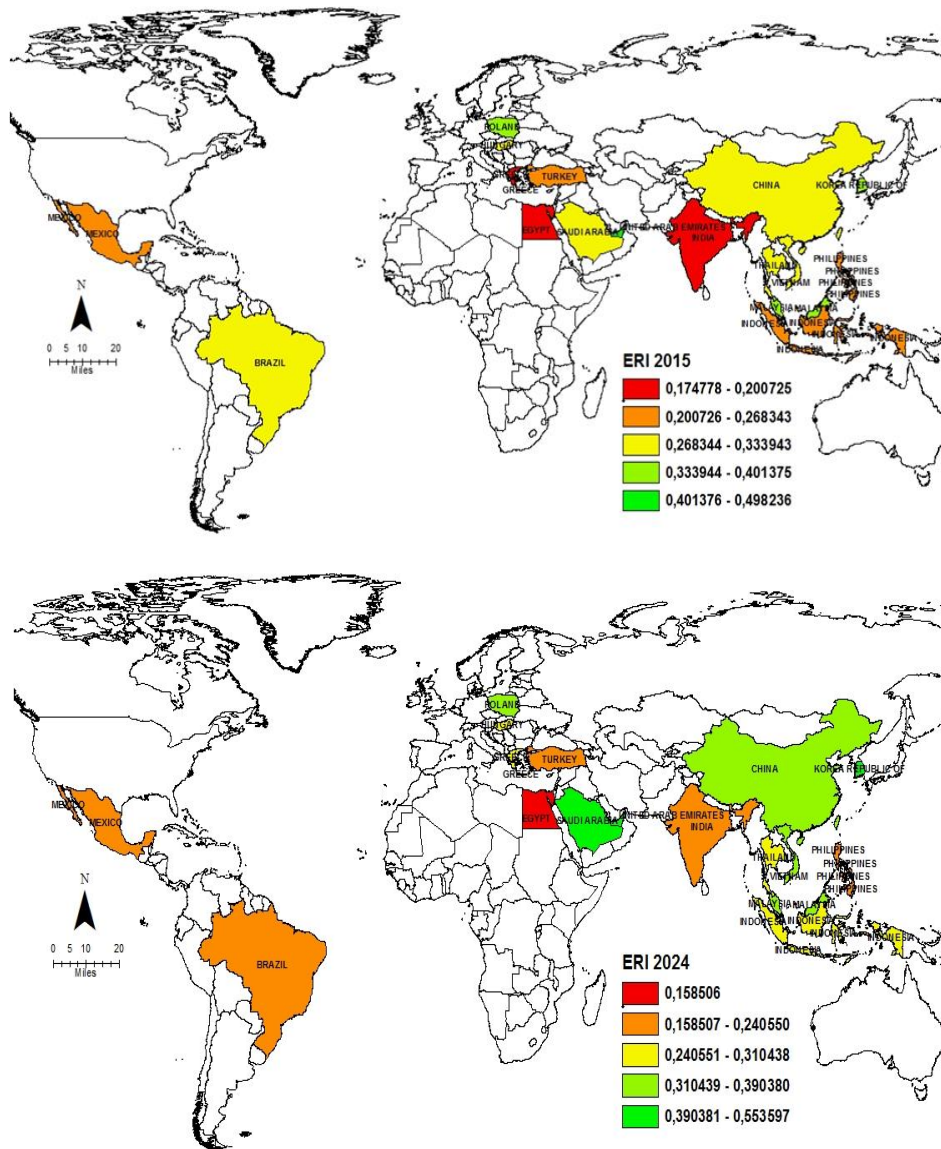
Country	ERI 2015	ERI 2024	Average ERI 2015-2024	Change 2024-2015	Average ERI Rank
United Arab Emirates	0,4982	0,5536	0,5264	0,0554	1
South Korea	0,4014	0,4433	0,4195	0,0419	2
Saudi Arabia	0,3192	0,4415	0,3885	0,1223	3
Poland	0,3729	0,3903	0,3799	0,0175	4
Malaysia	0,3684	0,3900	0,3737	0,0216	5
China	0,3339	0,3414	0,3404	0,0074	6
Vietnam	0,3190	0,3502	0,3357	0,0312	7
Thailand	0,3249	0,2991	0,3176	-0,0257	8
Hungary	0,3079	0,3104	0,3093	0,0026	9
Indonesia	0,2683	0,2843	0,2838	0,0160	10
Turki	0,2507	0,2286	0,2436	-0,0222	11
Brazil	0,3076	0,2405	0,2420	-0,0670	12
Greece	0,2007	0,2656	0,2361	0,0648	13
Mexico	0,2229	0,2330	0,2265	0,0100	14
Philippine	0,2398	0,2340	0,2260	-0,0057	15
India	0,1898	0,2181	0,1991	0,0283	16
Egypt	0,1748	0,1585	0,1707	-0,0163	17

Note: Average ERI represents the mean annual ERI over 2015–2024. Change is calculated as ERI 2024-ERI 2015. Rankings are based on the average ERI, with a higher average ERI indicating a higher level of economic resilience over the study period.

