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ANDRIUS MONTRIMAS

IMPACT OF CHANGES IN INDUSTRIAL PORTFOLIO ON RESILIENCE OF COUNTRIES TO ECONOMIC SHOCKS

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Norėčiau, kad šis darbas būtų naudojamas.

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LIST OF ABBREVIATIONS

EC – European Commission
EU – European Union
EU countries/ EU economies:
- AUT – Austria
- BEL – Belgium
- BGR – Bulgaria
- HRV – Croatia
- CYP – Cyprus
- CZE – Czech Republic
- DNK – Denmark
- EST – Estonia
- FIN – Finland
- FRA – France
- DEU – Germany
- GRC – Greece
- HUN – Hungary
- IRL – Ireland
- ITA – Italy
- LVA – Latvia
- LTU – Lithuania
- LUX – Luxembourg
- MLT – Malta
- NLD – The Netherlands
- POL – Poland
- PRT – Portugal
- ROU – Romania
- SVK – Slovakia
- SVN – Slovenia
- ESP – Spain
- SWE – Sweden
- GBR – Great Britain (EU member state until January 2020)

FE – Fixed Effects
GDP – Gross Domestic Product
GVA – Gross Value Added
HHI – Hirschman-Herfindahl index
IC – Intermediate Consumption
IOT – Input-Output Table
ICIOT – Inter-Country Input-Output Table
IT – Information Technology
KSI – Krugman Specialisation Index
NAs – National Accounts
OECD – Organisation for Economic Co-operation and Development

OLS – Ordinary Least Squares
RE – Random Effects
R&D – Research and Development
SNA – System of National Accounts
UN – The United Nations
US – The United States of America
WoS DB – Web of Science Database

INTRODUCTION

Relevance of the research

The global economy is increasingly suffering from economic shocks that have been increasing in quantity and severity. Hundt and Grün (2022) portrayed the history of the modern economy as a history of disturbances and recessions induced by economic shocks. The global financial crisis of 2008 has increased research interest in addressing the negative effects of economic shocks. Martini (2020) highlighted a significant increase in the popularity of resilience in economic geography following the economic shock of 2008. The COVID-19 pandemic in 2020 further boosted the interest of scientists, along with the public sector, in researching resilience to economic shocks. Mascaretti et al. (2022) stressed that the restrictions on the economic environment during COVID-19 renewed attention on the importance of developing tools and frameworks to enable public institutions to mitigate the potential risks and consequences of economic shocks.

Shifts in the geopolitical situation in the global arena, together with the growing frequency of natural disasters, increasingly impact the global economy, which is constructed on the economic structures of national or regional economies worldwide. The properties of shocks, as well as their occurrences, are multidimensional and difficult to predict. According to Martini, 2020, economic shocks vary in severity, duration, and impact across different regions. Martin et al. (2016) discussed how different shocks can generate various reactions in economies. Economic shocks are also characterised by their tendency to spread easily from industry to industry and country to country (Pilinkienė et al., 2021). Mitigating or managing the possible consequences of an economic shock is a challenging task that involves many factors. Therefore, resilience is explored in science as an instrument for assessing how economic systems are affected by recessionary downturns (Martin, 2012).

Economic development consists of constantly alternating time intervals of economic growth and downturns. Challenges related to economic downturns are embedded in the very definition of economics, which is about the allocation and management of scarce resources. Early scientific research, along with early economic theories, such as those of Adam Smith (Manis, 2005), John Stuart Mill (Pelsa & Balina, 2021), and David Ricardo (Ricardo, 1821), was based on evidence from local environments and directed local economies towards efficiency and effectiveness. Neff (1949) argued for the necessity of efforts to address economic downturns at a global level because of the limited impact of local attempts to address the issue. According to Martini (2020), scientific discussions on resilience gained momentum among economists after the global financial crisis of 2008. Researchers encounter the task of investigating the same global economic issues in diverse settings, starting from Krugman's (1992) concept of "economic geography" and progressing to the theories and models of regional resilience proposed by Martin and Sunley (2015), Martin et al. (2016), Di Pietro et al. (2020), and Oprea et al. (2020). The exploration of regional resilience has advanced considerably, with studies becoming more comprehensive and detailed. Following the COVID-19 pandemic, an increasing number of resilience-measuring models have been introduced to investigate the impact of specific areas of economic activity on local or regional economic performance (Hundt & Grün, 2022; Pamucar et al., 2023; Delgado-Bello et al., 2023). Economy develops in cycles, and economic research is in a constant process of learning from information gathered from past events. On the other hand, the global economic environment constantly changes with the increasing global population (UNESCO, 2010; Carneiro Freire et al., 2019) and rapid technological advancements (Veseth, 2014; Milgrom, 2017; Loungani et al., 2017). Thus, formerly developed breakthrough resilience assessment methods and models, such as those of Solow (1956), Swan (1956), Romer (1986), and Mankiw et al. (1992), may require updating by applying contemporary information on regional economic performance. Meanwhile, the level of detail in the statistical information available today enables researchers to enhance resilience assessment capabilities beyond previous developments. Economic performance data from various nations worldwide (OECD, 2023) is now available at the level of detail of internationally standardised national accounts (NAs; Eurostat, 2023c).

Scientific problem and the extent of its investigation

Martin and Sunley (2015) described resilience as a highly complex and multifaceted process involving various interrelated factors. It is shock-dependent; a resilient region during one period could be non-resilient during the next (Martini, 2020). Martin and Gardiner (2019) stressed the growing scientific literature on resilience, although no generally agreed methodology for measuring it has been developed so far. Assessment of resilience is a complex process due to the diversity of the concept. Studies by Briguglio et al. (2009), Fingleton et al. (2012), Béné (2013), Martin and Gardiner (2019), Martini (2020), and Hundt and Grün (2022) highlight the specifics of economic, social, political, geographical, cultural, and territorial differences, as well as the abundance and variety of resilience-determining capacities and factors. Differences in the nature of economic shocks further increase resilience complexity. Economic growth is typically emphasised through the performance of selected industries in conventional resilience assessment models (Solow, 1956; Swan, 1956; Hundt & Grün, 2020; UNDRR, 2022a; UNDRR, 2022b).

European countries are characterised by unequal resilience (Cuadrado-Roura & Maroto, 2016); however, while there is a wide variety of literature on the topic for Western European states, Eastern European countries have rarely been assessed for their resilience in the literature (Oprea et al., 2020).

Research gap

There is extensive scientific literature on resilience studies at the regional level (Martin, 2012; Martin & Sunley, 2015; Martin et al., 2016; Martini, 2020; Di Pietro et al., 2020; Ženka et al., 2021), the organisational level (Mehta et al., 2024), and supply chain analyses at the microeconomic level (Echefaj et al., 2024).

There are resilience-measuring models developed for the assessment of communities when they face natural disasters (Tierney & Bruneau, 2007; Norris et al., 2008; Cutter et al., 2010; Renschler et al., 2010; UNDP, 2016). Complex resilience-measuring models have been developed for the assessment of regions or countries (Solow, 1956; Swan, 1956; Mankiw et al., 1992; Martin & Gardiner, 2019;

UNDRR, 2022a; UNDRR, 2022b) that concentrate on economic growth and the consumption side of the performance of the economic system. Profitability, employment, and growth are the main performance indicators, while qualitative factors of the local environment are utilised at the community level. According to Feldman et al. (2016), the concept of economic development is often blended with economic growth, which raises confusion in discussions on economic resilience among scientists and official institutions. Pelsa and Balina (2021) emphasised the increasing number of scientists who base their studies on economic growth rates, such as GDP, and exclude the true well-being of the economy and society from their studies.

The mainstream economic geography today is increasingly focused on green manufacturing and services, yet it still relies heavily on traditional growth paradigms (Schulz & Bailey, 2014). The severity of environmental crises has been increasing, and Lange et al. (2021) stressed the climate crisis as a particularly important topic for public discussion.

The research gap in resilience studies is the lack of a methodology that could be used to compare countries by their resilience to economic shocks through industrial portfolios while assessing the aims of development and sustainability of economies.

Research object

The impact of industrial portfolio changes on the resilience of different economies.

Aim of the research

To develop a methodology for evaluating resilience to economic shocks through changes in industrial portfolios and empirically validate it using the EU case.

Research objectives

1. To analyse the concepts of resilience to economic shocks and theoretical insights into the impact of industrial portfolios and other related factors.
2. To determine the current methods used to evaluate resilience to economic shocks.
3. To assess the applicability of the industrial portfolio approach for measuring national resilience to economic shocks.
4. To develop a methodology for evaluating resilience to economic shocks of different countries.
5. To evaluate the resilience of EU countries to EU-wide economic shocks using the developed methodology.

Research methods and data

The research is based on the dataset of Inter-Country Input-Output tables (ICIO Tables; OECD, 2023), which are constructed on the foundations of Leontief’s (1936) input-output theory and are widely used by member countries of the Organisation for Economic Co-operation and Development (OECD), including all European Union (EU) countries (Eurostat, 2013) and other economies worldwide. The ICIO Tables include harmonised data for 77 economies and 45 industries per country, retrieved from the national accounts (NAs; Eurostat, 2023c) of the world economies. Therefore, the ICIO Tables dataset accounts for nearly the full scope of global economic performance during the analysed period between 1995 and 2020.

This research develops a new methodology for comparing countries' resilience to economic shocks, based on the relative resilience model of Martin and Gardiner (2019). The proposed methodology incorporates a global perspective on economic development grounded in holistic theory, thus minimising the effects of externalities that tend to distort the cyclicality of the development of local economies (Martini, 2020; Hundt & Grün, 2022; Delgado-Bello et al., 2023).

Industrial portfolio indicators in this research are the values of intermediate consumption (IC) within the ICIO Tables, adjusted to 1994 price levels. In NAs, IC reflects the resources used to build GVA or GDP. IC is therefore the indicator of the production side of equilibrium in each industry of a given economy, and its proportional fluctuations reveal the level of competitiveness of the industry. Furthermore, this research finds that a comparison of countries by their resilience can be performed by comparing their competitiveness.

Scientific novelty and theoretical significance

This research has developed a methodology to compare countries by their resilience to economic shocks.

Resilience assessment in the literature is typically performed by analysing statistics of GDP (Martin et al., 2016; Martini, 2020), employment (Martin & Sunley, 2015; Oprea et al., 2020; Hundt & Grün, 2022), and output (Martin & Gardiner, 2019), with an emphasis on economic growth. The scope of the literature research is limited to the community (Cutter et al., 2010; Renschler et al., 2010; UNDP, 2016) or regional/national levels (Solow, 1956; Swan, 1956; Martin & Gardiner, 2019; UNDRR, 2022a; UNDRR, 2022b). In the literature, industrial portfolios are assessed by selecting one or several industries of interest and analysing them separately from the performance of the remaining industrial portfolio (Martin & Gardiner, 2019; Picek & Schröder, 2018; Hundt & Grün, 2022; Pamucar et al., 2023). An integral analysis of the full industrial portfolio can be noted in Lewis et al. (2021), although this research analysed the aggregated performance of goods and services industries. The time intervals between economic shocks and recoveries in conventional resilience assessments are identified empirically (Friedman, 1988; Hamilton, 1989). The link between regional or national resilience and competitiveness in the literature is considered at a theoretical level (Bristow, 2010; Davies & Tonts, 2010), while it has been statistically considered at the organisational level (Romer 1986).

Unlike previous research, the methodology presented in this study is designed to measure changes in intermediate consumption (IC) within national industrial portfolios that define countries' ability to compete in international markets along value chains. Each industry in this analysis has its weight in the integral analysis of national industrial portfolios, and the assessment can be extended to the global level. Competitiveness is an essential feature of the relative resilience measurement model and can be statistically derived from the measure of relative resilience in the context of global economic performance. Therefore, the comparison of countries by their competitiveness proves to be sufficient to represent the comparison of countries by their resilience. This research ultimately enables the identification of time intervals of global or regional economic shocks and recoveries by applying statistical calculations. Moreover, it becomes possible to statistically determine the source industries and regions or countries responsible for global economic disruptions caused by disruptive environmental, economic, and political events on the international stage.

This research highlights that a country's resilience to economic shocks is essentially its ability to compete in international markets, regardless of the source or nature of an economic shock or other disruptions in the global economy. The main driver of competitiveness is human behaviour, with a primary focus on securing a better position in trade. Thus, failing entities in disrupted value chains are replaced by their competitors.

This research proposes a new characterisation of the concepts of "economic shock", "resilience" ("resistance", "recoverability", "reorientation") and competitiveness through the perspective of industrial portfolios. Changes in industrial portfolios are measured through the dynamics of IC values, thus reflecting both qualitative and quantitative aspects of economic systems.

The assessment of the impact of human resource availability and their distribution across industrial portfolios on competitiveness has identified different strategies among EU countries to resist and recover from EU-wide economic shocks, which have not yet been discussed in previous literature. While conventional literature provides arguments either in favour of or against industrial specialisation, this research highlights the importance of timing in national fiscal and monetary policy decisions when moving towards industrial specialisation or diversification. Many EU countries resist and recover from the economic shocks more effectively if they enter the shocks with diversified industrial portfolios and then specialise their industrial portfolios during the shocks and recoveries. A tendency is revealed that some small-to-medium EU economies, conversely, may resist and recover better when they enter economic shocks with more specialised industrial portfolios. Additionally, they recover better with an increase in the national population.

The economic reality portrayed in this research suggests that the optimal industrial portfolio composition is flexible and capable of quickly adapting to the constantly changing economic environment. Industrial portfolios consist of industries, each of which depends on the uninterrupted inflow of resources. Resources are unique to each industry to some extent, while each industry seeks and competes for the same result (revenue, profit), which can be unilaterally expressed in monetary terms. Thus, in the case of a disruption in the value chain, when industries face shortages in the supply of resources, they either search for substitutes for the lost resources or look to reorient their activities to areas that are not affected by the resource shortage to compensate for the losses in the result (revenue, profit).

Meanwhile, the assessment highlights the possibility for countries to identify, predict, and direct their policies towards a more effective industrial portfolio setup before economic shocks, which could help counter possible negative effects of future economic shocks.

Possible practical application of the results

The results of this research open a wide range of opportunities for further scientific investigations on the topic of resilience to economic shocks. The proof of a direct correlation between relative resilience and competitiveness shifts the discussions on national resilience towards the search for factors that improve economies' competitiveness in disruptive environments. This significantly reduces the complexity of the resilience question due to the wide variety of competitiveness enhancement techniques at the organisational level available in the scientific literature.

The practical application of the proposed methodology can be adapted to the decision-making processes of public authorities.

Limitations

The proposed methodology in this research has several limitations.

First, the harmonised statistics of the OECD's inter-country input-output tables, when this dissertation was completed, were available only from 1995 to 2020. Later and more relevant periods of global economic performance can be considered once the OECD publishes updated datasets. It is also possible in future studies to measure the national competitiveness of the countries of interest by exploiting national input-output tables of those countries directly from publicly available sources of the respective national institutions responsible for publishing official statistical data.

Second, the proposed methodology in this research ignores the qualitative indicators of national resilience. The analysis of resilience measurement methods and models highlights the importance of qualitative indicators in assessment because they significantly contribute to economic development and sustainability. Qualitative indicators, such as air quality, biodiversity, legal services, healthcare, sociocultural capital, and others are indeed important to understand when assessing economic systems at the local (community or city) level. The literature analysis in this research notes that such indicators are available at the local level, and the comparison of several regions or countries might be difficult because local properties in different regions may substantially differ. The proposed methodology, on the other hand, uses national accounts datasets that incorporate the results of annual accounts of economic entities within the considered countries. The annual accounts of the entities, upon submission to the tax authorities, accumulate their annual financial results, which were achieved by exploiting all the efforts, capabilities, available resources, and advantages of the local environment to obtain those financial results. A change in the social, legal, or other types of environment may respectively influence the entity's financial results. This means that the qualitative properties of the local environment are indirectly included in the annual financial statements of the entities that, in turn, accumulate into the national accounts. The inter-country input-output tables consequently incorporate and indirectly represent all the qualitative properties of the countries in the form of fluctuations in the intermediate consumption value in their industries. This methodology does not differentiate between the types of disruptive events that invoke economic shocks. However, in the course of this research, a direct correlation was identified between relative resilience and competitiveness measurement results, concluding that relative resilience can be measured through competitiveness. Competitiveness, meanwhile, is a property that includes qualitative economic performance factors within itself. This research ultimately considers the qualitative factors of the local environment as being indirectly included in the fluctuations in the value of intermediate consumption.

Third, the concept of "competitiveness" is very broad in the scientific literature. However, in the research on organisational resilience, it is strongly linked to resilience. This research narrows the concept of "competitiveness" to denote the statistical result of proportional changes in intermediate consumption at the industry, country, or global level. This perception of the concept stems from the holistic approach, where intermediate consumption changes in national accounts reflect the overall capitalised results of local entities' efforts to maximise their gains (income, profit) by exploiting all possible advantages in competition against others in the local or international market. This understanding aligns with the definition of "competitiveness" used in EU legislation, where a competitive economy is one whose sustained rate of productivity can drive growth and, consequently, income and welfare (EUR-Lex, EU). Nevertheless, to understand the scope of the "competitiveness" concept in this research, it could be assessed against other frequently used "competitiveness" concepts in the scientific literature.

Fourth, there is an ongoing discussion about whether countries of different sizes can be compared based on their resilience. World-leading economies like Germany or France have different economic development structures and paths from smaller countries such as Estonia or Slovenia. In the proposed methodology, the resilience of all countries is measured through their own proportional changes in the IC value. Thus, a fraction of a percent change in the IC value in France or Germany can exceed the total IC value of smaller economies like Estonia or Slovenia. This research tested the implication that large economies behave differently from smaller ones because they are more self-sufficient and, therefore, independent of external effects, as their industrial portfolios are more complete. Smaller economies, on the other hand, are considered as the ones complementing larger economies in certain industries. However, this assumption failed in the econometric assessment in this research, as the behaviour of small and large countries was revealed similar in terms of the correlation between industrial specialisation and population changes with their competitiveness. In this case, either the small EU economies function self-sufficiently or the large EU countries are strongly dependent on the economic performance of their international trading partners. These questions can be explored further in future studies by applying the methodology developed in this dissertation.

Lastly, the validation of the proposed methodology is limited to the scope of EU countries. The question is where the EU economies stand in competition against countries of the rest of the world. Further analysis of this question may lead to the identification of the comparative advantages of EU countries in the global market, potentially revealing an optimal industrial portfolio composition for an EU country that would enable its economy to maintain or improve its position in global trade. This discussion can be elaborated in future research.

Structure of the dissertation

The dissertation is divided into three main chapters. The logical structure of the research is illustrated in Fig. 1.

The first chapter establishes the theoretical background from the literature on resilience to economic shocks and its connection to theories on changes in the industrial portfolios of economies. It introduces the concepts of resilience to economic shocks and the components of resilience found in the analysed literature. This chapter reveals the links between the concepts of resilience to economic shocks and industrial portfolios, as well as their structural changes within economies. It also introduces relevant economic geography theories that focus on resilience research alongside key aspects of the evolution and contemporary relevance of resilience studies.

The second chapter analyses methods applied in the literature to measure economies' resilience to economic shocks by considering their industrial portfolio properties. It examines the key resilience measurement methods and models employed by leading researchers and public institutions worldwide. The analysis of the methods and models emphasises the resilience quantification indicators used in previous studies. A set of concepts from these studies, relevant to the further research of this dissertation, is defined in this chapter to support the development of the theoretical methodology. Additionally, this chapter develops a methodology for measuring resilience of countries to economic shocks through their competitiveness in the global market by evaluating changes in their industrial portfolios. The methodology is developed based on the analysis of the concepts, theories, and methods presented in earlier chapters of the dissertation. The logical sequence for implementing the assessment, which is based on the developed methodology, is portrayed in the conceptual research model.

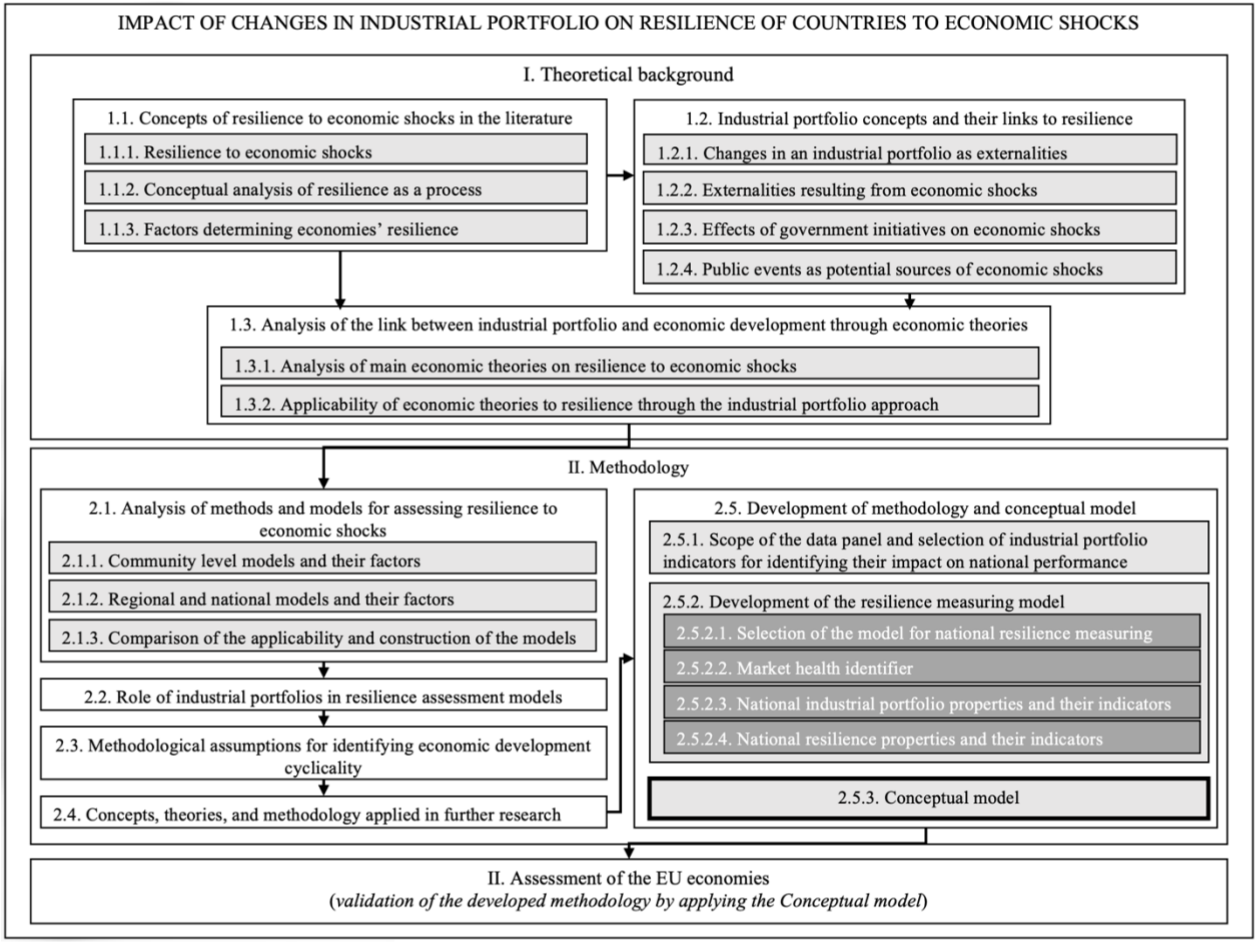


Fig. 1. Logical structure of the research

As shown in Fig. 1, the third chapter validates the developed methodology by assessing the impact of national properties on the resilience of EU economies to EU-wide economic shocks. The validation follows the sequence of the conceptual model. While this dissertation focuses on the economic performance of the EU region, the available dataset in the ICIO Tables and the developed methodology also allow for the measurement of national resilience in other regions of the global economy. Thus, this research promotes the further use of the developed methodology by extending the analysis to countries beyond the EU region.