Spatial Distribution and Regional Patterns of Economic Resilience

Figure 1 presents the spatial distribution of the Economic Resilience Index (ERI) among selected economies in 2015 and 2024. The spatial comparison between the two periods highlights several important patterns. First, the overall level of economic resilience shows a positive movement, as several countries experienced improvements in their ERI classification by 2024. This pattern suggests that many economies have made progress in strengthening their capacity to adjust and respond to economic disturbances and external pressures.

Figure 1. Spatial Map of Changes in ERI Levels 2015 and 2024



Second, the GIS visualization reveals visible geographical differences in the distribution of higher and lower ERI values. In both observation years, relatively high ERI values are observed among several East Asian and Middle Eastern economies, particularly the United Arab Emirates, South Korea, Saudi Arabia, China, and Vietnam. These descriptive geographical patterns are broadly consistent with the cross country results and indicate that relatively stronger resilience is associated with a combination of financial capacity, institutional quality, labour market capacity, and productive structure. However, these geographical patterns should be interpreted descriptively and do not constitute evidence of statistically significant spatial clustering, as the present study does not employ spatial autocorrelation or spatial econometric tests.

Third, changes in ERI reveal heterogeneous resilience trajectories across the selected economies. Saudi Arabia recorded the largest increase in ERI between 2015 and 2024

+0.1223, followed by Greece +0.0648 and the United Arab Emirates +0.0554. In contrast, Brazil experienced the largest decline -0.0670, followed by Thailand -0.0257 and Türkiye -0.0222. These differences reinforce the finding that the level of resilience and the magnitude of improvement are distinct aspects of economic resilience. While several economies with relatively high average ERI values also experienced improvements, some lower-ranked economies, such as Greece, recorded substantial gains over the study period. Overall, the spatial visualization complements the composite-index analysis by illustrating the geographical distribution and temporal changes in economic resilience, while highlighting the heterogeneous resilience trajectories observed across the selected economies.

Conclusion

This study demonstrates that economic resilience across the selected economies is a multidimensional phenomenon shaped by the interaction of economic, human, labour-market, financial, institutional, structural, and external capacities. The EWM results indicate that financial, institutional, and labour-market dimensions provide substantial statistical differentiation in the construction of the ERI. At the country level, the findings reveal considerable variation in both the overall level and dynamics of resilience, with some economies maintaining relatively strong resilience while others show substantial improvement or deterioration over the study period. The GIS-based visualization further highlights visible geographical differences in resilience across the selected economies, although these patterns are descriptive and should not be interpreted as evidence of statistically significant spatial clustering.

Overall, the findings reinforce the importance of viewing economic resilience beyond short-term economic performance and emphasize the combined role of financial capacity, institutional quality, labour-market conditions, human development, productive structure, and external stability. This study is limited by the selected indicators included in the ERI and by the descriptive nature of the GIS analysis, which focuses on two benchmark years. Future research may extend the indicator framework by incorporating technological innovation, digital transformation, environmental capacity, and climate-related resilience, as well as applying spatial autocorrelation tests or spatial econometric models to examine cross-country dependence and spillover effects.

The findings provide several policy implications for strengthening economic resilience. Given the relatively prominent role of financial capacity in differentiating ERI performance, policymakers should promote productive financial intermediation and improve private-sector access to finance while maintaining financial stability. The importance of institutional indicators further suggests that financial development should be accompanied by improvements in government effectiveness, transparency, and corruption control. In addition, strengthening labour absorption, human capital, and productive capacity can support economies in adapting to structural changes and external shocks. For economies with relatively low or declining ERI, policy priorities should therefore focus on addressing weaknesses across multiple dimensions rather than relying primarily on short-term economic

growth. An integrated resilience strategy combining financial development, institutional strengthening, employment creation, human-capital development, productive transformation, and external-sector stability may provide a more sustainable foundation for long-term economic adaptability.

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