Finally, the conclusions are structured to reflect the objectives of the dissertation.

Approval of the research results

Three scientific articles have been published on the topic of the dissertation. The results of the research have been presented at three international scientific conferences. The PhD candidate won the competition for the most active doctoral student at Kaunas University of Technology in 2023.

Scientific articles (WoS DB, Scopus DB):

1. Montrimas, A., Bruneckienė, J., Navickas, V., & Martinkienė, J. (2024). Measuring national economic resilience through industrial portfolios. *Journal of International Studies, 17*(1), 124–154. doi:10.14254/2071-8330.2024/17-1/8
2. Montrimas, A., Bruneckiene, J., & Giziene, V. (2023). Measuring economic resilience through industrial portfolio: the cases of new EU member states since 2004. *Engineering economics, 34*(5), 593–611. doi:10.5755/j01.ee.34.5.35515
3. Montrimas, A., Bruneckiene, J., & Gaidelys, V. (2021). Beyond the socio-economic impact of transport megaprojects. *Sustainability, 13*(15), 1–29. doi:10.3390/su13158547

International conferences:

1. Montrimas, A. (2023). Methodological approach for measuring resilience through industrial composition. In *18th prof. Vladas Gronskas International Scientific Conference Abstract Book* (p. 25). Vilniaus universiteto leidykla. https://www.journals.vu.lt/proceedings/article/view/34082/32562
2. Montrimas, A., & Bruneckienė, J. (2023). Understanding the patterns of economic turbulences through the composition of the global industrial portfolio. In *43rd EBES Conference, April 12-14, 2023, Madrid, Spain: Program and Abstract Book* (pp. 96–97). Istanbul: EBES. https://ebesweb.org/conferences/past-conferences/43rd-ebes-conference-madrid/43rd-madrid/
3. Montrimas, A., Mikalonis, Š., Bruneckienė, J., & Gaidelys, V. (2021). Application of the classical free market theory to model modern externality-driven economies. In *35th EBES Conference, Rome, Italy April 7-9, 2021, online* (pp. 52–52). Istanbul: EBES. https://ebesweb.org/conferences/past-conferences/35th-ebes-conference-rome-2/

1. THEORETICAL BACKGROUND OF THE IMPACT OF CHANGES IN INDUSTRIAL PORTFOLIO ON RESILIENCE TO ECONOMIC SHOCKS

Prior to assessing the impact of changes in industrial portfolios on the resilience of European Union (EU) countries to economic shocks, it is important to understand the concepts, theories, and the economic environment in the previous scientific literature that analysed the impact of changes in industrial portfolios on resilience to economic shocks. Resilience has gained popularity in economics, especially since the global financial crisis of 2008 (Martini, 2020). Scholars are tasked with examining the same global economic challenges across various contexts, starting with Krugman's (1992) "economic geography" and evolving through the theories and models of regional resilience developed by Martin and Sunley (2015), Martin et al. (2016), Di Pietro et al. (2020), and Oprea et al. (2020). The study of regional resilience has seen significant progress, with research becoming increasingly comprehensive and detailed.

This chapter introduces the concepts of resilience to economic shocks and the components of resilience found in the analysed literature. It reveals how they are interlinked with the concepts of industrial portfolios and the structural changes of economies. The chapter presents the most relevant economic geography theories that focus on resilience research alongside the main aspects of the evolution of resilience studies and their current relevance. This chapter aims to establish the theoretical background from the literature on resilience to economic shocks and its connection to theories regarding changes in the industrial portfolios of economies.

1.1. Concepts of resilience to economic shocks in the literature

This section introduces the concepts of economic resilience to economic shocks and describes their characteristics. It also explores how the resilience question has evolved to become highly relevant in contemporary research. The following subsection examines the concepts of "resilience" and "economic shocks" found in the literature, identifying those most suitable for further exploitation in this dissertation.

1.1.1. Resilience to economic shocks

Resilience. The term "resilience" originates from the Latin root *resilio* or *resilire*, meaning to leap back or rebound (Simmie & Martin, 2010; Bruneckienė et al., 2018). This concept refers to the ability of an entity or system to "recover from and position elastically" following a disturbance or disruption of some kind (Simmie & Martin, 2010). The term is widely used in various scientific fields and contexts, demonstrating its interdisciplinary nature. Originally developed from psychology, "resilience" has since spread to environmental and social sciences, humanities, and disaster research (Lorenz & Dittmer, 2016; Babic et al., 2020; Endreß et al., 2020). This research investigates the resilience concept in terms of its applicability for mitigating the effects of economic shocks. Table 1 presents various definitions of resilience from the literature.

Table 1. Definitions of the concept of "resilience"

Authors	Concept of "resilience" used in the literature
Briguglio et al. (2009)	The ability of a regional economy to cope with and recover from various shocks, whether economic, political, or environmental, by either returning to its previous development path or moving on to a new, better one.
Simmie and Martin (2010)	The ability of a local socio-economic system to recover from a shock or disruption.
Martin (2012)	An instrument used to examine how regions are affected by recessionary downturns.
Hill et al. (2012)	The ability of a region to recover successfully from economic shocks that disrupt its prior growth path and lead to an economic downturn.
Martin and Sunley (2015)	A multifaceted process, not a singular, static state or fixed characteristic of a regional or local economy.
Martin et al. (2016)	Can capture how an entity or system reacts to and recovers from an adverse disruption.
Bruneckienė et al. (2018)	Abilities and possibilities of regional economic entities to employ dynamic capacities and regional infrastructure, enabling the whole regional economic and social system to cultivate anticipated economic development in both the present and future situations; to remain unaffected or less affected by an economic shock and to reach the economic development status of the region before the shock as soon as possible after the shock by executing a strategy for renewal, recovery, or reorganisation.
Martini (2020)	A multifaceted process composed of several interrelated dimensions, such as resistance, renewal, recovery, and reorientation.
Di Pietro et al. (2020)	Describes how regional economies respond to undesired external disturbances.

Table 1 illustrates that the most relevant uses of the term refer to a local economic system's ability to respond to and recover from shocks. Di Pietro et al. (2020) and Oprea et al. (2020) emphasise that there is still no universally accepted definition of "resilience". However, the concepts presented by various scholars in Table 1 suggest "resilience" is used as an instrument to measure the health of an economic system when facing broader economic challenges.

In this respect, there is an intensive discussion in the literature regarding the adaptability of this concept as an instrument. According to Martin et al. (2016), when analysing "resilience", the key question is how long it takes for an entity or system to return to its pre-shock state and whether it actually returns to that state or is instead shifted by the shock to another (preferably more favourable) state.

Simmie and Martin (2010), Martin (2012), and Béné et al. (2014) identified two trajectories for the use of the "resilience" concept in the literature: the first as a measure of process and the second as a measure of capacity or result. The first trajectory, which focuses on resilience as a process, has been more widely explored (Simmie & Martin, 2010; Martin, 2012). The second trajectory emphasises that the resilience of a system depends on its constituent components, which can change or adapt while reacting to changes in other parts. Simmie and Martin (2010) suggested that when assessing regional resilience, it is more meaningful to analyse it in terms of capacities. They defined resilience as an ongoing process that integrates various capacities and capabilities. These capacities are aimed at sustaining and developing operations despite current or potential external or internal shocks. Martin (2012) and Béné et al. (2014) consequently depicted the concept of "resilience" as a dynamic process rather than a static outcome. They emphasised that resilience can be actively managed when viewed as a process. This management involves forecasting and measuring capacities, adapting to changes, and ultimately ensuring survival. Cutter et al. (2008), Zhou et al. (2010), and O'Brien and Wolf (2010) highlighted the adaptable nature of the "resilience" concept, noting its applicability across diverse entities such as individuals, communities, organisations, companies/enterprises, cities, regions, countries, and entire systems.

Bruneckienė et al. (2018) suggested that for a thorough analysis of resilience, it is crucial to precisely define the context in which it will be examined. When resilience is viewed in the context of an individual or subject, it is understood as a swift rebound from stress, tension, or other shocks. However, when applied to a system, the analysis shifts towards ensuring continuous functionality (maintaining operations), including the ability to anticipate potential shocks, prepare for them, withstand their extreme challenges, recover from them, and reorganise or restructure after the shock.

In the literature, resilience is considered a variable dimension because, in the process of recovering to the system's initial state, change is necessary. As Martin (2012) explained, during a significant downturn, outdated and unproductive businesses may be eliminated from economic activity. The elimination of these businesses creates space for the emergence of new sectors and a fresh growth phase. Change occurs during the recovery after an economic shock, as the system absorbs the consequences and adapts to the new economic environment (Béné et al., 2014). Adaptation is likely to be a path-dependent process (Martin, 2012).

The analysis of the literature discusses "resilience" in parallel with "economic shocks", referring to resilience as an instrument to measure the consequences faced by economic systems encountering or recovering from economic shocks.

Economic shocks. Various concepts in the literature refer to economic shocks or recessions. For example, Martin (2012) and Martin and Gardiner (2019) referred to an economic shock as a "recessionary shock", while Martini (2020) used the term "crisis". Meanwhile, the economic recession has been described as a "depression" (Vining, 1945; Neff, 1949) or "disruption" (Conroy, 1975; Simmie & Martin, 2010; Martin et al. 2016). Another concept found in the literature is "economic turbulence", which Goulielmos (2018) defined as an extreme economic phenomenon caused by forces that exhibit chaotic behaviour and have certain intensity. In the literature, "economic turbulence" refers to the same events as "shocks", such as Black Tuesday in 1929 and the Great Recession on September 29, 2008 (Goulielmos, 2018); however, it is often used as a more general expression, denoting economic downturns in general and encompassing both shocks and recessions.

Economic shocks can vary in length or severity and impact regions differently (Martini, 2020). Martin et al. (2016) noted that different shocks can generate different reactions and resilience levels. Pilinkienė et al. (2021) characterised economic shocks not only by their transition from one sector of the economy to another but also by their capacity for easy transmission to other countries' economies. According to Hill et al. (2012), economic shocks can be grouped into three categories: 1) shocks caused by downturns in the national economy; 2) shocks resulting from disruptions in particular industries that form a significant part of a region's export base, and 3) other external shocks, such as natural disasters, relocation of an important firm, closure of a military base, etc. Martini (2020) provided two examples of economic shocks in Italy, each differing in nature:

- Shock of 1992–1995: This shock was caused by internal problems, such as the hyper-devaluation of the Italian currency and corruption scandals.
- Lehman Brothers default, 2008: This external shock originated in the United States and spread to Europe.

Economic shocks are considered in the literature at various levels of economic activity. For example, Pike et al. (2006) identified "external shocks" at the company level, such as increases in factor input prices. Krugman (1992) and Martin (2012) examined shocks at the regional level. Martin and Gardiner (2019) evaluated regional resilience from the perspective of the shock-affected national economy of Great Britain, while Martini (2020) examined the effects of shocks at the international level.

Early scholars, such as Vining (1945) and Neff (1949), initiated discussions on shocks and recessions within business cycles using terminology that differs from what is employed today. Vining (1945) identified at least two aspects of regional economy business cycles that have since been used in statistical studies:

- Depression – a situation in which three components of economic development—real income consumed, real income produced, and employment rates—are declining or are subnormal, characterised by idle resources and unused capacity.
- Prosperity – the opposite situation, where real income and employment are rising.

Neff (1949) emphasised the need for global efforts to combat deflation and depression, as local attempts to address these issues are influenced by irregularities in local business cycles, which are shaped by interactions with other regions.

Different regions worldwide have addressed these economic challenges in various ways, a diversity evident in discussions on the topic of "resilience". Hospers (2003) and Martin et al. (2016) highlighted the works of Vining (1945) and Neff (1949), which focused on regional business cycles and economic fluctuations based on Keynesian and export-based theories. Conroy (1975) emphasised economic diversity, illustrating how a region's unique mix of economic activities and their interdependencies influence the response of a region's economy to recessionary disruptions. Subsequently, studies shifted towards highlighting regional production networks, agglomeration processes, innovation systems, and competitiveness (Schumpeter & Stiglitz, 1976; Romer, 1986; Hospers, 2003). Concurrently, ideas on regional resilience evolved towards geographical economics (Krugman, 1992), concerns about uneven regional development (Cooke, 2001), and the importance of human capital (Lucas, 1988).

The focus on regional business cycles resurfaced between the 1990s and 2010s, with attention to the synchronised movements of regional economic activities, encompassing both trends and cycles (Carlino & Sill, 2001; Clark, 1998; Clark & Shin, 2000). These analyses focused primarily on promoting production growth through optimisation and the development of labour potential. Scientific research by Simmie and Martin (2010), Martin (2012), Pindyck and Rubinfeld (2013), and Martin et al. (2016) focused on specific regions and their recessions, such as those in the United Kingdom during 1974–1975, 1982, 1991, 2001, and 2008. These works identified economic shocks through significant decreases in GDP levels, as well as declines in wages, local employment rates, and equipment purchases. Pindyck and Rubinfeld (2013) generalised the concept of an "economic recession" as a period in the economic cycle when the economy contracts.

Kahler (2004) linked economic security issues worldwide with the evolution of globalisation. Many researchers have noted that, despite its benefits, globalisation can lead to economic shocks and disruptions. For example, Stiglitz (2006) emphasised that unregulated globalisation can result in financial instability, job losses, and inequality, while Rodrik (2011) argued that globalisation can create tensions between national sovereignty and economic integration. Both scholars proposed that policymakers need to find a balance between these two forces. Kose et al. (2010) demonstrated that financial integration can lead to greater macroeconomic volatility and increased exposure to external shocks.

In the literature, Pilinkienė et al. (2021) noted that it is difficult to provide a unified description of an "economic shock" as these shocks affect many areas and vary in terms of impact intensity, duration, and environmental factors. Bruneckienė et al. (2018) suggested that an economy is characterised by constant fluctuations, referred to as economic cycles in the economic theory, with these fluctuations being caused by economic shocks. According to Martin et al. (2016), regional economic cycles are characterised by periods of recessionary contractions or shocks, followed by recoveries or expansions. Martin (2012) proposed that a major recession can be considered a "system-wide" shock, which periodically interrupts and disrupts the process of economic growth and development. Bruneckienė et al. (2018) defined "economic shocks" as accidental, unforeseen events or stochastic processes that arise within a region's (national) economy or from outside its boundaries. Ženka et al. (2021) defined an economic shock as an unplanned change or event that affects the economic, political, social, and/or natural conditions of national and/or regional economies. If not addressed, or if the current developmental strategy is not maintained, these shocks can have sudden and significant impacts on regional economic development. Martin (2012) characterised a recession as a type of economic shock that is generally unexpected and unpredictable, leading to disruption of the "normal" growth trajectory of an economy. Martin et al. (2016) observed that recessions are inherently negative, involving economic activity contraction (output), potential business closures, and employment decline due to reduced hiring and increased layoffs or redundancies. Yu et al. (2022) linked socio-economic shocks to disruptions in global supply chains.

To summarise, in this research, the concept of an "economic shock" is understood as a significant disruption in the development of an economy caused by any external or internal economic, social, or environmental events. The concept of "resilience", as proposed by Simmie and Martin (2010)—the ability of a local socio-economic system to recover from a shock or disruption—forms the foundation for further research. This concept is central in the most relevant literature, while subsequent works by Martin (2012), Martin and Sunley (2015), Martin et al. (2016), Martini (2020), Di Pietro et al. (2020), and Ženka et al. (2021) have either specified this concept or amplified certain characteristics of it based on their research questions. Thus, "resilience" is understood as a process, and its characteristics are conceptually analysed in the following subsection.

1.1.2. Conceptual analysis of resilience as a process

Regional resilience is generally viewed as a complex concept that includes numerous characteristics across different stages. Martin (2012) characterised regional resilience through resistance, recovery, reorientation, and renewal by denoting them as the four main "dimensions" of regional resilience that later formed the basis for economic interpretations by other economists (Martin & Sunley, 2015; Di Pietro et al., 2020; Oprea et al., 2020). These four dimensions identified by Martin (2012) are as follows:

- Resistance refers to the vulnerability or sensitivity of a regional economy to disturbances and disruptions, such as recessions.
- Recovery denotes the speed and extent of disruption.
- Re-orientation reflects the extent to which the regional economy undergoes structural change, including the implications of such changes for the region's output, jobs, and incomes.
- Renewal indicates the degree to which the regional economy returns to its growth path before the shock.

The subsequent analysis by Martin and Sunley (2015) structured the resilience process into four sequential (and recursive) stages. Fig. 2 outlines these stages and their interconnections:

- Vulnerability refers to a pre-shock stage that identifies how much a region's entities or institutions are vulnerable or exposed to shocks.
- Resistance refers to the depth of a reaction of a region's entities and institutions to the impact of a shock, depending on its scale, nature, and duration.
- Robustness identifies how entities adjust and adapt to shocks through external mechanisms, public interventions, and support structures.
- Recoverability is the post-shock regional development pathway, assessing the degree and nature of the region's recovery to the pre-shock economic level.

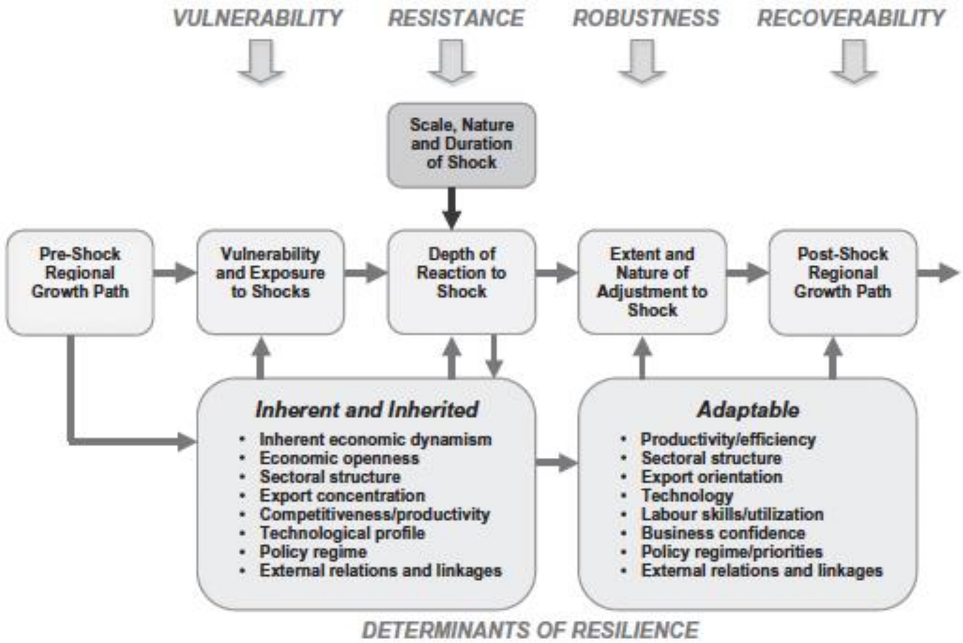


Fig. 2. Schematic view of the resilience process (Martin & Sunley, 2015)

Martin et al. (2016) noted that these sequential stages (characteristics) of the resilience process depend on factors, such as the nature, depth, and duration of the recession, the prior growth path of a region, and various aspects of that path, including regional economic structures, resources, capabilities, competences, and supportive measures from public authorities (local or national).

Studies by Martin and Sunley (2015), Martin et al. (2016), and Giannakis and Bruggeman (2017) introduced and elaborated on additional characteristics describing a region's sensitivity, robustness, responsiveness, and adaptiveness to various shocks. However, a common property of "resilience" in the works by Simmie and Martin (2010), Martin (2012), Pindyck and Rubinfeld (2013), Martin and Sunley (2015), Martin et al. (2016), Di Pietro et al. (2020), Oprea et al. (2020), Picek and Schröder (2018), and Hundt and Grün (2022) is that this concept is analysed as an instrument to mitigate the effects of economic shocks or recessions. Thus, in the literature (Martin et al., 2016; Martin & Gardiner, 2019; Martini, 2020; Oprea et al., 2020; Hundt & Grün, 2022), resilience is generally measured through two primary characteristics: resistance and recovery/recoverability.

Resistance to an economic shock is typically measured by the depth of an economy's reaction to the unforeseen and sudden disruption of the economic business cycle (Martin, 2012; Martin & Sunley, 2015). The identification of the recovery level from a shock and the subsequent economic development path has been a subject of discussion among leading scholars (Holling, 1973; Friedman, 1988; Perrings, 2001; Simmie & Martin, 2010; Martin & Gardiner, 2019). Two models in the literature portray the recovery path of an economy after an economic shock. The first, known as "engineering resilience", focuses on how quickly a system, once disrupted, returns to its pre-shock or equilibrium state (Martin & Gardiner, 2019). Friedman (1988) called it a "plucking model" and pointed out that the cycles are symmetrical, with each contraction having the same amplitude as the succeeding expansion (recovery). Simmie and Martin (2010) initiated this discussion by stressing that the "equilibrist" definitions restrict the idea of resilience to the ability of an economy either to return to an equilibrium state or to move quickly to a new one. Holling (1973) and Perrings (2001) noted that, from a static point of view, economic resilience can be defined as the ability or capacity of a system to absorb damage or loss or to cushion against them. Thus, a system's ability to recover from a severe shock could be considered a more general definition that incorporates dynamic considerations, including stability (Navarro-Espigares et al., 2012).

The second model is called "ecological resilience", which is more concerned with the absorptive capacity of a system in the face of a shock (Simmie & Martin, 2010; Martin & Gardiner, 2019). It is also referred to as evolutionary resilience because it involves structural and operational adaptation in response to shocks, with economies moving forward to a new equilibrium (Martin & Sunley, 2015). According to Martin and Gardiner (2019), the assumption is that many systems have different possible combinations of components and resources, and an economic shock can push a system beyond an absorptive threshold that marks the limit of the stability domain of the original state, causing the system to shift to a different or alternative stable state. This model differs in quality from the engineering resilience model, in which the economy returns to its original state. The ecological resilience model also involves the adaptation of components, structures, functions, and the use of resources. Simmie and Martin (2010) suggested that the evolutionary dynamics of an economy are periodic, with episodic shocks driving the system to adapt from one regime to another. Their idea implies that there is no single unique equilibrium state or path for an economy, but rather several possible states or paths, with the economy shifting from one equilibrium to another through an economic shock. Therefore, Simmie and Martin (2010) make the following distinction:

- A resilient regional economy would be one that adapts successfully and either resumes or better still improves its long-run equilibrium growth path.
- A non-resilient regional economy would fail to transform itself successfully and instead becomes "locked" into an outmoded or obsolete structure, with a consequential lowering of its long-run equilibrium growth path.

This evolutionary model, drawn from the field of ecology, implies, as Simmie and Martin (2010) describe, the logic of the notion of industrial "mutation" that takes place through a process of "creative destruction". The conceptual expression of this model is extremely appealing. However, it has been assessed as rather difficult to capture in practical econometric modelling cases.

Martin and Gardiner (2019) aligned the two models into one system by enabling the possibility of comparing them through the same economic development parameters. Friedman's (1988) "plucking model" identifies the recovery from a shock to the same growth path, while Hamilton's (1989) concept of "hysteresis" is introduced as the counterpart to “ecologic resilience”. Specifically, Martin and Gardiner (2019) described models in which economic shocks or disturbances result in permanent, typically negative effects on the growth trajectory of an economy, causing the trend itself to shift, usually downward. Their study identified different types of hysteresis based on Hamilton’s (1989) concepts (Fig. 3):

- Hamilton negative hysteretic recession: An economy undergoes a regime shift during a shock, resuming its pre-shock growth rate, although it remains below it and follows a new growth path parallel to the original trend.
- Hamilton negative hysteretic recession with lowered growth rate: A more severe form in which the recession disrupts the productive base of the economy to such an extent that it shifts onto a new growth path with both lower and less steep growth rates.
- Hamilton positive hysteretic recession: An economic shock initiates the processes of “creative destruction”, leading to rapid recovery and settling on a growth path parallel to and above the pre-shock trend.
- Positive hysteretic recession with raised growth rate: Rapid recovery that results in a new growth path with a higher growth rate due to transformative reorientation towards new industries, technologies, products, markets, and skills.

Fig. 3 illustrates the integrated system of recovery paths proposed by Martin and Gardiner (2019) in the context of the resilience process:

- The recovery path a–b–c–d–e is the “plucking model” of Friedman (1988) when the economy recovers from a shock to the same growth path as before.
- The recovery paths a–b–c–f and a–b–c–h–i are the negative and positive hysteretic recessions of Hamilton (1989), when the economy recovers either to the lower or higher (respectively) growth path but maintains the same growth rate as in the pre-shock stage.
- Positive and negative hysteretic recessions (Simmie & Martin, 2010; Martin & Gardiner, 2019) assume a raised (a–b–c–j) or lowered (a–b–c–g) growth rate after the shock and continue economic development at a new growth path.

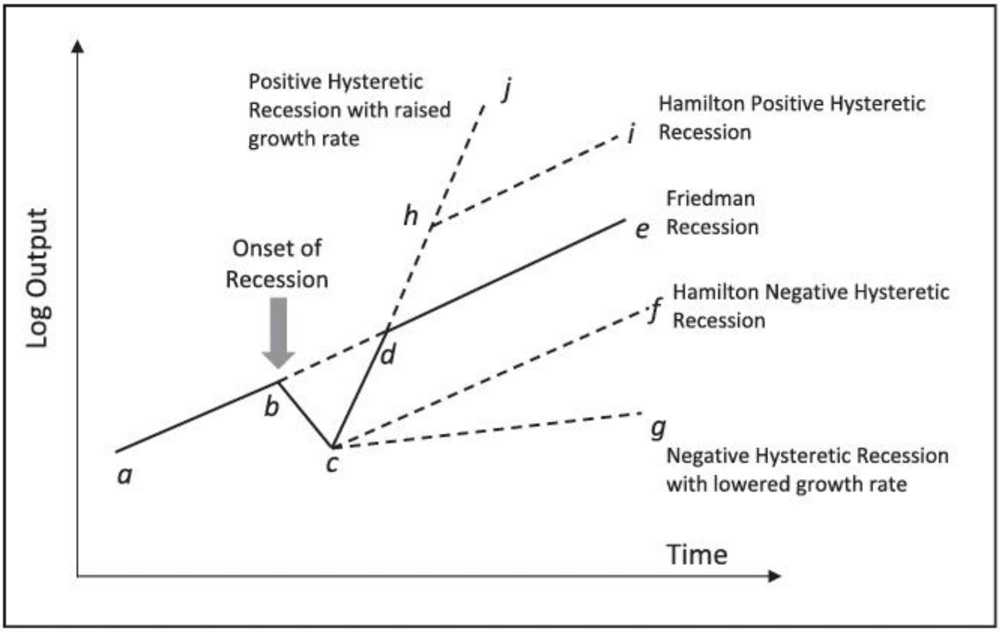


Fig. 3. System of recovery paths (Martin & Gardiner, 2019)

Based on the nature and duration of an economic shock, as well as the extent of damage and the resources available, Fig. 3 illustrates the different reactions of socio-economic systems: resiliently, by adapting to a new situation without significant impact on development; or non-resiliently, by suffering heavy losses and disrupted development.

The issue of disruptions in economic development, such as shocks, and the performance of economies facing these disruptions has been relevant in scientific research for nearly a century. Research has highlighted the distinctiveness of economies and the diverse developmental trajectories observed in different regions. The following subsection analyses the factors discussed in the scientific literature that can increase or decrease economic resilience.

1.1.3. Factors determining economies' resilience

Various assumptions for defining regional resilience to economic shocks have been discussed in the literature. Rose (2004) pointed out that regional resilience is shaped by both innate capabilities and adaptive capacity. Their combination and interaction with the larger economic system, according to Rose (2004), determine the resilience of regions to economic shocks. Empirical evidence from Davies and Tonts (2010) revealed that a region's resilience to economic shocks is influenced by its main strengths. Consequently, regional resilience depends on the region's history and can be shaped by the structure of its economy, the nature of prior economic development, reorientation skills, resources, and technological potential (Simmie & Martin, 2010). The research by Davies and Tonts (2010) conducted in North America and Europe suggested that regions with a narrow economic base are more prone to economic volatility, decline, and marginalisation than diversified economic systems. They emphasised that factors such as market size, access to larger external markets, natural resource contributions, and physical and human capital play an important role in shaping the changing effect. Furthermore, Hill et al. (2012) highlighted that regions with a narrow economic base are more likely to suffer harmful and long-term consequences following an economic shock, as even a relatively small loss of jobs or firms can lead to a larger reduction in demand for goods and services from local businesses.

Another integral factor is the industrial structure of regions. The study by Davies and Tonts (2010) showed that a region's vulnerability to economic shocks is related to its sectoral (industrial) specialisation. However, in some cases, specialisation is considered an important source of the competitive advantage. They emphasised that multiple specialisations within a local economy are important for economic stability and well-being, particularly in cases where industries can compensate for one another during economic shocks.

Meanwhile, Bristow (2010) argued that regional resilience is increasingly recognised as a critical concept within the evolving theoretical framework of evolutionary and ecological systems, where "place" is crucial for understanding how regions function, develop, and evolve.

Davies and Tonts (2010) and Martin (2012) demonstrated that regions specialising in limited industrial areas are particularly vulnerable to sectoral economic shocks, retain risks, and experience permanent declines in businesses and jobs or suffer negative spillover effects. This suggests that a more diverse economic structure, compared to a highly specialised one, makes regions more resilient to economic shocks, as risk is effectively spread across the region's business structure, although a high degree of inter-industrial linkages may limit this resilience.

There is a debate at both academic and strategic levels on why some regional economies recover independently while others weaken, and why some regions are more vulnerable than others (Palekienė, 2016). Resilience is also discussed at the organisational level, where its capabilities are portrayed similarly to those at the regional level, although they are considered more practical. Dwaikat et al. (2022) identified the following resilience capabilities within supply chain resilience at the organisational level:

- Operational resilience – the organisation's ability to pursue its mission and seize opportunities in adverse conditions, such as security incidents or financial crises.
- Dynamic capability – the ability of an organisation to integrate, create, and reconfigure its internal and external competencies to cope with changing conditions in the business environment.
- Capacity for renewal – beyond resistance, an organisation must quickly adapt and develop new solutions when facing major disruptive events.
- Capacity for appropriation – the ability of an organisation to learn from experienced shocks.

- Change capacity – the organisation's ability to adapt to new situations by shifting its production to different products.

Mehta et al. (2024) highlighted the importance of integrating organisational resilience and sustainability practices into organisational strategies to navigate disruptive environments and ensure sustainable success. They distinguished four pillars of organisational resilience—preparedness, responsiveness, adaptability, and learning—that are essential for enhancing an organisation's ability to withstand and recover from disruptive events. Meanwhile, Echefaj et al. (2024) distinguished responsiveness, readiness, flexibility, and adaptability as the most important capabilities for supply chain resilience, with commitment and communication as key maturity factors influencing resilience capabilities.

The pillars identified by Mehta et al. (2024) and Echefaj et al. (2024) can be considered coherent with the sequential stages identified by Martin and Sunley (2015) that characterise resilience at the regional level (Table 2).

Table 2. Comparison of coherent characteristics identified in the literature at organisational, supply chain, and regional levels

	Mehta et al. (2024)	**Echefaj et al. (2024)**	**Martin and Sunley (2015)**
Level of application	***Organisational***	***Supply chain***	***Regional***
Characteristic Pre-shock	Preparedness	Readiness	Vulnerability
Characteristic During shock	Responsiveness	Responsiveness	Resistance
Characteristic Post-shock	Adaptability/ learning	Flexibility/ adaptability	Robustness/ recoverability

The coherence of resilience characteristics at different levels of application, as shown in Table 2, is notable when economic systems—whether they are organisations, supply chains, or regions—are resisting (responding to) economic shocks and when they are adapting to a new economic environment during the recovery period.

Michel-Villarreal (2023) identified flexibility, redundancy, collaboration, visibility, and agility as the **dynamic capabilities** of supply chains at the organisational level. Considering the property of dynamic capabilities to have a continuous effect on organisational performance, the author associated the following strategies with dynamic capabilities that help increase organisational resilience:

- Strategy for flexibility: alternate distribution channels, flexible production facilities, multi-sourcing, postponement, mass customisation, standardisation of parts, processes, and production systems.
- Strategy for redundancy: emergency back-up and storage facilities, back-up sites, overcapacity, multiple sourcing, surplus raw materials, and finished inventory.
- Strategy for collaboration: risk sharing, collaborative forecasting, communication and information-sharing trust, joint decision-making, supplier certification, and development.

- Strategy for visibility: business intelligence gathering, information exchange, collaboration with customers and suppliers, information technology, early warning indicators, real-time and financial monitoring, and information management.
- Strategy for agility: communication, quick supply chain redesign, velocity, visibility, and flexibility, close collaboration with suppliers, speed, and responsiveness.

Sousa et al. (2010) added the following dynamic capabilities for organisational resilience that help increase resilience in organisational activities: long-term plans, regular meetings, benchmarking, communication, partnerships, and eco-efficient actions. These capabilities are essential for developing organisational resilience towards sustainability. Warmbier (2024) further noted that congruent operations, network capabilities, and sustainable firm performance are interconnected, emphasising the need for a multidimensional understanding of sustainable resilience.

At the regional level, resilience emerges as a highly intricate, multidimensional characteristic of regional economic systems (Martini, 2020), involving numerous variables. It is a multifaceted and dynamic process with constantly changing attributes (Martin, 2012; Martin & Sunley, 2015). In the face of external factors that significantly influence regional economic development, there is a tendency to prioritise industrial specialisation over diversification (Martin et al., 2016; Picek & Schröder, 2018; Hundt & Grün, 2022). However, this focus on specialisation can limit the potential to achieve robust outcomes. Additionally, an economy's diverse industries are interconnected through various networks of external relations, resulting in differing levels of resilience (Martin, 2012), thereby complicating the issue of resilience. The mixed findings of research on economic resilience underscore its dependence on context, prompting further examination and comparison of economies by their structural properties. Although scientists agree that economic structure (industrial portfolio), economic capacity and vitality of the region, geographical conditions, historical development, the psychological climate of the population, and other factors play an important role in regional resilience to economic shocks. The implementation of strategies and management are also important factors in increasing regional resilience to economic shocks. Although innovative, complexity-oriented practices have emerged, the dominant applications of resilience diverge substantially from science, posing challenges in practice (Reyers et al., 2022). Therefore, the following subsection analyses the discussion in the literature on the industrial portfolio properties and structural changes within the development of economies.

1.2. Industrial portfolio concepts and their links to resilience

In the literature, the industrial portfolio is considered a key instrument in shaping a region's resistance to economic shocks. According to Conroy (1975), a region's economic structure, or **industrial portfolio**, is a particular mix of economic activities and their interrelationships that can influence the reactions of a region's economy to recessionary disturbances and fluctuations. Eurostat (2023a) characterised economic activity by an input of resources, a production process, and an output of products (goods or services). Activities occur when resources, such as capital goods, labour, manufacturing techniques, or intermediary products, are combined to produce specific goods or services (Eurostat, 2023a). Martin et al. (2016) defined "economic structure" as the collection of industries or products within an economy, and this concept relates to Conroy's (1975) definition of "industrial portfolio".

A wide variety of concepts are referred to as "industrial portfolio" in the scientific literature. For example, Delgado-Bello et al. (2023) denote "industrial portfolio" as an economic structure and argue that it is one of the main factors when studying resilience at both theoretical and empirical levels. Pike et al. (2006) referred to the "industrial portfolio" as a sectoral structure and emphasised its importance, where manufacturing is interpreted as a "flywheel of growth", capable of fostering innovation and generating significant productivity benefits and faster growth for manufacturing-specialised regions compared to resource-based regions.

According to Martin (2012), when other factors do not change, a diverse or varied economic structure ("industrial portfolio") is often assumed to provide greater resistance to economic shocks at the regional level than a more specialised structure. The reason noted by the author is that different industries have different sensitivities to business fluctuations, changes in export markets, major shifts in monetary conditions, such as exchange rates and interest rates, and other factors related to risk diversification and the maintenance of investment portfolios. A significant covariance of several industries in an economy can cause a downward economic shock to one or more industries in the region, which may initiate subsequent disruptions in the economic activities of other industries across the economy, thereby imposing consequential depressive effects on a large part of the economy (Conroy, 1975; Martin, 2012). Martin et al. (2016) and Martini (2020) pointed out that regional responses to economic shocks are not always linked to the industrial portfolio structure. A reaction of an economic system to and recovery from a shock, according to Fingleton et al. (2012), does not explain why an economy displays a particular type of resilience or whether an economy's resilience varies over time.

A wide variety of evidence can be found in the scientific literature emphasising the importance of industrial portfolio properties on economies' resilience. According to Hill et al. (2012), a region's industrial portfolio structure affects the probability that a region will experience an economic recession (downturn). More diversified regions experience lower volatility, whereas regions whose fluctuations are induced by their economically strong neighbours have significantly lower benefits from their own diversification (Kluge, 2018). Construction, real estate, and financial services in China, according to Mai et al. (2019), have the greatest disruptive potential on the national economy, whereas the industrial sector has the greatest stabilising potential. Service industries, according to Ray et al. (2017), are among the best performers during economic shocks, whereas manufacturing industries amplify economic shocks. Information and communication technology-intensive countries can counteract some economic losses because they are more resilient to the lockdowns triggered by the pandemic (Kim & Hong, 2021; Papaioannou, 2023). Construction and similar industries are closely related to the cycle and, therefore, are more sensitive to economic shocks (Delgado-Bello et al., 2023). Public services and administration, on the other hand, tend to impose more stability on an economy over time (Martin et al., 2016).

In these examples, while the concept of "resilience" is viewed as a process, the concept of an "industrial portfolio" or "economic structure" must be understood in its dynamic nature. According to Martin (2012), regional economic **reorientation or realignment** represents a dimension of the resilience process. In this context, a major shock can trigger or accelerate pre-existing changes in a regional economic structure (industrial portfolio). These changes themselves can create negative or positive hysteresis, which could lead to a new (lower or higher) growth trend. Therefore, Martin (2012) stressed that some level of structural change occurs continuously. In terms of regional resilience, the concern is whether and to what extent such changes restore a region's employment trajectory following a significant economic shock. The analysis of industrial portfolio changes consequently focuses on how rapidly and effectively a region's economy transitions from slow-growing or declining industries to those that are fast-growing. According to Martin (2012), reorientation signifies shifts in a region's economic structure as outcomes of recessionary shocks, while continuous structural changes are ongoing.

Eaton and Kortum (2002) quantified an international trade Ricardian model that includes a factor of geography and captures the competing forces of comparative advantages that promote trade and geographic barriers (both natural and artificial) that inhibit it. Lewis et al. (2021) subsequently introduced the concept of "structural composition", drawing from the international trade model of Eaton and Kortum (2002) and using data from the UN nomenclature within the World Input-Output Database. In the literature of structural changes, according to Lewis et al. (2021), **structural change** refers to changes in the expenditure of goods and services as a share of total expenditure over time. In this context, expenditure specifically refers to final demand, which includes consumption, investment, and government spending. Matsuyama (2019) highlighted a common approach in existing studies on structural change, in which closed economy models are typically used. These models assume that domestic supply must equal domestic demand industry-by-industry, but the domestic supply composition in an open economy does not necessarily need to match the composition of domestic demand. Intuitively, international trade makes the domestic demand composition less significant as a driver of structural change. Matsuyama (2019) also noted that the common treatment of income elasticity differences across sectors and productivity growth differences across sectors are two separate exogenous causes of structural change.

Martin and Gardiner (2019) linked an economy's reorientation capabilities to the speed at which it recovers to its pre-recession economic growth trend rate or even surpasses it. This suggests that the ability to undergo structural change and adapt the structural composition of expenditures may influence the pace and success of economic recovery.

Romer (1986) introduced the competitive equilibrium model at the microeconomic level of endogenous technological change by including externalities. The competitive equilibrium here targets the quantified results of maximising companies' earnings, measured through changes in the marginal productivity of knowledge and physical capital. Snieška and Bruneckienė (2009) applied the concept of competitiveness to measure regional economic performance. They defined "regional competitiveness" as the ability to use factors of competitiveness to establish and maintain a competitive position among other regions. Pilinkienė and Snieška (2002) used the national business structure to measure regional competitiveness. Bristow (2010), meanwhile, noted a close but complex relationship between the concepts of competitiveness and resilience, where a narrow contextual approach to competitiveness leads to limited solutions for resilience problems. This is because the hegemonic discourse on competitiveness has so far focused on regional economic development by building comparative advantages in productivity and its performance or by attracting new firms and labour into the region.

In the context of economic structure, further research uses a mixed concept of Conroy (1975) and Martin et al. (2016), which denotes "industrial portfolio" as a particular mix of industries and their interrelationships that can influence the reactions of an economy to economic shocks. Industries are the economic activities or products within an economy, while industrial portfolios undergo "structural changes" (Lewis et al., 2021)—changes in the expenditure of goods and services as a share of total expenditure over time—within the reorientation dimension of the economic resilience process, which could be expressed through competitiveness. Pike et al. (2003) identified opportunities of international trade for the regions of early industrialisation, as well as risks from negative relationships with international partners that could create vicious circles of decline, potentially resulting from a loss in competitiveness of the region's exports or external shocks. In this regard, Martini (2020) and Pilinkienė et al. (2021) emphasised economic shocks, which by their nature, are generated by external or internal economic events. Bristow (2010) noted a close relationship between the concepts of competitiveness and resilience, highlighting the importance of an economy's geographic location within the resilience concept, thus prompting a thorough analysis of the literature in terms of economic geography.

1.2.1. Changes in an industrial portfolio as externalities

Conceptual analysis of the literature (Hill et al., 2012; Martini, 2020; Pilinkienė et al., 2021) has revealed that economic shocks can be caused by the following events: 1) downturns in the national economy, 2) economic downturns within industries across multiple economies involved in international trade, 3) external events, such as natural disasters, the closure of a military base, the relocation of an important firm out, or 4) internal events, such as hyper-devaluation of the local currency or externalities linked to local or national affairs. External events are more frequently identified in the literature as sources of shocks, while internal events are typically portrayed as measures to counter the effects of economic shocks, although they carry the risk of becoming potential sources of shocks themselves. The economic consequences of these external or internal events are known as "externalities", referring to the indirect effects of one agent's consumption or production activities on the well-being or economic activities of other agents (Oxford, 2024). Martin and Sunley (2015) drew a parallel to the "rivet effect" from ecological studies, which suggests that economic systems may contain certain components that occupy a crucial, pivotal role within the entire system's functioning. The collapse or removal of this pivotal component could cause sudden and catastrophic failure of the entire system. They illustrated this concept with a region whose economic structure is concentrated around one company or industry (the "rivet") and supported by a network of various suppliers and subcontractor activities that dependent on the activity of the "rivet". If the "rivet" company or industry is hit by an economic shock, it would either have to close or undergo drastic retrenchment, triggering the collapse or decline of many of the remaining industries within the economy, unless the local suppliers can find alternative customers elsewhere. Conversely, a positive externality could arise from the emergence of a technology-led "rivet" company or industry within the functioning economy, which could drive the whole industrial portfolio to a higher economic growth trajectory. These examples lead to a discussion on the industrial portfolio composition of an economy that could better absorb the effects of economic shocks in terms of externalities.

1.2.2. Externalities resulting from economic shocks

Pike et al. (2003) and Eaton and Kortum (2002) provided descriptive models of regions' trade with other regions, including significant yet unpredictable "externalities" in regional business cycles. Conroy (1975) stressed the importance of industrial portfolio diversification to reduce the risk of negative effects of recessionary shocks in the region. Marshall (1890), Arrow (1962), and Romer (1986) favoured the effects of localised specialisation, also known as MAR externalities (Hundt & Grün, 2022), whereas Beaudry and Schiffauerova (2009) argued in favour of urbanisation effects. Brown and Greenbaum (2016) discovered that more concentrated counties in Ohio (US) tend to have lower unemployment rates during prosperous times, whereas counties with more diverse industry structures perform better during national or local employment shocks. Meanwhile, economies with more diverse industry structures tend to fare better during periods of national or local employment shocks. This suggests that diversity in industry structure can help mitigate the impact of industry-specific shocks and contribute to overall economic stability, as argued by Doran and Fingleton (2018). On the other hand, Cuadrado-Roura and Maroto (2016) asserted that specialisation in dynamic sectors can enhance regional economic resilience. They highlighted the potential benefits of focusing on sectors with growth potential to boost resilience. In addition, Hundt and Grün (2022) emphasised not only the effects of specialisation and the MAR and Jacobs (Beaudry & Schiffauerova, 2009) externalities but also the timing of these effects and their impact on resilience. They also suggested that the temporal occurrence of specialisation effects can have a significant and timely influence on regional resilience.

These examples portray externalities as the result of economic shocks. Moreover, they stress the unpredictable external or internal events in inter-regional trade that cause externalities and note a clear link between regional economic structure and its competitiveness in the market. However, the problem of an effective economic structure remains either unsolved or region-specific.

1.2.3. Effects of government initiatives on economic shocks

Resilience measures are often defined as national or regional governments' responses to economic shocks. In a recent example, Benmelech and Tzur-Ilan (2020) noted that nations grappled with the economic shock of the COVID-19 pandemic primarily through various public health measures aimed at containing the spread of the virus. Makin and Layton (2021) noted the difficulty of applying scientific theory to the unique case of a health-related economic shock of global magnitude that resulted from lockdowns initiated by national governments. Gopinath (2020) emphasised the significant uncertainty surrounding the post-lockdown economic landscape.

Economists have collectively highlighted high public debt levels in high-income countries before the COVID-19-induced recession. Makin and Layton (2021) pointed out that, globally, total public and private debt reached a record high of around 225% of global GDP before COVID-19, marking a 12% increase compared to debt levels before the global financial crisis of 2008. Another challenge for global economies has been the surge in global budget deficits following the implementation of fiscal measures to combat the pandemic crisis. The International Monetary Fund (IMF) reported a global fiscal deficit of 14% in 2020, which was 10% higher than the previous year and nearly three times higher than after the 2008 global financial crisis.

Despite these sobering statistics, recent economic literature generally conveys a positive and supportive tone towards the immediate policy responses from governments worldwide to address the consequences of the pandemic crisis. Economists have identified preventative health measures, along with swift and robust fiscal policy reactions involving unprecedented support for households, firms, and financial markets, as crucial for a strong global recovery.

However, heightened uncertainty remains about the medium- and long-term impacts of these measures on economies, particularly concerning increased inflation pressures and the burden of higher taxes on future generations. According to the OECD's Mann and Gori (2017), while funding is necessary to support economic activity and innovation, it can also increase growth risks and exacerbate inequality in the medium term. Long-term concerns include vulnerability to shocks, ongoing deterioration of credit quality, changes in corporate financing structures, increased forex risk, and buoyant asset price dynamics.

Economists have noted an unprecedented range of fiscal and monetary measures taken by governments worldwide to support individuals and businesses during the pandemic. Alberola et al. (2020) highlighted the complementary efforts of central banks and financial regulators with policies aimed at easing financial conditions and ensuring the continued flow of credit to their economies. This combined policy response aimed not only to stabilise financial markets but also to prevent temporary disruptions from causing lasting damage to economies. Fiscal measures are primarily intended to cushion the short-term impact of economic shocks.

Ramey (2016) noted that fiscal regulatory actions to address economic shocks are more publicly popular than monetary regulatory actions. However, he emphasised that since the development of Keynesian models in the 1960s, most empirical research on shocks has predominantly focused on monetary policy. The global financial crisis and subsequent rise in public debt levels have shifted researchers' focus towards examining global fiscal actions.

Makin and Layton (2021) distinguished the following fiscal responses:

- Fiscal stimulus – directed at the demand side of an economy by increasing government spending to reverse unexpected economic downturns. In the fiscal context, it refers to deliberate budgetary actions, such as increased public spending, tax cuts, cash handouts, or generous social welfare payments, to stimulate economic activity.
- Fiscal relief – primarily directed at the supply side of an economy, to stabilise production by imposing tax breaks. Tax breaks, in this case, can have secondary demand effects that may lead to future gains in output.

The term "fiscal stimulus" is often used by most governments around the world, but this definition is often misleading. According to Makin and Layton (2021), a significant portion of the fiscal packages announced to counter the economic impact of the COVID-19 pandemic economic shock were not stimulus packages, as they aimed to keep economies and supply chains on life support rather than boost their recovery. They argued that the guiding principle in crafting a fiscal response to any economic shock should, first and foremost, be fiscal relief that temporarily lightens the burden on the supply side of the economy, which consists of both small and large businesses. They stressed that productivity and real wage-enhancing investment decisions are made within businesses, where the largest share of jobs is created within an economy. Meanwhile, the benefit of corporate tax relief is limited to the impacted companies, due to the lower profitability resulting from it. Makin and Layton (2021) viewed direct government subsidies paid to private firms to preserve employment as a form of fiscal relief as well, because they are aimed at the production side of economic systems.

Alberola et al. (2020) proposed an alternative breakdown of fiscal measures. They pointed at the fiscal packages with the notion that by applying budgetary measures, the budget has a direct negative impact on fiscal balances, whereas the non-budgetary measures do not have an immediate impact on the fiscal balance:

- Budgetary measures: spending on healthcare, transfers to firms and households, wage and unemployment subsidies, and tax cuts or deferrals.
- Non-budgetary measures: funding and credit guarantees. Funding includes loans issued by governments, financial agencies, or state banks to small businesses, as well as other forms of financial support, such as equity injections into strategic firms (e.g., national airlines, railways). Government credit guarantees provide

fiscal backing for central bank programmes intended to maintain economic credit flows.

The variety of fiscal measures taken by governments during the recent COVID-19 pandemic-induced economic shock has been broader than ever before. One of the main reasons for this, according to Benmelech and Tzur-Ilan (2020), is a country's ability to deploy conventional policies, such as lowering interest rates. Public debt had already reached unprecedented levels before the pandemic shock on the global economy. Makin and Layton (2021) explained that private investment worldwide has been weak since the global financial crisis of 2008. According to them, the measures resulting from fiscal stimulus actions during the global financial crisis of 2008 included more restrictive bank credit conditions imposed on businesses and increased uncertainty stemming from the global public debt overhang. To stimulate economies, central banks held their interest rates very low and, in some cases, even negative. Benmelech and Tzur-Ilan (2020) revealed that during the pandemic shock, low-interest-rate countries could not significantly reduce interest rates and used more unconventional tools, such as central bank guarantees and financial asset purchases. Furthermore, governments were more likely to relax lending rules based on macroprudential regulations to limit shareholder payouts in the form of dividends or share repurchases by financial institutions (Benmelech & Tzur-Ilan, 2020).

Makin and Layton (2021) revealed empirical evidence that overlooks the realistic possibility that rising public debt levels may lead to downgrades in creditworthiness and an increase in interest rate risk premia. In addition, the statistical findings of Benmelech and Tzur-Ilan (2020) showed that the effect of the debt-to-GDP on fiscal spending exhibits a positive trend. This insight contrasts with the previously accepted view that lower debt levels encourage more aggressive fiscal policy implementations during crises (Romer & Romer, 2018). Benmelech and Tzur-Ilan (2020) also found that countries' ability to respond to adverse economic shocks with fiscal policies is facilitated by their higher sovereign credit ratings. Their findings raise concerns about countries with poor credit histories. Lower-income countries with lower credit ratings may not be able to implement effective fiscal policies to counter economic shocks. This information suggests that a country's credit ranking is a key factor in its ability to resist economic shocks. Evidence provided by Benmelech and Tzur-Ilan (2020) and Makin and Layton (2021) clearly shows that high-income countries, despite historically low interest rates before the shock and a lesser reduction in those rates, were able to announce larger fiscal policies than low-income countries. Bianchi et al. (2019) additionally provided empirical results from a study of 100 countries, showing that countercyclical fiscal policies are rarely observed in high- and medium-risk countries, while low-risk countries (such as the U.S., Sweden, and France) tend to implement countercyclical policies. In terms of a country's ability to pursue expansionary fiscal policies, Benmelech and Tzur-Ilan (2020) argued that credit rating is also essential, particularly among high-income advanced economies.

Caldera Sánchez et al. (2017) analysed data from 1970 to the post-Global Financial Crisis times, capturing the trade-offs between policy measures and economic vulnerability. Two key aspects of this analysis are crucial for understanding how a resilient economy decomposes. The first is the institutional quality to minimise fragility and ensure a higher pace of growth of an economy. This aspect is commonly reflected in resilience measurement performances, as described in the previous section. The second aspect is the sufficiency of policy actions implemented by regional and national governments. The analysis by Caldera Sánchez et al. (2017) clearly shows that appropriate policy actions do not necessarily drive high economic growth; they rather maintain economic stability. Conversely, a lack of appropriate policy actions leads to higher levels of economic vulnerability. The timing of policy implementation in response to various economic challenges could be another subject for future research.

Alberola et al. (2020) also emphasised the peak in fiscal actions among high-income economies in late March 2020, while emerging and low-income economies responded later. Meanwhile, Benmelech and Tzur-Ilan's (2020) data analysis revealed that countries with interest rates below 1% at the beginning of the COVID-19 pandemic deployed larger fiscal spending, primarily through government guarantees.

The room for fiscal policy is another important factor, stressed by Alberola et al. (2020). According to Reinhart et al. (2003), international investors are more sensitive to the fiscal fundamentals of low-income economies and less tolerant of their debt levels. In times of financial stress, such as the present, higher financing costs and restricted access to external financing constrain these countries' fiscal response.

These government measures discussed in this subsection to counter economic shocks walk a fine line between ensuring stability and increasing the economy's vulnerability. If not implemented properly, these internal economic events could become potential sources of economic shocks in future business cycles.

1.2.4. Public events as potential sources of economic shocks

As noted in the previous subsection, internal economic events intended to counter economic shocks may, if not properly implemented, become sources of future shocks. Internal events within a country, along with their economic consequences, can be perceived as external events by surrounding countries. In addition to analysing the actions taken by governments to counter the recent pandemic shock, much of the recent economic literature has focused on the analysis of the long-term impact of the fiscal measures applied. For example, Makin and Layton (2021) noted that although there have been flaws in the operation of wage subsidy programmes, which have come at a great fiscal cost, in principle, they have been more justifiable than the other more basic Keynesian elements of the fiscal response aimed at boosting aggregate demand. However, they stressed that government debt will continue to increase in the absence of substantial budget repairs.

Auerbach et al. (2021) outlined the necessity for governments to not only provide proper support to low-income households but also create an economic environment that encourages spending by high-income households on services provided by lower-income individuals. Their evidence shows that rising inequality between the rich and poor might drag down the country's GDP, particularly if there is a further reallocation of spending by wealthy households away from service sectors where low-income households are employed.

Government investments in infrastructure are widely recommended in the economic literature as reliable and effective fiscal tools, especially for fighting recessions. Yanushevsky and Yanushevsky (2014) highlighted the associated risk of significantly increasing public debt levels resulting from such investments. Ferrari et al. (2016) provided statistical evidence on the infrastructure investment commitments made by national governments to counter the global financial crisis of 2008. Their findings show that this instrument has been commonly utilised by governments in both developed and emerging. Meanwhile, Yanushevsky and Yanushevsky (2014) provided statistical evidence that government infrastructure investments alone are insufficient to reduce public debt levels. Further elaborations on the effectiveness of public investments as fiscal measures naturally lead to a consideration of their distinct, and not necessarily positive, effects on economic development. The frequently published "whatever it takes" fiscal mindset of various public officials can easily devolve into a "spend like there's no tomorrow" approach (Makin & Layton, 2021). Public spending is a sensitive topic at various levels when considering its effectiveness and efficiency—ranging from a project level (Knudsen & Rich, 2013; Nocera et al., 2018; Zanon, 2011) to a fiscal package level (Makin & Layton, 2021; Yanushevsky & Yanushevsky, 2014). Lehtonen (2014) noted increased attention to public investments in the form of "megaprojects". Scholars have defined megaprojects as public investments with total capital costs ranging from EUR 1 billion (Lehtonen, 2014; Denicol et al., 2020) to a national GDP (Pitsis et al., 2018). Flyvbjerg et al. (2003) stressed that even for a large country, the economic ramifications of a single megaproject could likely hinder the economic viability of the entire country. "Mega-projects" and "mega-events" are often associated with the initiatives of policy elites who adopt these types of projects and policies for their symbolic value. At the same time, they highlight the role of power in planning disasters and policy fiascos (Jennings, 2013). Mega-events, such as the Olympic Games, according to Jennings (2013), encompass major public events, including the construction of large-scale infrastructure and facilities (mega-projects), as well as complex event operations that involve the escalation of regular levels of public and private sector activities, such as air and rail transport services, police, and emergency services.

Many scholars (Flyvbjerg et al., 2003; Priemus, 2010; Lehtonen, 2014; Denicol et al., 2020) have elaborated on various pathological issues of infrastructure megaprojects, such as complexity, urgency, size, local institutional behaviour, multilevel and multi-actor governance, lack of project management competence, high uncertainties, and so on. These issues often lead to cost overruns, implementation delays, and deviations from predefined specifications. Love and Ahiaga-Dagbui (2018), Knudsen and Rich (2013), and Lehtonen (2014) highlighted the issues of strategic misrepresentation and optimism bias that deserve significant attention during the planning process of infrastructure megaprojects by public agencies in developed economies. Denicol et al. (2020) added escalating commitment as a third predominant component, in which megaproject executives continue to follow the predefined pattern leading to unsuccessful outcomes rather than diverting and pursuing an alternative and safer course of action.

Makin and Layton (2021) considered the impact of incurring public debt on economies as an empirical question, but they viewed it unfavourably. They provided evidence from studies across various countries, indicating that a 10% increase in public debt is associated with a decrease in economic growth of approximately 0.3%. This negative effect suggests that public debt has not effectively funded additional productive economic activity in the long term.

The analysis of changes in industrial portfolios in the literature reveals a cyclical shift in the causal effects between economic shocks and both internal and external events in the development of economies, where externalities play a key role in determining the resilience of economies to shocks. Economic responses to shocks are identified in the literature as efforts to reorient and enhance the properties of their economic structure (industrial portfolio). However, such responses may lead to subsequent economic shocks.

Matsuyama (2009) noted that there is no closed economy in the real world, with the only closed economy being the global economy itself. This, consequently, indicates that the mixed results in economic resilience research (Martini, 2020; Oprea et al., 2020; Hundt & Grün, 2022; Delgado-Bello et al., 2023) could derive from the necessity for an economy to engage in trade with other economies, with externalities from surrounding economies potentially distorting the cyclicality of economic development.

1.3. Analysis of the link between industrial portfolio and economic development through economic theories

Economic geography encompasses a wide range of theories and perspectives relevant to economic growth and development, focusing on integrating local initiatives and addressing contemporary global economic challenges. According to Clark et al. (2018), economic geography explores theories and perspectives relevant to economic geography today as it expresses the linkages between inequality, instability, and sustainability in the global economy, economic behaviour, strategies, and practices, as well as resources and development. Research in economic geography is influenced by the social development environment, with topics evolving rapidly due to new findings and emerging trends (Zhan & Gu, 2022).

1.3.1. Analysis of main economic theories on resilience to economic shocks

The objects of this dissertation are the resilience factors of EU countries. This subsection therefore summarises key economic geography theories discussed in the literature on resilience factors at various levels (industrial, national, and regional).

Classical theory promoters described the general view of the forces that shape economic growth and the mechanisms of the growth process. Classical economic theory is envisioned as the cornerstone of subsequent theories in economic geography (Table 3). Private ownership, free market, limited government intervention, savings, and productive investments in the form of profits were considered the main drivers of the economy (Pelsa & Balina, 2021).

Table 3. Classical theories

Theory	Founders	Focus of the theory	Sources of literature
Classical economic theory	Adam Smith (1723–1790)	Wealth is created from labour; self-interest motivates individuals to use their resources to earn money.	Manis (2005); Butler (2011)
Classical economic liberalism	John Stuart Mill (1806–1873)	Economic development is a function of land, labour, and capital. Encourages free market and laissez-faire economics, emphasising individual economy, limited government, economic freedom, and freedom of speech.	Pelsa and Balina (2021); Anschutz (2024)
Ricardian economics	David Ricardo (1772–1823)	Comparative advantage: free trade between two or more economic systems can be mutually beneficial. Supply and demand are price-dependent in short periods. Distribution theory: division of national product among social classes: - wages for workers, - profits for capital owners, - rents for landlords.	Ricardo (1821)
Labour-based theory of value	Adam Smith (1723–1790), David Ricardo (1772–1823)	Pricing is based on the production cost.	Baumol (2024)

The integration of externalities into economic geography theories becomes more visible in the literature, starting with Keynesian theories (Table 4). Keynes (1936) promoted government policies to ensure the management of economic crises and boost production and growth. The works of Arrow (1962), Maki (1991), and Leontief (1936) evaluated external effects on local economic development paths; however, the perspective of evaluation remains primarily local.

Table 4. Keynesian theories

Theory	Founders	Focus of the theory	Sources of literature
Keynesian economics	John Maynard Keynes (1883–1946)	Measures to prevent economic downturns through government-backed policies aimed at full employment. Focuses on active government policies to manage	Keynes, (1936); Greenwald and Stiglitz (1987)

		aggregate demand and avert economic downturns. The key factor is real demand; economic growth should arise from an expansion of real aggregate demand.	
General equilibrium theory	John Hicks (1904–1989), Kenneth J. Arrow (1921–2017)	Labour-saving technological progress does not necessarily reduce labour's share of income. The IS-LM (Investment-Saving and Liquidity Preference-Money Supply) diagram illustrates that an economy can achieve equilibrium even with less-than-full employment. In certain circumstances where rationality and equality are considered, it may be impossible to ensure that a ranking of societal preferences precisely matches the rankings of individual preferences, especially when multiple individuals and alternative choices are part of the equation.	Arrow (1962); Britannica (2024)
Export base theory	John Alexander, Douglass North, and Charles Tiebout	Export is the main driver of regional development due its regional multiplying effect. Regional economic activity can be divided into activities that produce goods and services for export to other regions (export base) and activities that produce goods and services for local consumption (non-basic activities).	Maki (1991); Sousa (2010)
Input-output theory	Wassily Leontief (1905–1999)	Activities within a local economy have varying multiplier effects. These local multiplier effects depend on the local industrial mix and the linkages between local industries.	Leontief (1936); Sousa (2010)

Neoclassical and subsequent theories consider regional diversity, which is influenced by globalisation (Table 5). According to Solow (1956) and Dimand and Spencer (2008), financial globalisation should lead to capital flows from capital-rich economies to capital-poor economies.

Table 5. Neoclassical and subsequent theories

Theory	Founders	Focus of the theory	Sources of literature
Neoclassical economics	John Bates Clark (1847–1938)	Buyers maximise their gains by increasing their purchases of goods until the benefit from additional units is just balanced by the cost of	Leonard (2002); Sousa (2010)

		obtaining them (utility maximisation — the satisfaction associated with the consumption of goods and services) Labour, capital, and technology are the three driving forces, and their combination results in a stable rate of economic growth.	
Neoclassical growth model	Robert M. Solow, Trevor Swan	Exogenous model of economic growth that analyses changes in the output of an economy over time, resulting from changes in: - population growth rate, - savings rate, - technological progress rate. The system of economic growth requires equilibrium, which can be ensured by the equality of total demand and total supply.	Solow (1956); Dimand and Spcencer (2008); Kose et al. (2010)
Monetarism	Milton Friedman (1912–2006)	Changes in the money supply affect real economic activities in the short run and the price level in the long run (opposite to the Keynesian view that "money does not matter")	Caldwell (2024)
Endogenous growth theory	Robert Emerson Lucas Jr. (1937–2023), Paul Romer	The main sources of economic growth are endogenous. Long-term regional growth is envisioned as the product of capital accumulation and labour (traditional neoclassical view), along with regional characteristics such as human capital, R&D, innovation, knowledge, and the spillover effects of knowledge and technological developments.	Romer (1990); Sousa (2010)
Agglomeration theory	Alfred Marshall (1842–1924)	Mechanisms that cause employees and firms to co-locate geographically.	Marshall (1890); Potter and Watts (2011)
Economic development theory	Jozeph Alois Schumpeter (1883–1950)	Quality improvement, risk reduction, innovation, and entrepreneurship are the criteria that put economies on a higher growth trajectory.	Schumpeter (1939); Feldman et al. (2016)
Portfolio theory	Harry Markowitz, Andrew Donald Roy (1920–2003)	Portfolio diversification involves allocating wealth across various assets. Diversification is a key component of investment decision-making under the risk of uncertainty.	Markowitz (1952); Roy (1952); Koumou (2020)

Evolutionary economic geography	Ron Boschma and Koen Frenken	Changes in the economic landscape over time by applying the concept of "routine". Inspired by processes of innovation and regional growth in evolutionary economics.	Boschma and Frenken (2006); Wataru (2013)
Regional diversification theory	Ron Boschma	Processes of unrelated diversification in the role of an entity from the point of view of: - institutional entrepreneurship, - enabling and constraining factors at various spatial scales.	Boschma and Frenken (2006); Boschma et al. (2017)
Human capital theory	Robert Emerson Lucas Jr. (1937–2023),	Distinction between the economic development of poor countries and the economic growth of rich countries. A common economic system should be applied to every country, with a focus on understanding how poor countries can achieve growth.	Lucas (1988)
New economic geography	Paul Krugman	Focus on imperfect competition and increasing returns in the international economy.	Krugman (1990)

The theories listed in Tables 2, 3, and 4 collectively outline the influence of geographical characteristics, the evolution towards incorporating space and place into innovation processes, classification into different models, and a research focus on innovation, growth, and global trends. According to Crescenzi (2014), economic geography theory has evolved to incorporate the role of space and place in the analysis of innovation processes, emphasising specialisation, diversification patterns, institutional-relational factors, and non-spatial proximities. Dunford et al. (2014) noted that existing theories of geographical specialisation and trade can be classified into supply-side, demand-side, endogenous growth, and institutional models. Redding and Rossi-Hansberg (2017) highlight that the distribution of economic activity in economic geography is influenced by exogenous geographical characteristics and endogenous interactions between agents in goods and factor markets.

Apart from its characteristics, findings in the scholarly literature identify the following key principles of economic geography theories:

- Interdisciplinary approach – economic geography incorporates theories and methods from sociology, management, anthropology, and cultural studies, reflecting its interdisciplinary nature (He et al., 2014).
- Context sensitivity – economic geography emphasises the role of context throughout theory development, highlighting the sensitivity to local context in the theorising process (Gong & Hassink, 2020).
- Relational perspective – the relational approach in economic geography emphasises the importance of social relations, spatial and temporal interplay, and

inter-firm interactions in understanding the contemporary economy (Bathelt & Glückler, 2018).
- Evolutionary turn – economic geography has experienced turns in research perspectives, including the evolutionary turn, which focuses on economic evolution and the examination of production structures, value networks, clusters, and institutions (He et al., 2014; Dunford et al., 2014).

The emphasis on the local context stands out in economic geography theories as critically important during the period when globalisation reached its peak (Kahler, 2004). It is important to note Matsuyama's (2009) perception that there is no closed economy in the real world, and the only closed economy we know of is the global economy itself. In resilience research, the necessity for an economy to participate in trade with other economies triggers the need to include externalities, which alter the development paths of the economy.

The following examples demonstrate that despite differences in approaches, both endogenous growth theories and neoclassical theories attempt to incorporate externalities into the development of a local economy. The endogenous growth theory (Romer, 1990) states that economic growth in an economy is formed internally, through endogenous, rather than through exogenous, forces. This theory contrasts with the neoclassical theory, which states that the main sources of economic growth are external factors, such as technological progress (Pelsa & Balina, 2021). Romer's (1986) competitive equilibrium model also includes the effects of externalities. Other theories (Agglomeration, Economic development, Portfolio, Regional diversification, Human capital, New economic geography) include the inter-regional or international context in their definitions, yet the perceptions tend to drift towards a local or regional level, leading the research towards regional-specific outcomes. The theory of economic development emphasises quality improvement, risk reduction, innovation, and entrepreneurship—characteristics that place an economy on a higher growth trajectory. Additionally, Schumpeter's (1939) business cycle theory promotes the view that economic development is possible only in cycles that are based on the creation and exploitation of new knowledge and innovation. However, Schumpeter's (1939) research focused on the regional level. Krugman's (1990) New Trade Theory emphasises increasing returns and imperfect competition in the international economy, but regional specifics prevail.

The analysis of the theories in Tables 3, 4, and 5 suggests a common property: their construction on the basic principles initially laid out in the Classical economic theory (Table 3). The following subsection analyses the applicability of economic geography theories for measuring economic resilience, with an emphasis on how their principles could be applied to measure national resilience when economic cycles are continuously disrupted by external and internal events.

1.3.2. Applicability of economic theories to resilience through the industrial portfolio approach

The main economic geography theories are closely interlinked. The discussion of various concepts in subsequent theories arises from the basic principles of classical economic theory. For example, promoters of classical economic theory suggest that the most important factor in the price of a product is the cost of its production. Promoters of neoclassical theories, on the other hand, argue that the main factor in the definition of price is consumers' perception of the value of the product. According to the neoclassical perspective, the main economic problem is the organisation and allocation of limited resources (Pelsa & Balina, 2021).

The following analysis aims to address the applicability of classical economic theory in today's economic environment and, subsequently, its relevance to resilience research.

A nation's wealth, according to Adam Smith, is its per capita national product for a given mix of natural resources (Manis, 2005; Butler, 2011). Smith's subsequent elaborations considered skill, labour efficiency, and a productive population as the main components of the nation's wealth that contribute to the accumulation of per capita product. Smith's "invisible hand" theory highlights how self-interested actions of individuals collectively manage to maintain a functional social order within an economy. Since the introduction of Smith's "invisible hand" theory, various economists have widely elaborated on the rational reasoning of individuals and businesses (Milgrom, 2017). However, these discussions primarily revolve around the proportion of the population engaged in productive work and the availability of natural resources in the economy. Their analyses suggest that classical thinking prevails in the real economic environment. This led to the textbook notion that governments should refrain from attempting to control free markets (Pindyck & Rubinfeld, 2013; Bueno de Mesquita, 2016; Milgrom, 2017). Bueno de Mesquita (2016) noted that rational individuals do not consider externalities when making decisions (rational thinking). Milgrom (2017) suggested a definition of the classical economic approach to the structure of a market, explaining how markets can be effective on their own without external control, based on the following well-known economic theories:

- The "invisible hand" theory of Adam Smith.
- The Coase theorem: In a conflict of property rights (under ideal economic conditions), the parties involved negotiate terms that accurately reflect the full costs and underlying values of their rights, resulting in the most efficient outcome.
- Arrow-Debreu model: An economy is a combination category of entities—households, producers, and the market. Households and producers perform their activities within the market, and their activities have a rather indirect effect on each other.
- The first welfare theorem: Under certain conditions, an allocation achieved by a market economy is Pareto efficient. This means that resources within the economy cannot be reallocated to make one entity better off without making at least one entity worse off.

Veseth (2014) highlighted the strengths of free market choice, whereas Pindyck and Rubinfeld (2013) identified four basic reasons for the failure of free markets: market power, incomplete information, externalities, and public goods. While both approaches identify the conditions necessary for free market operations, Milgrom

(2017) suggested a different approach. He provided important insights into the essential aspects that form the basis for the well-known economic theories mentioned above. All these theories explain how parties can achieve efficient outcomes without external control and establish the foundation for the classical economic approach. However, all the theories are based on certain preconditions, which must be minimal or have no influence on them in real life:

1. Externalities should not be a significant factor, allowing the rational thinking of parties to prevail.
2. Perfect competition should be considered, allowing all parties to operate under the same market conditions.
3. Product homogeneity is elaborated in the Arrow-Debreu model, which proposes that consumers and businesses are indifferent to which specific products they receive or supply because all products in the same category are assumed to be identical. Thus, the only relevant constraint on market transactions is the quantity demanded, which must equal the quantity supplied.
4. Prices exist in an economy where supply equals demand, as explained by the first welfare theorem.

The global population was approximately 1 billion in the 1800s, with around 3% of the population living in cities or urban centres (UNESCO, 2010). Two centuries ago, when Adam Smith's "invisible hand" was a novelty, the economic environment was much more favourable to exploit the benefits of a free market. The distribution of the population was more widespread, with people living in rural areas. They were also more isolated from each other, as their social life, compared to today, was quite poor. This environment implies that access to information was limited as was the sufficiency of relevant information. In fact, Florini (2007) reflected on the events in Europe at the end of the eighteenth century, which essentially initiated discussions on free information flows. For example, in the context of the fight for transparency and the right to know, she pointed out Sweden as the first country to grant citizens the right to government-held information. Individuals had to rely on their basic knowledge when making business decisions. Therefore, people tended to make rational decisions (Bueno de Mesquita, 2016). The rational decision-making naturally resulted in outcomes that differed from those in today's world. The insignificance of overlapping between business activities due to the isolated environment of the 1800s resulted in the environment, where externalities naturally had a relatively small effect on the welfare of third parties. Rational reasoning, based on individuals' basic economic knowledge, led to an environment where perfect competition prevailed (Milgrom, 2017). The dominance of agricultural production two hundred years ago naturally suggests that product homogeneity was common. In this agricultural market setup, the possibility of Pareto optimal prices existing was significant. As a result, the classical economic approach was found to be very viable.

The understanding of the market in the current world differs from the classical approach. According to estimates by the United Nations (2022), the world population has been increasing at a tremendous rate over the last seven decades, with no signs of slowing down in the near future. From 2.5 billion in 1950, it has more than tripled, reaching almost 8 billion by 2022, with an estimate to reach 10.4 billion by 2100. Carneiro Freire et al. (2019) reported that, as of 2015, the urban population rate had exceeded 76.5% (more than 5.6 billion people). This figure is on the path to reaching 85% by 2100. The OECD (2015) stressed that within 150 years, the urban population will have increased from less than 1 billion in 1950 to 9 billion by 2100. Urban areas currently consume over 75% of the planet's resources, and future estimates project significant challenges for governments to ensure urban development sustainability. Loungani et al. (2017) noted structural changes that are placing services at the centre of global commerce, as the share of services exports in total goods and services exports doubled from 1970 to 2014.

According to Eurostat data (2023b), in 2022, services accounted for about 20.8% of the world's total trade value, whereas services in the EU account made up to 30.9% of the total trade value of goods and services within the EU. However, these numbers do not reflect the true share of human effort in services compared to total human effort in global economic activities today. First, the trading prices of services are significantly lower than those of goods. This is because the trading prices of services consist of the efforts of employees to create and deliver the service. The trading prices of goods usually have a significant share of supplies and raw materials evaluated, whereas the efforts of personnel to finalise the goods account for a lesser share. The prices of supplies and raw materials can be quite high because the breakdown of the value of materials (as described in the sub-chapter above) includes the value of labour involved in the extraction and production of those materials. A construction project serves as a suitable example in this case. Design and technical supervision services typically account for around 10% of the total project value (Sistela, 2023), whereas the cost of materials needed for the project is generally much higher. Additionally, the economic shock of the COVID-19 pandemic at the beginning of 2020 was named by the International Monetary Fund "the worst recession since the Great Depression of 1930" (Gopinath, 2020). There is much econometric (Oprea et al., 2020; Martini, 2020; Di Pietro et al., 2020) and empirical (Makin & Layton, 2021; Auerbach et al., 2021) evidence supporting the importance of developing the services sector to effectively respond to economic shocks. In the context of the recent COVID-19 pandemic shock, Auerbach et al. (2021) emphasised the necessity for governments to not only provide proper support to low-income households but also create an economic environment that encourages high-income households to direct their spending towards services provided by lower-income individuals. Bold and timely fiscal policy decisions by the world's leading economies (Makin & Layton, 2021) led to the most recent communication from the International Monetary Fund on promising trends in the recovery of the world economy (Gopinath, 2021). With respect to Loungani et al.'s (2017) perceptions, the rapid growth of the telecommunications and information technology (IT) services sector could have played a significant role in the recent economic recovery worldwide. This discussion emphasises the need to alter the structure of the global industrial portfolio by directing more efforts towards the supply of services while reducing global efforts in materials production. However, a gap in scientific knowledge remains regarding the identification of the optimal share of services in world trade.

Massive information flows from internet sources have designed the contemporary world, leading to dramatically increased social interactions. By providing examples of externalities from everyday life in modern society, Bueno de Mesquita (2016) explicitly illustrates the spillover effects of individuals on the welfare of others at nearly every step. Veseth (2014), therefore, questioned the possibility of achieving perfect competition nowadays and suggested careful governmental actions to assist the market. Milgrom (2017), meanwhile, investigated how complexity causes the failure of unregulated and decentralised markets, and how the components of market design can affect market performance in such cases. Milgrom (2017) challenged the redundancy of popular justifications for classical thinking because of the inefficiency of scientific formalisation processes. Bueno de Mesquita (2016) additionally proposed illustrations of contemporary situations where the influence of information externalities jeopardises the environment in which rational decision-making leads to various failures. As a solution, Milgrom (2017) referred to the preconditions of perfectly competitive, unorganised markets, as defined in the context of classical economic theory, which significantly contribute to their eventual failures: externalities, identical conditions, product homogeneity, and prices at which supply equals demand in the market. Milgrom (2017) linked the need for careful market regulation to the complexity of the market's constraints. Veseth (2014) added that an externality is created when there is a breakdown in the structure of private property rights, which causes imperfect competition in the contemporary economy. According to Bueno de Mesquita (2016), externalities ignored by individuals in decision-making create serious social problems, whereas policymaking could be an effective tool to improve social well-being. Milgrom (2017) suggested that market regulation could be a justified measure when market power is contained, for instance, when monopolies are prevented from engaging in disruptive price manipulations. Regulatory actions help deal with the neighbourhood effect, as described by Veseth (2014), when an individual's decision-making, including the costs and benefits of their actions, extends well beyond the individual's backyard. Economists generally point out that it is impossible to impose perfect regulatory rules in real life. Regulatory rules require the creation of regulatory systems and processes with firm missions of their own, and failures to achieve this often lead to excessive and counterproductive regulations (Milgrom, 2017).

These implications suggest that the current economic environment in the world has changed in a way that one could consider the theories of Adam Smith to no longer be applicable. This notion may be partially applicable to the "invisible hand" theory, but the "wealth of nations" theory is more relevant today than ever before for the following reasons.

The first is that the global economy functions as a complex system with interconnected elements and scales, involving interactions among the economies of nations, regions, and local entities within the processes of globalisation, as outlined by Dicken (2003). The second is the availability of statistical data today, which enables research to assess economic performance at the global level with a higher degree of precision (OECD, 2023; Montrimas et al., 2023).

Mainstream economic geography today is increasingly researching green manufacturing and services, but conceptual approaches continue to rely on traditional growth paradigms, prompting the need for critical contributions on post-growth economies and potential research topics in economic transition (Schulz & Bailey, 2014). Environmental crises are becoming increasingly severe. Lange et al. (2021) highlighted the climate crisis as a particularly prominent topic for public debate. Ideas about the utilisation of natural resources have emerged as important components of economic development since the 1970s. Consequently, the increase in greenhouse gas concentrations in the atmosphere is just one particularly striking anthropogenic intervention in ecosystems (Bindoff et al., 2013; Lange et al., 2021).

Feldman et al. (2016) stressed that economic development is often conflated with development and growth, which elevates confusion in both policy and academic debates. Pelsa and Balina (2021) stressed that an increasing number of economists highlighted that existing economic growth rates, such as GDP, do not reflect the true well-being of the economy and society. They emphasised that the theories of economic growth are based on the belief that economic growth always guarantees the progress of humankind, but they cannot be assessed on their own. This is because these assessments underestimate the current ethical issues of wealth creation and ignore their future negative effects. Economic growth has a strong theoretical foundation and can be easily quantified as an increase in aggregate output (Feldman et al., 2016). Ricardo (1821) and Solow (1956) in their theories of economic growth, defined an economy as a machine that produces economic output as a function of labour, land, and equipment in the form of inputs. They did not account for subsequent negative changes in prosperity or quality of life. In this respect, growth occurs when output increases, and it can be easily quantified and measured (Feldman et al., 2016). This notion makes economic growth a straightforward concept that dominates research.

Economic development, on the other hand, is associated with institutions, social capital, labour and capital mobility, and income and wealth equity (Feldman et al., 2016). It also places particular emphasis on fairness for future generations, based on the concept of intergenerational justice (Pelsa & Balina, 2021). In the effort to distinguish economic development from economic growth, Feldman et al. (2016) outlined the economic development properties of focusing on quality improvements, risk mitigation, innovation, and entrepreneurship as factors that place the economy on a higher growth trajectory. They stressed that economic development represents the conditions that determine the microeconomic functioning of the economy, affecting both the quality of inputs and the opportunity set for firms, while economic growth is more closely tied to macroeconomic conditions and a function of market forces.

Along with the evolution of economic growth and development theories, a new movement of "Postdevelopment" theory promoters began in the 1980s. The founders of the "Postdevelopment" theory (Illich, 1979; Escobar, 1984) contributed to the literature by raising a stringent and multifaceted critique of the idea of economic development while taking a critical stance against globalisation (Matthews, 2010).

Lange et al. (2021) emphasised the post-growth stages of economic cycles within post-growth theory. They stressed that economic geography has paid little attention to concrete forms of work and their influence on production structures, networks, and spatial constructs, prompting a perspective on post-growth that places the category of "work" and its particular socio-spatial implications at the centre of consideration.

Today, the goal is to ensure the sustainable development of society, which includes economic, social, and environmental aspects for a better quality of life (Pelsa & Balina, 2021). Thus, the economic theories applied in this research must be oriented towards quantifying resilience in economic development theories. The significant presence of externalities, stressed in the previous subsections, increases the difficulty of measuring economies' resilience, considering the necessity to evaluate the conditions that describe their microeconomic performance in the context of economic development. Moreover, Matsuyama's (2009) perception of the open nature of economies around the world, where the only closed economy is the global one, prompts the consideration of the global perspective of economic development, although the microeconomic environment must still be considered.

Therefore, this research considers the application of holistic theory in further research when comparing resilience in economies. **Holistic theory** posits that the parts of any whole cannot exist and cannot be understood except in their relation to the whole (Vocabulary). Holistic theory has been widely applied in psychology (e.g., Individual psychology by Alfred Adler; Ewen & Ewen, 2010), and scholarly research is also found in the areas of ecology and sustainability (Rosen, 1991; Milne, 2017). Rosen (1991) and (Milne, 2017) underlined that ideal models in holistic theory reliably relate natural causality to syntactic entailment, but the level of abstraction required to meet this requirement is higher than the epistemological level of subjects and objects that constitute the domain of sustainability. Despite its adaptation to specific areas of study, holistic theory retains its mains unchanged because, according to Milne (2017), a worthy theory is distinctly separate from the phenomenon it seeks to explain, and the principles it adopts remain independent of the specific problem being addressed.

There is limited direct information on holistic theory in economic geography studies. Similarly to the "resilience" concept in economics, which was adapted from ecology studies, this research envisions the global economy from a holistic perspective in search of long-term economic sustainability based on the holistic theory of the great economic philosopher Adam Smith (Sobel, 1979). This research, therefore, aims to adapt holistic theory from the field of ecology, as it represents and connects the main concepts of national resilience to economic shocks, assessed through industrial portfolios. Various studies on regional resilience in the literature review identified external interactions with other regions (externalities) as causes of unpredictability in the development of regional business cycles (Neff, 1949; Pike et al., 2003; Eaton & Kortum, 2002). An analysis from a holistic perspective would suggest that all other regions and their business cycles are internal.

Vitousek et al. (1997) and Huesemann and Huesemann (2011) noted that holism rejects practices that externalise the consequences of development, which routinely lead to toxic accumulations, reduced biodiversity, compromised ecosystem function, injustice, and economic disparity. They argued that it provides novel freedom to embrace diversity at multiple levels of organisation as a prerequisite for meeting both present and future challenges. Milne (2017) identified essential elements for the predominant concepts of holistic theory for the ecology sector, which may not apply to the topic of economic resilience to shocks. However, the essential component—the complex and multifaceted nature of humans and their behaviour, along with their role in the development of the world—aligns with the ideas of the great economic philosopher Adam Smith, as well as those of many other subsequent economists.

The adaptability and relevance of the analysed concepts and theories are discussed in the following chapter, where they are applied to the methodology and models for measuring resilience in previous scientific research.

2. METHODOLOGY FOR ASSESSING THE IMPACT OF CHANGES IN INDUSTRIAL PORTFOLIO ON RESILIENCE TO ECONOMIC SHOCKS

Based on the analysis of the concepts and theories found in the literature and discussed in Chapter 1, this chapter is dedicated to analysing the methods applied in the literature to measure the economies' resilience by considering the properties of their industrial portfolios. It examines the main resilience evaluation methods and quantification models used by other researchers, with an emphasis on the resilience quantification indicators employed in previous studies. It also evaluates their applicability for solving the problem considering the current state of statistical data availability. This chapter ultimately identifies the set of concepts taken from previous studies and develops the theoretical methodology for further research in this dissertation. The developed methodology will later be used to assess the impact of industrial portfolio changes on EU economies' resilience to economic shocks. Although the data are set for global economic performance within the ICIO Tables, the developed methodology could be applied to any region of the global economy.

This chapter addresses the visible issue of the presence of externalities in economic geography theories, which distort the results obtained by applying resilience measurement models at the regional, country, and community levels. The proposed approach in this chapter is to consider the global economy as one integral economic system in which most externalities become integral parts of global economic development. Second, the concepts, theories, and methodology from the literature analysis are adapted for the development of a new methodology. Third, the construction of the new methodology is described along with the development of the conceptual model.

2.1. Analysis of methods and models for assessing resilience to economic shocks

The problem of resilience has been studied for a long time, but the issue of assessing resilience to economic shocks gained significant relevance among scientists at the beginning of the 21st century when the consequences of the 2008 global financial crisis were devastating to many economies (Martini, 2020).

In the scientific literature, there are many methodologies for assessing the resilience of regions, but there is a lack of a generally recognised methodology for measuring the resilience of regions to economic shocks (Palekienė, 2016; Martin & Gardiner, 2019). Their absence encourages a deeper look at this problem from both theoretical and practical perspectives to form and justify the necessity, methodological foundation, and timeliness of creating a methodology for assessing the resilience of regions to economic shocks.

A region, according to Palekienė (2016), is a system that consists of economic, social, demographic, cultural-historical, political, natural, and infrastructure subsystems. This concept could also be applied to a country because a country includes the same properties. The resilience of the whole system within a country depends on the resilience of each subsystem, i.e., the capacity to ensure the economic stability and continuity of the country during a shock period. The resilience of each subsystem takes on a different meaning, depending on the depth of its vulnerability and ability to quickly recover and return to the pre-shock level of economic development (Martin et al., 2016). Therefore, when assessing the resilience of the entire system, it is necessary to justify the importance of each subsystem in the context of the system and to analyse and highlight its capabilities that ensure its resilience within the whole system to an economic shock.

In the literature, various resilience models have structurally combined the factors that contribute to the resilience of the whole system. The most popular models are designed to examine the system's resilience to various external conditions, such as natural disasters. UNDRR (2022a) stressed that for the global community, the coming years present an unprecedented opportunity to achieve the twin goals of sustainability and resilience, highlighting the joint efforts of scientists in economics and environmental studies to achieve the same goal. Yet, there is a lack of universally recognised models to examine the resilience of regions or cities to economic shocks. Insufficient analyses of the suitability of general resilience models for assessing regional resilience to economic shocks demonstrate the necessity of their further theoretical and practical modelling.

Martin and Gardiner (2019) identified four main recessionary resilience measurement methods that are commonly applied in the literature. Representative examples of these methods are presented in Table 6.

Table 6. Main resilience measurement methods (adapted from Martin & Gardiner, 2019; references in the table amended by the author)

Method	Representative authors
Descriptive case studies	Simmie and Martin (2010); Hill et al. (2012); Hu and Hassink (2017); Pilinkienė et al. (2021)
Resilience indices	Martin (2012); Martin et al. (2016)
Statistical time series models	Fingleton et al. (2012); Doran and Fingleton (2018); Di Pietro et al. (2020)
Causal and structural models	Picek and Schröder (2018); Oprea et al. (2020); Ženka et al. (2021); Hundt and Grün (2022)

- Descriptive case studies – mainly narrative-based, using simple descriptive data. The focus is on interviews with key actors and the interrogation of policies. Sometimes they are comparative (e.g., two cities or regions).
- Resilience indices – focus on unitary or composite measures, often related to a reference position. These models may use "dashboards" incorporating key economic indicators. The models are often comparative between cities or regions and develop resilience rankings.
- Statistical time series models – ARIMA-type models, which include dummies for shock and recovery periods. These models are used to generate counterfactual or expected positions for cities or regions, assuming no economic shock occurred. The counterfactual positions are then compared to actual outcomes. These models may as also include stochastic mean reversion models.

- Causal and structural models – include dummies as regressors for economic shocks or estimate counterfactual positions. They are used to develop impulse responses or error corrections. These models also include properties for regressing resilience indices on selected independent variables.

Descriptive studies from previous research provide valuable insights for developing quantitative problem-solving approaches. Therefore, the quantitative methods in Table 6 are reflected in the resilience measurement model construction.

The analysis of key resilience models used in contemporary scientific literature and practice of international institutions, presented in the following subsections, highlights the advantages and disadvantages that should be considered when assessing the resilience of economies to shocks. The analysis also distinguishes the main resilience assessment indicators most commonly identified in scientific studies.

2.1.1. Community level resilience assessment models and their factors

The research has shown that there are many resilience assessment models worldwide that structurally combine the factors determining resilience into a common whole (models in Table 7). These methods allow the assessment of resilience based on the dynamics of both quantitative and qualitative individual indicators, which in turn helps to achieve the goals of economic development and sustainability. Many of these models are composite indicators. The term “composite indicator” refers to the manipulation of individual variables to produce an aggregate measure of disaster resilience (Cutter et al., 2010).

Table 7. Summary of key resilience assessment models at the community level of application

Model	Authors	Levels of application	Properties and indicators for assessment of resilience to economic shocks
Earthquake engineering research model	Tierney and Bruneau (2007)	Community	Factors for assessing the resilience of a community to natural disasters: - robustness (safety assessment in the construction of new infrastructure, intensity of disaster occurrence and action planning, social vulnerability, economic diversification); - redundancy (ability to shift to substitutes, alternative solutions to cope with natural disasters, possibilities to provide housing and necessary assistance to victims, adaptation of mobility to a changing environment); - resourcefulness (availability of resources for recovery, ability to transform, capacity to meet the needs of community members, ability to improvise and innovate); - rapidity (duration of system contraction, duration of recovery, duration between the onset to shock and the beginning of recovery, duration of recovery of vital services, duration of regaining the system's functionalities and lost income).
Network of adaptive capacities model	Norris et al. (2008)	Community	A system can perform several functions simultaneously: adapting to the consequences of an economic shock while also seeking strategic solutions to not only recover from the experienced shock but also to implement structural changes. 4 dimensions of a system's adaptive capacities: - economic development (risk assessment and vulnerability, level and diversity of economic resources, balance of resource distribution); - social capital (received social support, expected social support, social establishment (informal ties), organisational ties and cooperation, resident involvement, leadership and roles (formal ties), sense of community, attachment to the place of residence); - community skills and competencies (community action, critical thinking and problem-solving skills, flexibility and creativity, collective effectiveness and empowerment, political partnership); - information infrastructure and communication (media tools, presentation of factual events, reliable sources of information).

System resilience model	Cutter et al. (2010)	Community	Resilience of a system to external impacts (disasters, catastrophes, etc.) by systematically distinguishing the resilience-forming capacities within the subsystems. Composite indicators for disaster resilience measure: - social resilience – the differential of social capacity within and between communities; - economic resilience – economic vitality of communities, including housing capital, equitable incomes, employment, business size, and physician access (variables include share of employment, share of homeownership, business size, female labour force participation, proxy for single-sector employment dependence); - institutional resilience – characteristics of mitigation, planning, and prior disaster experience (from Norris et al., 2008); - infrastructural resilience – mainly an appraisal of community response and recovery capacity (sheltering, vacant rental housing units, and healthcare facilities); - community capital (social capital) – relationships between individuals and their larger neighbourhoods and communities.
PEOPLES resilience model	Renschler et al. (2010)	Community	The PEOPLES (Population and Demographics, Environmental/Ecosystem, Organised Governmental Services, Physical Infrastructure, Lifestyle and Community Competence, Economic Development, and Social-Cultural Capital) model is the adapted MCEER (Multidisciplinary Center for Earthquake Engineering Research) model (Renschler et al., 2010) with 7 potential qualitative and quantitative indicators for assessing the resilience of a system: - population and demographics (distribution, socioeconomic status, etc.); - environmental protection/ecosystem (air quality, biodiversity, etc.); - government regulation (legal services, healthcare, etc.); - physical infrastructure; lifestyle and community competence (quality of life, etc.); - economic development (production, finance, labour force distribution, etc.); - sociocultural capital (scientific institutions, care services, etc.).
CoBRA model	UNDP (2016)	Community	The CoBRA (Community-based resilience analysis) model is used mainly in Africa by the UNDP (United Nations Development Programme) under the framework of the Humanitarian Aid and Civil Protection Department of the European Commission's Drought Risk Reduction Action Plan. The model is used to assess the effects of natural disasters. The

			considered threshold for a resilient community is when it meets the basic needs (food, water, healthcare, etc.). There are 5 factors ensuring resilience for assessment: - physical capital (infrastructure – roads, electricity supply, water, etc.), access to new technologies, land ownership); - human capital (level of education of household members, their food safety and health protection); - financial capital (employment opportunities, trade, price and income changes, functioning market, access to financial services, etc.); - natural capital (abundance and quality of natural resources, sustainable development and regulation of natural resources, issues of human and animal populations); - social capital (local community support networks; number, scale and their functionality; the ability of community members to plan, mobilise resources, and implement the planned strategic decisions, etc.).

According to Cutter et al. (2010), the strengths and weaknesses of composite indicators are based on the quality of the variables chosen. Microeconomic-level quality indicators may effectively represent a particular region in a model; however, challenges arise in evaluation at the macroeconomic level, where community-specific indicators can be difficult to compare with each other. Another issue with community-level resilience assessment models is that they are intended to examine a system's resilience to shocks, mainly caused by hydrometeorological or climatic events (e.g., earthquakes, tornadoes, etc.), rather than those originating from the market disruptions or economic affairs.

There are resilience measurement models that incorporate composite indicators at the national level, applicable for measuring resilience when countries face disruptions of economic origin as well. Briguglio et al. (2009) developed a composite Resilience Index at the national level, which includes four assessment areas:

- Macroeconomic stability – determines the interaction of aggregate demand and supply. The equilibrium characteristic of the economy ensures the sustainable fiscal condition of the system, i.e., low inflation and unemployment rates.
- Microeconomic market efficiency – determines the sustainable distribution of resources in an economy by selecting appropriate market regulation mechanisms.
- Good governance – covers the integrity of the legal system, impartiality of courts, judicial independence, protection of intellectual property rights, and military interference in the rule of law and political affairs.
- Social development – measured through educational advancement, life expectancy, etc.

The following subsection discusses the tendency of researchers to construct resilience measurement models at the regional or national levels. It takes a different approach from those described above, incorporating the Cobb-Douglas production function or Leontief's (1936) input-output model, or both, through fluctuations in employment, human or physical capital, investment, GDP, or output.

2.1.2. Regional and national resilience assessment models and their factors

Table 8 summarises the factors and their indicators from recent key models commonly used in practice for assessing the resilience of systems to economic shocks at regional and national levels.

Table 8. Summary of key resilience assessment models at regional and national levels of application

Model	Authors	Levels of application	Properties and indicators for assessment of resilience to economic shocks
Solow-Swan model	Solow (1956); Swan (1956); Knight et al. (1993)	National	A model for analysing a country's output in relation to its input. Account for human capital in the Cobb-Douglas production function. The key variables are as follows: - output (dependent); - physical capital; - human capital; - labour; - technological advancements.
Augmented Solow-Swan model	Mankiw et al. (1992); Knight et al. (1993)	National	Building on the endogenous growth theory, Mankiw, Romer, and Weil developed an augmented version of the Solow-Swan model. The model also includes an augmenting factor that reflects the level of technology and efficiency in an economy stemming from exogenous technological progress and the openness of the economy.
Relative resilience	Martin (2012); Martin et al. (2016); Martin and Gardiner (2019); Martini (2020)	Cities, regions	Compares the economic performance of cities and regions to their national (macro-aggregate) economic performance during periods of observed national recessionary shocks and recoveries. Relative resilience is measured through: - proportional changes in employment (Martin, 2012; Martin et al., 2016); - proportional changes in output (Martin and Gardiner, 2019); - structural changes in employment, measured using the Krugman specialisation index (KSI; Krugman, 1992) (Martin et al., 2016; Martin and Gardiner, 2019).
RHOMOLO	Di Pietro et al. (2020)	EU regions at NUTS 2 level	The RHOMOLO model is the European Commission's spatial computable general equilibrium model (developed by the EC Joint Research Center). It is a regional holistic model used to simulate the impact of EU policies at the regional level (NUTS 2), providing policy support for evaluating investments, reforms, and structural changes in the economy. The key indicators include: - Inputs: interest rate, private capital, elasticities of substitution at consumer and producer levels, etc. - Outputs (produced by region, industry, and year): ○ Households: income, taxes paid on income, savings, aggregate consumption, etc.

			○ Firms: export prices, monopoly power, market share, profits, production costs, etc. ○ Investment-related: aggregate investment, household investment, etc. ○ Government-related: factor supply by the government, government income, etc. ○ Import-related: demand for composites of each good, exports (real, single firm), etc. ○ Other variables: unemployment rate, sales of each good, number of firms in each industry.
DYNAMMICs model	UNDRR (2022a)	National	The DYNAMMICs (Dynamic Model of Multi-Hazard Mitigation Co-Benefits) model is utilised by the United Nations Office for Disaster Risk Reduction (UNDRR) within frameworks such as the Sendai Framework for Disaster Risk Reduction 2015–2030, the 2030 Agenda for Sustainable Development, and the New Urban Agenda – Habitat III. It follows the Hyogo Framework for Action 2005–2015 (UNISDR, 2007) and focuses on disaster risk reduction through a business cycle model approach. DYNAMMICs model considers economic activities by: - endogenous capital, - exogenous technical progress, - incorporating the labour supply indicator. The value added is measured using the Cobb-Douglas production function. The output is measured by using Leontief's (1936) input-output theory. Natural disasters impact economic activity. The potential disaster risk reduction investment is assessed as a measure of resilience.
ECAM (Economic Consequences Assessment Model)	UNDRR (2022b)	National, regional	ECAM has evolved into a mainstay planning tool by various government agencies of the United States, including the Department of Homeland Security, the US Army, the Bureau of Reclamation, and FEMA. It quantifies changes in output and employment—often referred to as indirect economic impacts—resulting from natural hazard events such as floods, earthquakes, or hurricanes. ECAM uses its own-constructed computable general equilibrium (GCE) model instead of the input-output model because of the need to link particular physical assets (buildings, machines, and workers) impacted by a disaster to the output at the national level.

Social capital is derived from participation in social and community activities, voluntary work, belonging to various organisations, etc. Considering the participation in these activities, a network of social relations and connections is created between individuals, economic entities, and surrounding communities (Cutter et al., 2010). Norris et al. (2008) defined social capital as a function of accepting and perceiving social support: social establishment (informal connections), organisational relations and cooperation, leadership, and roles (formal relationships), and involvement in community activities.

Human capital, according to Lucas (1988), is the most valuable resource in modern society. During global economic and technological changes, the learning component becomes one of the most important factors, offering dual benefits for both individuals and social groups. The knowledge, competencies, and abilities acquired by individuals not only contribute to social advantages, such as increased self-confidence and tolerance but also yield economic benefits. Competent employees enhance economic productivity, reduce unemployment rates, stimulate regional GDP growth, and maintain high levels of entrepreneurship.

Physical capital forms the essential foundation or network used to produce goods, provide services, or create economic value. A region's infrastructure must meet the needs of society and businesses by facilitating the movement of goods and people and enabling effective communication. In the long term, this contributes to regional development and enhances quality of life.

Financial capital provides the financial capacity of a region, contributing to financial stability and increasing development opportunities.

Natural capital or natural resources and environmental functions are necessary for sustaining human life and supporting economic activities.

All the mentioned indicators interact with each other, influencing one another and the overall system either positively or negatively. Effective use of these indicators could ensure regional development continuity, enabling regions to withstand economic shocks and adapt to or overcome their consequences.

2.1.3. Comparison of the applicability and construction of resilience assessment models

The Resilience Index of Briguglio et al. (2009), as well as the resilience quantification models developed from Keynesian and neoclassical economic growth theories (e.g., the Solow-Swan and Augmented Solow-Swan models in Table 8), rely largely on statistical data of employment, labour, and human and physical capital. The dependent variables are typically changes in GDP (GDP per capita), output, or employment levels, which produce country-specific outcomes. Economic performance (growth, in this case) is expressed through employment, GDP per capita, or output. Knight et al. (1993) compared national economic growth quantitative models of the neoclassical growth theorists—Solow (1956) and Swan (1956)—against those of Mankiw et al. (1992), the promoters of endogenous growth theory. Knight et al. (1993) used cross-sectional and time-series data from 98 countries from 1960 to 1985. Both models were based on the neoclassical Solow-Swan model, which accounted for human capital in the Cobb-Douglas production function, where real output is the dependent variable and the independent variables include physical capital, human capital, and labour. The difference lies in the labour-augmenting factor proposed by endogenous growth theorists. It reflects the level of technology and efficiency in an economy stemming from exogenous technological progress and the openness of the economy. Knight et al. (1993) obtained evidence of significant country-specific effects, whereas the Solow-Swan model predicted results more consistent with empirical evidence. Lucas (1988) stressed the importance of human capital by analysing data of national income levels in the amended Solow (1956) model, which included labour, capital, and human capital.

The evaluation of resilience within regional growth patterns often relies on regional output and changes in employment, which are considered reflective of market responses to disturbances (Martin & Sunley, 2015; Martin et al., 2016). Efforts to assess resilience also focus on changes in GDP per capita in the regions of interest (Martin & Sunley, 2015; Oprea et al., 2020; Hundt & Grün, 2022). Other scientists follow Martin et al. (2016) and utilise employment statistics to quantify resilience (Martini, 2020). Oprea et al. (2020) cautioned that unemployment data are dependent on GDP and exhibit longer response periods to economic shocks than GDP. Martin and Gardiner (2019) also emphasised a constraint in the availability of partial employment data, necessitating assumptions regarding the occupational skill mix.

The works of Martin (2012), Martin et al. (2016), and Martin and Gardiner (2019) are among the leading studies in economic resilience quantification. Their quantification methods followed Keynesian business cycle theory, where the onset of economic shocks signified the iterations between the business cycles of the regions of the United Kingdom (UK). Martin (2012) proposed identifying economic shocks and subsequently quantifying resistance through the ratio of the decline in employment or output in a region to the respective decline in the UK as a whole. Martin et al. (2016) expanded this quantification method to measure both the resistance and recoverability of a city or region. They applied straightforward proportionate falls and increases in the chosen indicators (in their case—employment or output) in relation to the expected (counterfactual) falls and increases in the economy of the country or a wider region, which experienced a common economic shock. Despite the lack of a universally agreed-upon methodology or findings, Martin et al. (2016) and Martin and Gardiner (2019) underscored the importance of establishing a reference point, typically a specified counterfactual or expected position, against which resistance and recoverability can be evaluated. Martin and Gardiner (2019) consequently introduced the concept of "relative resilience", which refers to the economic performance of cities and regions compared to their national (macro-aggregate) economic performance during periods of observed national recessionary shocks and recoveries. However, these attempts to measure economic resilience are typically focused on specific regions and analysing macroeconomic data from periods with multiple shocks. Other research examples reveal similar results. For instance, Oprea et al. (2020) studied regional resilience in Eastern European states during the Global Financial Crisis using EU NUTS-2 regional data from 2008 to 2014. They emphasised the role of structural factors in influencing resilience, with public administration and tertiary education showing positive effects. Another study by Navarro-Espigares et al. (2012) examined the Spanish regional economies from 1986 to 2010, highlighting the counter-cyclical behaviour of the services sector during economic shocks and its cushioning effect on initial responses. Di Pietro et al. (2020) used the RHOMOLO resilience measurement model of general equilibrium for EU NUTS-2 regions, suggesting that regions resilient to supply-side shocks might be less resilient to demand-side shocks. They also found that highly specialised and open regions recover more slowly, with capital mobility exacerbating the negative effects of shocks. Martini (2020) exploited the relative resilience model of Martin et al. (2016) and analysed the reaction of Italian regions to economic shocks. They also emphasised the importance of region-specific factors and the dynamic nature of resilience, which can vary from one shock to another.

In addition to “relative resilience”, the concept of “competitiveness” proposed by Montrimas et al. (2024) is used to quantify and compare economies based on their ability to resist and recover from shocks. Romer (1986) considered the competitiveness of an economy through the competitive equilibrium model at the microeconomic level of endogenous technological change, in which long-run growth is driven primarily by the accumulation of knowledge by forward-looking, profit-maximising agents. While the initial models are perceived as static, Romer’s two-period competitive equilibrium model (1986) additionally included externalities. The competitiveness equilibrium here targets the quantified results of the maximisation of company earnings, measured through changes in the marginal productivity of knowledge and physical capital. Snieška and Bruneckienė (2009) used the concept of “competitiveness” as a composite measure for regional economic performance. The definition of “competitiveness” is also used in EU legislation to describe a competitive economy as one whose sustained rate of productivity can drive growth and, consequently, income and welfare (EUR-Lex, EU). These cases of “competitiveness” essentially refer to an economy’s or its industry’s capacity to compete in the trading of production against other economies or industries in local or international markets.

The research of Martin (2012), Martin et al. (2016), Martin and Gardiner (2019), Martini (2020), Oprea et al. (2020), Hundt and Grün (2022), and Delgado-Bello et al. (2023) focused on identifying the most or least resilient industries but resulted in mixed outcomes. Despite the challenges and lack of robustness in modelling approaches, common trends reveal the significance of the service sector, the dynamic nature of regional economies in response to shocks, and the importance of economic diversity and effective administration in facilitating resilience.

DYNAMMICs and ECAM are complex resilience measurement models utilised by the institutions of the United Nations Office for Disaster Risk Reduction and the United States government agencies, respectively, to assess the resilience of countries or regions to economic shocks caused by natural disasters. The DYNAMMICs model considers economic activities driven by both endogenous capital and exogenous technical progress, incorporating the labour supply indicator. Their value added is measured through the Cobb-Douglas production function, whereas the output of the economy is measured by applying Leontief's (1936) input-output theory. Two of the industrial portfolio industries—agricultural and composite goods—are included in the assessment. Natural disasters in the model impact economic activity in these industries, and potential disaster risk reduction investments are assessed as measures of an economy's resilience. The resilience measurement model of Béné (2013) allows for the evaluation of the operating costs of the adopted actions and measures, expressed through investment amounts, to neutralise or minimise the impact of the shock at the community or household level. The investment indicator is notable in the RHOMOLO model of the EU Joint Research Centre at the regional level for resilience measurement. Investments, meanwhile, have been identified as the components of reorientation in Chapter 1, which pose a risk of significantly increasing public debt levels (Yanushevsky & Yanushevsky, 2014). The ECAM is a self-constructed (GCE) model based on the most basic neoclassical assumptions about production and consumption (UNDRR, 2022b). The damage parameters of this model are capital losses and labour losses within the target region. The ECAM model requires a detailed geospatially referenced inventory of structures, population, and economic environment indicators at the household level. Meanwhile, quantified changes are expressed through output and employment. The specificity of the ECAM model requires a connection between physical changes and production and consumption inputs. UNDRR (2022b) consequently argue that the input-output approach may not be applicable for resilience measurement in their case.

Following the structure and national-level research of the DYNAMMICs and ECAM models, as well as the research of Lewis et al. (2021), where the input-output structures were used for the analysis of resilience at the national level, the regional relative resilience concept of Martin and Gardiner (2019) was applied at the country level in Montrimas et al. (2023). The authors compared the population of the British cities selected for analysis by Martin and Gardiner (2019) to the population of the East and South EU member states that joined the economic block in 2004. Due to the low population density in the Southern and Eastern EU, the productive population in both resilience measurement cases was similar. Martin and Gardiner (2019) also considered the distances between the regional centres of the United Kingdom as variables for comparison. Pindyck and Rubinfeld (2013) and Loungani et al (2017), in their discussion on the relevant practices to reshape the global trade environment, emphasised the significance of applying information technology (IT) developments in trade. Previous face-to-face transactions between buyers and sellers are no longer needed, as current IT solutions allow businesses to trade instantly across the world from different locations. Thus, business travel between the world's economic centres has largely been replaced by instant online communication. Considering the altered landscape of global trade, the distances between regional centres are no longer significant criteria for measuring the effectiveness of inter-regional trade.

2.2. Role of industrial portfolios in resilience assessment models

When evaluating the role of the industrial structure in shaping the reactions of economies to economic shocks, Martin et al (2016) employed the "coefficient of cyclical sensitivity"—a regression coefficient of the percentage change in employment in an industry relative to the percentage change in national total employment. The Hirschman-Herfindahl index (HHI) in Hundt and Grün (2022) and the Krugman specialisation index (KSI) in Martin and Gardiner (2019) are among the commonly used instruments found in recent literature. These instruments are designed to help identify the industrial portfolio properties that make a region more or less resilient to economic shocks. They use the shares of employment in industries within a city or region and compare them to the broader regional or national level over time.

Recent studies have utilised the Input-output tables (IOTs) of the OECD. These tables depict the relationship between sales and purchases of producers and consumers in a country. The literature, such as Picek and Schröder (2018) and Pamucar et al. (2023), has employed the Inter-Country IOTs (ICIO Tables; OECD, 2023) to measure the effects of certain industries on economies through the demand side of their performance. The OECD compiles national results of Input-output tables (IOTs) to produce a harmonised set of ICIO Tables, thus providing cross-national, standardised information on the economic performance of international regions that constitute the global economy.

IOTs comprise the accounting structure and data of National Accounts (NAs) that describe national and industrial output statistics. Among other national economic performance data, the NAs include industrial portfolio contents and employment outcomes in monetary terms (European Commission, 2008). In the NAs, a country's GDP is the sum of Gross Value Added (Eurostat, 2013) and net taxes on products. A crucial aspect of GDP in the context of the NAs is that it does not incorporate intermediate consumption. The NAs define **intermediate consumption** (IC) as the value of goods and services consumed as inputs in the production process at purchaser prices (European Commission). Wixted et al. (2006) denoted "intermediate consumption" as the cumulative input value of a country's products. An important property of the output and GDP variables within the structure of the NAs is that both include the monetary value of taxes on final products (VAT), which is commonly influenced by political decision-making through fiscal policy measures, especially when tackling economic shocks (Ramey, 2016; Alberola et al., 2020; Makin & Layton, 2021). The comparison of the volatility of intermediate consumption and output has shown that the value of intermediate consumption is more sensitive to economic shocks at both the global and regional (EU) levels (Montrimas et al., 2023). The perceptions of Makin and Layton (2021) imply that fiscal policy measures, through changes in taxes, can cushion output results during economic downturns in comparison to the results of IC. Consequently, IC in an economic system can be viewed as the resource that generates GVA and GDP. IC here indicates the supply side of the economic equilibrium and includes the qualitative and quantitative properties of economic performance.

Pamucar et al. (2023) used the same databases to model the interdependencies of industries through intermediate consumption inputs. IOT models are based on the idea that any output requires a corresponding input, meaning that consumption is equal to intermediate use in each industry (Van Leeuwen et al., 2005). "Intermediate", according to Mascaretti et al. (2022), refers to the inter-industrial relationships in IOTs that arise from the inter-industry input matrix. The row entries in this matrix represent outputs from specific industries, and the column entries represent inputs to an industry. The input values within a country from a set of industries aggregate to represent the intermediate use of domestic products by an industry (Wixted et al., 2006).

Mascaretti et al. (2022) highlighted IOTs as a powerful tool for reflecting and analysing the production structure of an economy. These tables are instrumental in conducting impact analyses or estimating the effects of various shocks at different geographic levels. The input-output structure is one of the basic elements in the construction of complex resilience measurement models (DYNAMMICs, ECAM in Table 4).

Lewis et al. (2021) used the ICIO Tables to compare the growth of aggregate values of goods and services across 26 countries worldwide, including the world aggregate considered as a separate entity. Their study employed an Eaton–Kortum two-sector trade model of the global economy by incorporating non-homothetic preferences, spanning the period from 1970 to 2015. Trade data were sourced from two main databases: bilateral trade in goods from the OECD’s World Input-Output Database (2013 and 2016 releases) for 1995–2015 and country-level goods trade data from the IMF Directions of Trade Statistics Database for the remaining years.

Picek and Schröder (2018) effectively exploited the ICIO Tables to show the effects of the final demand spillovers of Germany on Southern European nations from a consumption perspective. They were also employed by Lewis et al. (2021) to reveal the transformation of world expenditure from the goods sectors to the service sectors. Furthermore, Pamucar et al. (2023) used the IOTs to show how industries are interdependent through their product inputs.

These examples portray an iterated view of changes in the industrial portfolio of the analysed economies, with externalities integrated into the dynamics of the results. Thus, the following section analyses the role of externalities in changes in the industrial portfolio of an economy.

The summary of the models’ analysis reveals the following points to be considered when assessing resilience at the national level:

- Resilience measurement models highlight a strong connection between environmental studies and economics. The strong interdependence between the two fields of study calls for an integral solution to the problem of resilience measurement.
- The nature of an economic shock – whether it originated from a natural disaster, a disruption in economic activities, or other external or internal events.
- Economic shock mitigation phases – the key resilience models in Table 4, and subsequently the others mentioned in the description, mainly focus on shock resistance and recovery from the shock phases.
- Region- or country-specific results dominate in the research attempts, although some common trends can be identified when applying these resilience measurement models.

- Most models in Table 4 for the resilience measurement at the national level are based on the Cobb-Douglas production function and input-output mechanisms, which are modified depending on the specific focus of the models' targeted research. Changes in an industrial portfolio, based on the input-output construct, are widely used in resilience measurement models. However, some limitations of the input-output functionality appear to be applicable in specific cases, particularly regarding the linkage between economic activity outputs and damage to physical assets.
- Most resilience measurement models require a complex resilience assessment. Snieška and Bruneckienė (2009) argued that a complex measurement of competitiveness is essential because competitiveness cannot be fully defined by just one or a few economic and social indicators. In contrast, Martin et al. (2016) and Martin and Gardiner (2019) applied straightforward proportionate falls and increases in the chosen indicators to expected falls and increases at the macro-aggregate level, which experienced a common economic shock. The straightforward proportional fluctuation model (relative resilience model) showed similar results to those obtained from the other models.

The analysis of indicators within the key models in this section reveals the following considerations when assessing resilience at the national level:

- The dependent variables in the analysed models primarily reflect changes in GDP, output, or employment.
- The use of labour and employment indicators in resilience measurement models has been questioned due to their dependence on GDP. Unemployment or labour statistics also tend to exhibit longer response periods to shocks compared to GDP. Previous studies have also highlighted constraints in the availability of partial employment data.
- The output and GDP variables within the NAs structure include the monetary value of taxes on final products (VAT), which is often influenced by political decision-making through fiscal policy measures.
- Capital indicators (social, economic, human, physical, and natural) and infrastructure indicators (i.e., system capabilities) are used as measures for preventing or absorbing the negative impacts of economic shocks, or for facilitating recovery from them.
- Community-specific indicators are typically used to measure resilience in response to economic shocks caused by natural disasters. However, it is difficult to compare these indicators at the national level.
- Links between competitiveness and resilience measurement have been identified in the analysed research, suggesting that competitiveness could play an important role in assessing resilience.
- Industrial specialisation indicators (such as the HHI or KSI) are used to identify the industrial portfolio characteristics that make a region more or less resilient to economic shocks. However, industrial specialisation indexes have been evaluated through changes in employment in the research so far.

- The ICIO Tables contain cross-national, standardised information on the economic performance of countries, including employment outcomes and industrial portfolio characteristics. These are expressed in various dimensions (such as GDP, output, and intermediate consumption) in monetary terms. Empirical studies have also revealed that intermediate consumption values are more sensitive to economic shocks than output values at global, regional, and national levels, making intermediate consumption a more attractive variable for future research than output. Furthermore, intermediate consumption could replace employment values in resilience measurement models, particularly when referring to Adam Smith's labour-based theory of value.

According to Béné (2013), for a resilience indicator to be useful as an "analytical" tool from which lessons can be drawn for development interventions, it needs to satisfy several characteristics: it should be multi-scale, multi-dimensional, objective and subjective, generic, and independently constructed. The studies of Briguglio et al. (2009), Fingleton et al. (2012), Béné (2013), Martin and Gardiner (2019), Martini (2020), and Hundt and Grün (2022) have shown that assessing resilience is a complex process. This complexity arises from the diversity of the concept of resilience, the specificities of economic, social, political, geographical, cultural, and territorial differences, the abundance and variety of resilience-determining capacities and factors, and the differing nature of shocks. For these reasons, each method of assessing resilience is considered relatively but never absolutely accurate. Consequently, further research calls for an integral approach to solving the resilience problem.

2.3. Methodological assumptions for identifying economic development cyclicality

The global economy, as well as the economies of individual nations, is profoundly influenced by human behaviour. There is a considerable scientific discourse on the issues of human behaviour related to securing commodities and natural resources (Ross, 2004; Ron, 2005; Dunne & Tian, 2015; Musayev, 2016). Despite various findings, the possession and protection of scarce resources remain central to both civil and international conflicts. The close interrelation between geopolitics and economics is particularly evident in China's systematic development into the world's economic superpower over recent decades (Baláž et al., 2019) and its Belt and Road Initiative, which aims to manage capital accumulation issues through externalised development (Demiryol, 2022). Gat (2006) identified three main strategies—cooperation, competition, and conflict—that nations employ, often blending them in varying degrees based on the utility of each strategy in specific situations. These strategies are closely tied to a nation's specific configuration along its evolutionary path to ensure a better position in tackling scarcity. The availability of a productive population and natural resources is crucial in this context. Numerous country-, region-, and industry-specific cases demonstrate a significant number of externalities that continually distort regional business cycles worldwide.

When adopting the global perspective, the world economy is perceived as a single unit, with region-, country-, or industry-specific externalities becoming internal components of global economic performance. Fig. 4 presents a systemised view of the global market based on Keynesian input-output theory (Leontief, 1936), which includes the behaviour of industries in the international market as they resist and recover from economic shocks.

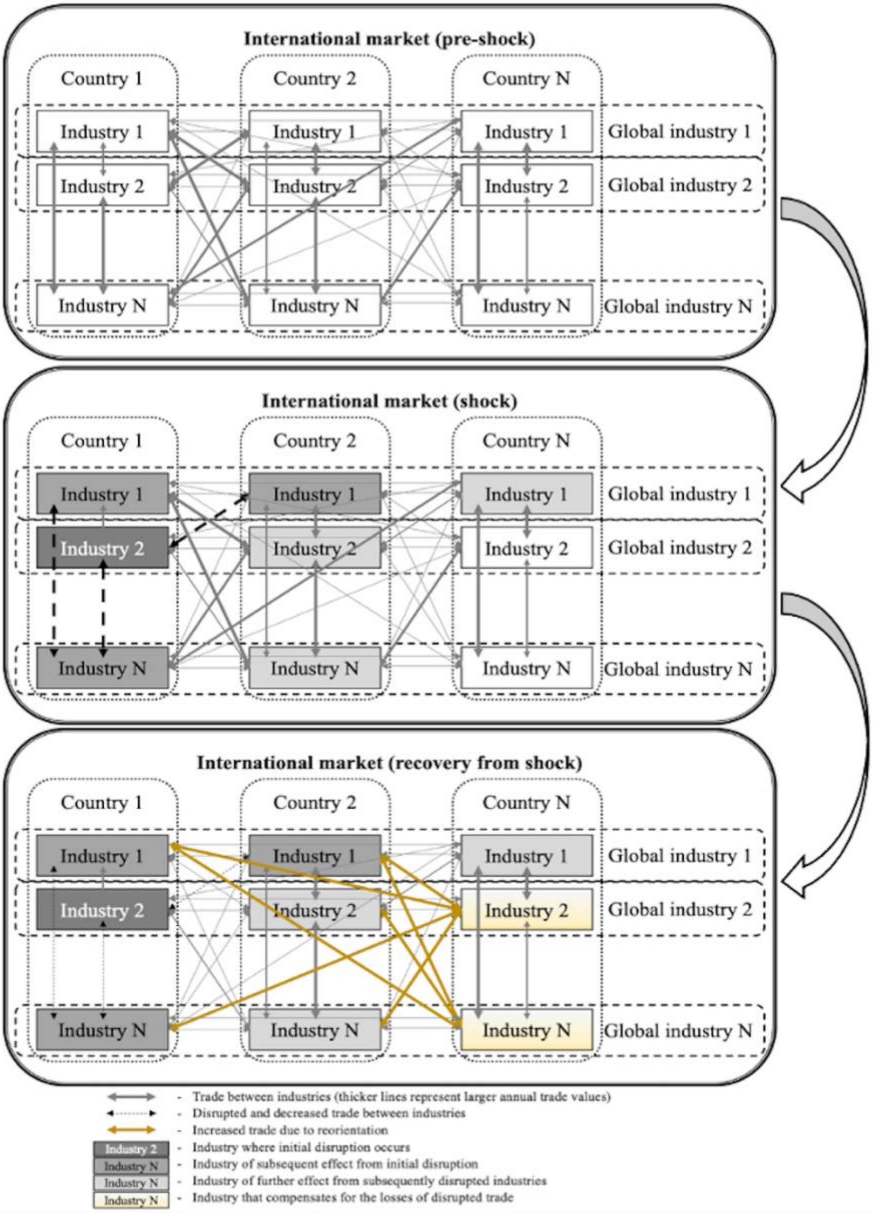


Fig. 4. Systemised view of global market performance in resisting and recovering from shocks through the industrial portfolio perspective

Fig. 4 illustrates a theoretical model of industry behaviour in different countries across the global market based on Keynesian input-output theory. The upper section of Fig. 4 represents normal market functioning, where similar industries in different countries trade the same production; thus, they are competitors (e.g., Industry 1 in Country 1 competes with Industry 1 in Country 2). They engage in significant trade with other industries in the value chain, prioritising trade within their own countries (e.g., Industry 1 in Country 1 trades extensively with Industry 2 in Country 1). Trade at larger or smaller values occurs between most industries in the international market.

The middle section of Fig. 4 models the occurrence of a shock, where trade within Industry 2 is disrupted due to unforeseen circumstances. As a result, stakeholders in Industry 2 are unable to fulfil their trading obligations to key partners in other industries, both domestically and internationally. Subsequent disruptions occur in the industries that were largely involved in trade with Industry 2, as their trade value with Industry 2 suddenly drops to a minimum.

The lower section of Fig. 4 identifies competing industries (e.g., Industry 2 and Industry N in Country N), which did not experience significant disruptions due to fewer trading engagements with the industries that suffered disruptions, although they are seeking to take over the market shares of their competitors from the countries where major market disruptions occurred. As a result, these industries experience rapid growth in trading value and market share because the disrupted industries along the value chain strive to compensate for their trade losses by replacing their failed partners. Montrimas et al. (2023) found that this market reorientation process, where industries take initiatives to recover from shocks, begins almost immediately after the occurrence of a more significant disruption.

Fig. 5 is an extract from the middle section of Fig. 4, which reveals market performance from a regional or national perspective. In this context, externalities (represented by the arrows in Fig. 5) are perceived as one-sided and unpredictable. These externalities arise from forces originating in interactions with other regions, introducing irregularities into local business cycles (Neff, 1949).

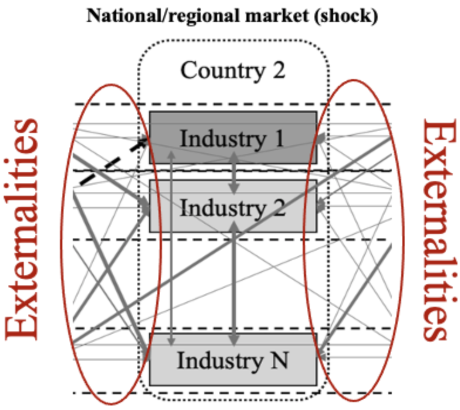


Fig. 5. Extract from Fig. 4 depicting the market view from a regional perspective, including the impact of externalities

The comparison of Fig. 5 with Fig. 4 clarifies the reason for the lack of success in previous research in effectively solving the problem of resilience, as the research attempts were performed at a regional level and involved unpredictable externalities. Neff (1949) urged collaboration in combating economic recessions worldwide. Internalising externalities involves any method of making those producing external costs or benefits consider them in their decision-making. In the context of Adam Smith’s concept, the term “nation” in this research refers to the world, and “nation’s wealth” denotes the world’s productive population along with a given mix of natural resources. The remainder revolves around human behaviour, which is internal to the world and may exhibit cyclical patterns throughout the history of civilisations. According to Gat (2006), violent competition, or conflict, is a rule in nature, as organisms compete to survive and reproduce under conditions of acute scarcity, heightened by their propagation processes.

Globalisation has reached its peak, and the world is contending with growing economic security issues (Kahler, 2004). Different regions have assessed these economic challenges in various ways, evident in discussions on resilience. According to Reggiani et al. (2002) and Martin (2012), the notion of “resilience” should be a key topic in the study of the dynamics of spatial economic systems, especially concerning how such systems respond to shocks, disturbances, and perturbations.

However, global analysis is only possible when appropriate statistical evidence is available. The availability of statistical data today is identified as the second reason for the relevance of Adam Smith’s “Wealth of Nations” in the current economic environment. The level of detail in statistical data enables researchers to perform economic performance calculations on a global scale using data panels with a microeconomic level of precision. The literature analysis reveals the complex challenges faced by scholars studying the same global economic problems in different environments. This challenge begins with the neoclassical models of Solow (1956) and Swan (1956) and continues through to the Keynesian business cycle models of Martin et al. (2016) and Martin and Gardiner (2019). The uniqueness of economic environments, as well as the different development patterns of regions, has been emphasised in scientific research. In the regional context, resilience consists of many variables and, therefore, is a highly complex and multidimensional property of economic systems (Martini, 2020). It is a multifaceted and dynamic process whose characteristics constantly change (Martin, 2012; Martin & Sunley, 2015). Resilience is the ability of economies to respond to undesired external disturbances (Di Pietro et al., 2020; Ženka et al., 2021). The research of Martin et al. (2016), Picek and Schröder (2018), and Hundt and Grün (2022) has focused on industrial specialisation rather than diversification in the presence of externalities that have a significant effect on regional economic development. However, the possibilities to obtain robust results are limited. Various industries in an economic system can also be linked to different networks of external relations, resulting in different levels of resilience (Martin, 2012). These properties make the question of resilience difficult to solve. The relative resilience concept, as proposed by Martin and Gardiner (2019), could become a key instrument because it allows the comparison of economic systems by their ability to resist economic shocks or recover from them. Furthermore, data availability enables researchers to assess economic performance on a global level.

The OECD has publicly made available harmonised economic performance data for 76 of the world's most significant economies over 26 years, encompassing 6 global economic shocks (OECD, 2023). The available data are iterated annually to the NAs level for 45 industries per country. Given the nature of the input-output structure, which collects and systematises data at the company level within national tax revenue information (Eurostat, 2013), the standardised national economic performance results (Leontief, 1936) in such a dataset enable the research to operate on a broad scale with a high level of precision regarding national economic performance.

The industrial portfolio of an economy is one of the main criteria for resilience in both empirical and theoretical contexts (Delgado-Bello et al., 2023). Conroy (1975) and Martin (2012) emphasised that a regional industrial mix (industrial portfolio) acts as one input to resilience. Conroy (1975) recognised industrial diversity as a means of economic stability or as having a neutral influence. Thus, industrial portfolio properties and their changes at the national level could be effective for investigating national and global economic health in various ways. The dynamic and multifaceted processes of resilience, with constantly changing characteristics in the presence of externalities, significantly affect the development of regional economies (Martin, 2012; Martin & Sunley, 2015; Martini, 2020) and produce mixed results.

Theories reflect the worldview and beliefs of their authors and emerge from societies through struggle and consensus (Milne, 2017). Holism is, therefore, the soundness and internal consistency, expressed through openness and closure as its counterpart. This framework helps explain the origin of subject identity through relationships and mutual contextualisation. When sufficient data are available, some aspects of the theory may turn into reality when appropriate data evaluation methods are applied. In the case of this research, the holistic approach to economic performance is useful for minimising the effects of externalities by internalising them, thereby reducing their impact on the cyclicality of economic development from the global market (closed economy) perspective.

The following section describes the foundation of the economic environment, which forms the basis for further research. These foundations include concepts, theories, and methods from the analysed research, drawn from or developed based on previous scholarly work.

2.4. Concepts, theories, and methodology applied in further research

To compare countries by their level of resilience, this research employs the methodology of Martin and Gardiner (2019) to measure "relative resilience", adapted to the national level. Available statistical data on national economic performances within the ICIO Tables enables the analysis of 76 countries worldwide (OECD, 2023), which together account for the vast majority of the global economy's value.

This research evaluates the European Union member states solely by their ability to resist and recover from economic shocks. The statistical information on global economic performance allows for the application of the holistic theory, thereby integrating the majority of externalities and enabling comparisons of countries within the context of a single global economy. A set of inputs from all 45 industries in each country, as represented in the ICIO Tables, reflects the industrial portfolio of the country as defined by Martin (2012).

Intermediate consumption (IC) is the aggregate input value of domestic and foreign products of a country, as reflected in the *product x product* ICIO Tables (OECD, 2023). **Output** within the structure of the NAs and ICIO Tables refers to the total of products produced by a country during the accounting period (Eurostat, 2013).

The developed methodology, described in this chapter, uses IC values at basic prices due to their higher volatility when considering the effects of economic shocks on economic performance.

The analysis by Martin and Sunley (2015) structured the resilience process into four sequential (and recursive) stages at the regional level. Considering the findings of the literature analysis in the previous chapters, Fig. 6 identifies the adapted version of the stages of the resilience process of Martin and Sunley (2015) and their interlinks:

- Risk – a pre-shock stage that identifies how vulnerable or exposed national entities or institutions are to shocks.
- Resistance – the depth of reaction of national entities and institutions to the impact of a shock, depending on the scale, nature, and duration of the economic shock.
- Re-orientation – the extent and nature of adjustment to shock, or the ability of national entities to proceed through adjustments and adaptations to resume core functions of the economy.
- Recoverability – the post-shock national development pathway that identifies the degree and nature of national recovery to the pre-shock economic level.

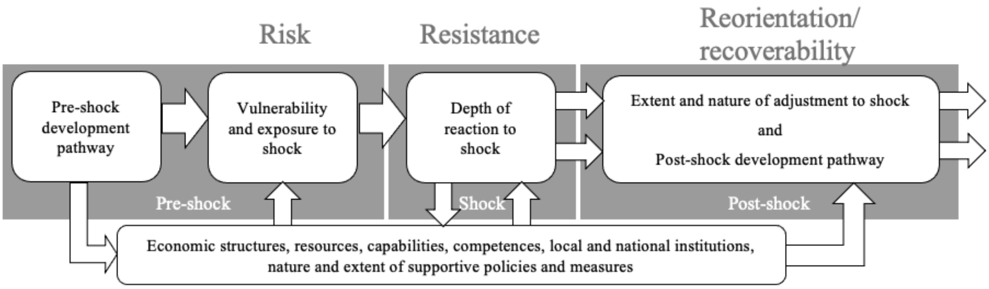


Fig. 6. Schematic view of the resilience process (definitions from Martin and Sunley, 2015, restructured and updated by the author)

The findings of Montrimas et al. (2023) revealed that economies tend to begin adjusting to a shock as soon as the effects are felt, while reorientation and recoverability are identified as rather parallel processes during the recovery stage (Fig. 6).

However, practice in the literature suggests that resilience is typically assessed based on two main characteristics: resistance and recovery/recoverability (Martin et al., 2016; Martin & Gardiner, 2019; Martini, 2020; Oprea et al., 2020; Hundt & Grün, 2022), and it is commonly understood as the capacity to bounce back from a shock or return to the pre-shock level. Thus, this research focuses on countries' economic resilience during the shock and recovery time intervals. The business cycle is identified from the onset of a shock (Fig. 7) to the end of recovery from the shock (Martin et al., 2016; Martin & Gardiner, 2019).

Following the analyses performed in the literature and methodology chapters, this research uses the following concepts for further analysis:

- This research characterises "economic shock" as an external or internal environmental, economic, or other event that impacts the levels of IC value of national economies. An **economic shock** can consequently be defined as a process involving a sudden, significant, and steep decrease in the national value of IC, resulting from internal or external events that disrupt the value chains in international trade.
- **Recession**, as proposed by Martin (2012), is a form of economic shock in the sense that it is (in general) an unexpected and unpredictable event that disrupts the "normal" growth path of an economy.
- **Resilience**, following Simmie and Martin (2010), is considered the ability of a local socio-economic system to recover from a shock or disruption. The goal of using the "resilience" concept, as proposed by Martin et al. (2016), is to capture how an entity or system reacts to and recovers from an economic shock. This concept in the research is understood as a process, following Simmie and Martin (2010), Martin (2012), Béné et al. (2014), and consisting of the following quantified aspects, as identified by Martin et al. (2016) and Martin and Gardiner (2019), expressed through the IC value fluctuations within national economies:
    - A new characterisation of "resistance" proposed in this research, denoted through the aspect of the industrial portfolio. "Resistance" refers to the depth of reaction of national industries to the impact of an economic shock, depending on the scale, nature, and duration of the shock.
    - A new characterisation of "recoverability"/"recovery" proposed in this research, denoted through the aspect of the industrial portfolio. "Recoverability" or "recovery" refers to the post-shock national development pathway that identifies the degree and nature of the recovery of industries within the country to its pre-shock economic level. An integrated system, as proposed by Martin and Gardiner (2019), allows for the consideration of recovery paths within both the "equilibrist" and "ecological resilience" models. The following recovery paths are presented in Fig. 7, in accordance with the concepts in the literature.
    - A new characterisation of "reorientation" proposed in this research by denoting it through the aspect of the industrial portfolio. "Reorientation" – the ability of the national industries to undergo the adjustments and adaptations necessary to resume core functions and performances. Reorientation is considered a parallel process to recoverability (Fig. 6). Following Martin (2012), **reorientation or realignment** is where a major

shock gives rise to or accelerates pre-existing changes in a national economic structure (**structural change**).

- A new characterisation of "relative resilience" proposed in this research, denoted through the aspect of the industrial portfolio. "Relative resilience" refers to the economic performance of national industries, benchmarked against global economic performance, during the observed time intervals of global recessionary shocks and recoveries. Following the logic of Martin and Gardiner (2019), when the focus is on comparing countries directly with one another during a major global recession (an economy-wide event), a logical counterfactual expectation is that each country making up that economy should react in the same way as the macro-aggregate. Thus, by benchmarking countries within the "relative resilience" concept of Martin and Gardiner (2019), the need to evaluate the duration of resistance or recoverability of regions is eliminated because the duration of shocks and recoveries is considered at the macro-aggregate level.
- A new characterisation of "competitiveness" proposed in this research, denoted through the aspect of the industrial portfolio. "Competitiveness" refers to a country's or its industry's ability to compete in the trading of its production against other countries or industries in the international market.
- "Industrial portfolio", a mixed concept of Conroy (1975) and Martin et al. (2016), which denotes a particular mix of industries and their interrelationships that can influence the reactions of an economy to economic shocks.
- "Structural change" **(**Lewis et al., 2021) refers to a change in the expenditure of goods and services as a share of total expenditure over time within the reorientation dimension of the economic resilience process (Martin et al. 2016), which could be expressed through competitiveness (Pike et al., 2006).

Fig. 7 illustrates the adapted version of the economic development integrated system of Martin and Gardiner (2019) that includes economic downturns caused by shocks and the recovery paths in the context of the national resilience process:

- The recovery path A–B–C is the "plucking model" of Friedman (1988), where the economy recovers from the shock to the same growth path as before.
- Recovery paths A–E and A–F are the negative and positive, respectively, hysteretic recessions of Hamilton (1989), where the economy recovers either to a lower or higher (respectively) growth path but maintains the same growth rate as in the pre-shock stage.
- Positive and negative hysteretic recessions (Simmie & Martin, 2010; Martin & Gardiner, 2019) assume a raised (A–G) or lowered (A–D), respectively, growth rate after the shock and continue economic development on a new growth path.

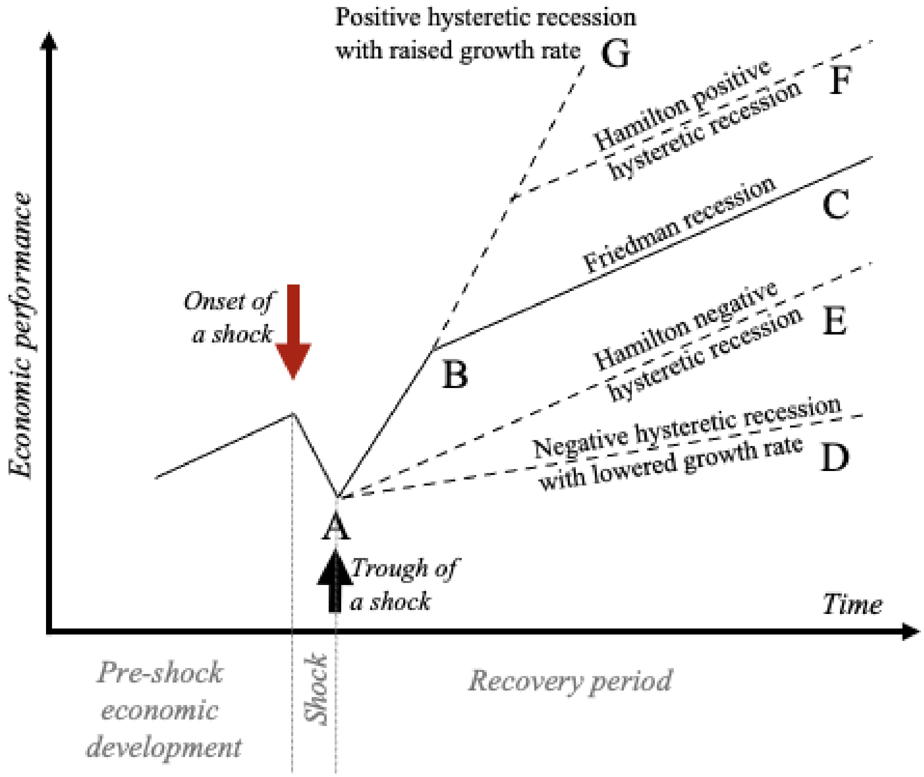


Fig. 7. System of recovery paths (definitions and structure adapted from Martin and Gardiner, 2019, restructured and expanded by the author)

Based on the nature and duration of an economic shock, along with the extent of damage and the resources available, Fig. 7 shows the reactions of socio-economic systems in several ways: resiliently, adapting to a new situation without significant impact on development, or non-resiliently, suffering heavy losses and disrupted development. The question of disruptions in economic development, such as shocks, and the performance of economies facing those disruptions has been relevant for nearly a century. The following subsection analyses of the main aspects of the evolution of resilience to economic shocks.

These concepts are utilised in the development of the methodology and conceptual model for assessing the impact of changes in the industrial portfolio on economies' resilience in the following section.

2.5. Development of methodology and conceptual model

The set of concepts identified and discussed in the previous section is used to develop the methodology, which incorporates a model for measuring the resilience of countries through their competitiveness in the international market by evaluating their industrial portfolio performance.

The model under development aims to compare countries based on their resilience to economic shocks. It focuses on national capabilities to compete in the supply chains of the global market. These capabilities are expressed through fluctuations in the IC value within each industry of the assessed countries. The IC value is defined as the measure of the value of goods and services consumed as inputs in the production process at purchaser prices (Eurostat, 2023c). It excludes most effects (e.g., VAT, subsidies) stemming from the fiscal policies of national governments. Therefore, the industrial portfolio includes the full range of industries within the assessed country. The standardised nomenclature of the NAs across the most influential economies of the world enables an effective comparison of these countries based on their abilities to participate in global trade. The input-output mechanism of Leontief (1936) is used in the most modern resilience measurement models (DYNAMMICs, UNDRR, 2022a; ECAM, UNDRR, 2022b). The focus of this research is primarily financial and centres on national capabilities to perform in international supply chains when they are disrupted by economic shocks and during recovery. The ICIO Tables are constructed based on the NAs, which could be envisioned as annual account statements at the national level that provide an overview of the national economic environment. The connection between financial outputs and physical inputs in this case is unnecessary (unlike in the ECAM model).

The following subsection establishes the scope of the data panel for the methodology of resilience measurement.

2.5.1. Scope of the data panel and selection of industrial portfolio indicators for identifying their impact on national performance

The industrial portfolio indicator in this research, as described in the previous section, is the **intermediate consumption (IC)** value within the ICIO Tables. The ICIO Tables include harmonised data of annual IC values for 45 industries in each country. These statistics are retrieved from the NAs of 76 countries (38 OECD and 38 non-OECD members; OECD, 2023). The period for the analysis spans from 1995 and 2020, as provided in the ICIO Tables. This data panel offers insights into global economic performance, expressed through the countries that define the core of world economic development. The ICIO Tables are constructed with one-year iterations, and the dynamics of the variable changes in the data panel of this research are evaluated on an annual basis. The economic performance of the rest of the world (ROW) is included in the ICIO Tables as the 77th economy.

The data panel of the ICIO Tables includes the annual IC values for each of the 45 industries, corresponding to the economic performance of 77 economies worldwide from 1995 to 2020.

The IC values in the data panel are in USD million at current prices, meaning they include year-by-year inflation. Economic shocks or recessions are usually followed by heightened inflation, along with various subsequent effects on economic systems, which complicates research aimed at understanding patterns of economic development. Martin and Gardiner (2019) in their relative resilience model have set the output values at basic prices throughout the observed period. This research similarly aims to compare countries based on their economic performance during the observed period; therefore, the data are adapted by benchmarking the IC values to 1994 basic prices. Given that the IC values in the IOTs are at purchaser prices, inflation factors on a national basis are eliminated by using inflation data from the World Bank, measured by the yearly consumer price index per country.

The elimination of the inflation factor from annual IC values is performed in this research as follows:

- The base national inflation rates are set at the price level of 1994, defined as 100% in the data panel.
- The inflation values, based on the yearly consumer price index, are converted into aggregated inflation rates and assigned to each country according to the respective annual inflation for each subsequent year until 2020. The consumer price index values are taken from the World Bank database for each country on the list of the ICIO Tables annually from 1995 to 2020.
- Aggregated inflation values are eliminated from the national IC values by applying the following formula:

$$IC_{ci}^{t} = \frac{IC\_infl_{ci}^{t}}{agg\_infl_{c}^{t}} * 100\%, \tag{1}$$

where:
c is the observed country;
i is the observed industry;
t is the observed year;

$IC\_infl_{ci}^{t}$ is the IC value for the observed national industry in the observed year, including inflation (from the ICIO Tables);

$agg\_infl_{c}^{t}$ is the aggregated inflation percentage rate set to 100% in 1994 for the observed country in the observed year (from the World Bank dataset);

IC_{ci}^{t} is the IC value of the observed national industry in the observed year, excluding inflation.

The literature review (Vining, 1945; Martin, 2012; Martin & Sunley, 2015; Matsuyama, 2019; Martini, 2020) indicated the problem of externalities from other regions of the world causing unpredictability in the economic cycles of a regional market (see Fig. 5 and Fig. 4 for comparison). This research maintains a holistic approach to address this issue. Consequently, the global economic performance dataset from the ICIO Tables is utilised in the model development.

2.5.2. Development of the resilience measurement model

The relative resilience model (Martin & Gardiner, 2019) measures the resilience of economic systems relative to one another. It uses straightforward fluctuations in output shares, benchmarked against their macro-aggregate fluctuations within the common economy. Its application is extended to the national level by considering that countries within the global economy should react similarly to global economic shocks, as an economic shock is a global event. The level of detail in the ICIO Tables allows applying two approaches:

1. **National resilience –** measured through resistance and recoverability, its two main components: national resistance—during the time intervals of the occurrence of global economic shocks and national recoverability—during periods of recovery:

$$RE_c^{\Delta y} = \frac{(\Delta IC_c^{\Delta y} - \Delta E(IC_c^{\Delta y})}{|\Delta E(IC_c^{\Delta y})|}, \quad (2)$$

where:

c is the observed country;

Δy is the observed time interval of an economic shock or recovery from the shock, which began in year ($y - x$) and ended in year y;

$\Delta IC_c^{\Delta y}$ is the change in the IC value in the observed country during the observed time interval ($\Delta IC_c^{\Delta y} = IC_c^{y} - IC_c^{y-x}$);

IC_c^{y} and IC_c^{y-x} denote the intermediate consumption of the observed country in year y and in year ($y - x$), respectively;

$RE_c^{\Delta y}$ is the national resistance or recoverability of the observed country during the observed time interval;

$\Delta E(IC_c^{\Delta y})$ is the "expected" change of the IC value in the observed country during the observed time interval. The calculation of the expected change follows the principles proposed by Martin and Gardiner (2019):

$$\Delta E(IC_c^{\Delta y}) = \left(\frac{IC_g^{y} - IC_g^{y-x}}{IC_g^{y-x}}\right) * IC_c^{y-x}, \quad (3)$$

where:

IC_g^{y} and IC_g^{y-x} denote the global IC value in year y and in year ($y - x$), respectively.

Equation (2) is thus transformed by considering that in the ICIO Tables $IC_c^{y-x} > 0$ and $IC_g^{y-x} > 0$ at all instances:

$$RE_c^{\Delta y} = \frac{(\Delta IC_c^{\Delta y} - \left(\frac{IC_g^{y} - IC_g^{y-x}}{IC_g^{y-x}}\right) * IC_c^{y-x})}{|\left(\frac{IC_g^{y} - IC_g^{y-x}}{IC_g^{y-x}}\right) * IC_c^{y-x}|},$$

$$RE_c^{\Delta y} = \frac{(IC_c^{y} - IC_c^{y-x}) * IC_g^{y-x} - (IC_g^{y} - IC_g^{y-x}) * IC_c^{y-x}}{IC_g^{y-x}} * \frac{IC_g^{y-x}}{\left|IC_g^{y} - IC_g^{y-x}\right| * IC_c^{y-x}},$$

$$RE_c^{\Delta y} = \frac{IC_c^y * IC_g^{y-x} - IC_c^{y-x} * IC_g^{y-x} - IC_g^y * IC_c^{y-x} + IC_g^{y-x} * IC_c^{y-x}}{|IC_g^y - IC_g^{y-x}| * IC_c^{y-x}},$$

$$RE_c^{\Delta y} = \frac{IC_c^y * IC_g^{y-x} - IC_g^y * IC_c^{y-x}}{|\Delta IC_g^{\Delta y}| * IC_c^{y-x}}. \quad (4)$$

2. **Industrial resilience** – a measure that shows how much the IC value increased or decreased in an observed industry of the observed country. The decreases and increases in the IC value in the industry reflect the degree of lost or gained positions of the country's entities in trading activities during respective economic shocks or recoveries. The calculation is based on the relative resilience measurement model of Martin and Gardiner (2019) but accounts for the economic performance statistics at the industry level:

$$RE_{ci}^{\Delta y} = \frac{(\Delta IC_{ci}^{\Delta y} - \Delta E(IC_{ci}^{\Delta y})}{|\Delta E(IC_{ci}^{\Delta y})|}, \quad (5)$$

where:
c is the observed country;
i is the observed industry;
Δy is the observed time interval of an economic shock or recovery. The time interval of a shock or recovery is considered to have started in year ($y - x$) and ended in year y;

$\Delta IC_{ci}^{\Delta y}$ is the change in the IC value in the observed national industry during the observed time interval;

IC_{ci}^{y} and IC_{ci}^{y-x} are the intermediate consumption values of the observed national industry in year y and in year ($y - x$), respectively;

$RE_{ci}^{\Delta y}$ is the industrial resistance or recoverability of the observed national industry during the observed time interval;

$\Delta E(IC_{ci}^{\Delta y})$ is the "expected" change in the IC value in the observed national industry during the observed time interval. The calculation of the expected change follows the principles proposed by Martin and Gardiner (2019):

$$\Delta E(IC_{ci}^{\Delta y}) = \left(\frac{IC_{gi}^{y} - IC_{gi}^{y-x}}{IC_{gi}^{y-x}}\right) * IC_{ci}^{y-x}, \quad (6)$$

where:

IC_{gi}^{y} and IC_{gi}^{y-x} denote the IC values of the global industry in year y and in year ($y - x$), respectively;

Equation (5) is transformed by applying the same calculations as for the equation of national resilience (Equation 2) by considering that in the ICIO Tables $IC_{ci}^{y-x} > 0$ and $IC_{gi}^{y-x} > 0$ at all instances:

$$RE_{ci}^{\Delta y} = \frac{IC_{ci}^{y} * IC_{gi}^{y-x} - IC_{gi}^{y} * IC_{ci}^{y-x}}{|\Delta IC_{gi}^{\Delta y}| * IC_{ci}^{y-x}}. \quad (7)$$

An important property of industrial portfolios, as emphasised by Conroy (1975), Martin et al. (2016), and Martin and Gardiner (2019), is that if a disrupted industry within an economy can be compensated by equal or higher gains in other industries, the economy may exhibit resistance to economic shocks or recover more effectively from them. Industrial resistance or recoverability from a country's perspective can therefore be expressed as follows:

$$RE_{c}^{\Delta y} = \sum_{i=1}^{45} \left(RE_{ci}^{\Delta y}\right), \quad (8)$$

where:

$RE_{c}^{\Delta y}$ is denoted under Equation (2), and $RE_{ci}^{\Delta y}$ is denoted under Equation (5).

The contents of the ICIO Tables allow the aggregation of the IC values of national industries into global IC values for each industry. This makes it possible to identify significant losses or gains in global industries that are linked to specific global economic shocks. The global industrial resistance or recoverability can be expressed as follows:

$$REI_{gi}^{\Delta y} = \sum_{c=1}^{77} \left(RE_{ci}^{\Delta y}\right), \quad (9)$$

where:

$REI_{gi}^{\Delta y}$ is the resistance or recoverability of the observed global industry during the observed time interval, and $RE_{ci}^{\Delta y}$ is denoted by Equation (5).

Alternatively, the global economic performance dataset of the ICIO Tables allows for the construction of a competitiveness measurement model that produces results equivalent to those developed using the relative resilience model. The construct of the competitiveness measurement model corresponds to the definition of "competitiveness" used in EU legislation, which describes a competitive economy as one with a sustained rate of productivity capable of driving growth and, consequently, income and welfare (EUR-Lex, EU). The competitiveness measurement model here emphasises the volatility time intervals of the industrial portfolios of the considered countries. Competitiveness can thus be measured through the proportional losses or gains in the yearly value of IC in the industrial portfolios of the considered countries, independent of global market fluctuations. A reduction in the industry's IC value marks a certain share of the lost market position of the considered country in global trade. An increase in the yearly value of IC of an industry indicates gains in the market position of the country in global trade. This logic reflects the ability of a country to compete within industries along value chains in international trade. As noted in the previous section, "competitiveness" is measured as the gained or lost share of the IC value in the industries of each country during the considered time interval. The following approaches for measuring competitiveness are possible:

1. **National competitiveness** is calculated through the proportional change in IC value within the industrial portfolio of the considered country. It aggregates the results of all the country's industries and includes the contribution factor of those industries to the national industrial portfolio:

$$CO_c^{\Delta y} = \sum_{i=1}^{45} \left(\frac{\Delta IC_{ci}^{\Delta y}}{IC_{ci}^{y-x}} * S_{ci}^{y-x} \right), \tag{10}$$

where:

c is the observed country;

i is the observed industry;

Δy is the observed time interval of an economic shock or recovery from the shock, which began in year ($y - x$) and ended in year y;

$\Delta IC_{ci}^{\Delta y}$ is the change in the IC value in the observed national industry during the observed time interval ($\Delta IC_{ci}^{\Delta y} = IC_{ci}^{y} - IC_{ci}^{y-x}$) ;

IC_{ci}^{y} and IC_{ci}^{y-x} are the intermediate consumption values of the observed national industry in year y and in year ($y - x$), respectively;

$CO_c^{\Delta y}$ is the competitiveness of the observed country during the observed time interval;

S_{ci}^{y-x} is the IC value share of the observed industry in the industrial portfolio of the observed country at the beginning of the observed time interval ($S_{ci}^{y-x} = IC_{ci}^{y-x}/IC_c^{y-x}$) .

Equation (10) is simplified using the following calculation:

$$CO_c^{\Delta y} = \sum_{i=1}^{45} \left(\frac{\Delta IC_{ci}^{\Delta y}}{IC_{ci}^{y-x}} * \frac{IC_{ci}^{y-x}}{IC_c^{y-x}} \right),$$

$$CO_c^{\Delta y} = \sum_{i=1}^{45} \left(\frac{\Delta IC_{ci}^{\Delta y}}{IC_c^{y-x}} \right),$$

$$CO_c^{\Delta y} = \frac{\sum_{i=1}^{45} (\Delta IC_{ci}^{\Delta y})}{IC_c^{y-x}}.$$

Since national competitiveness includes the full industrial portfolio, the fluctuations in the IC value across all industries of the considered country can be expressed as $\Delta IC_c^{\Delta y} = \sum_{i=1}^{45}(\Delta IC_{ci}^{\Delta y})$.

Thus, national competitiveness depends on the fluctuations of the industrial portfolio as a whole, with losses or gains in individual industries compensating for each other in the aggregate industrial portfolio result:

$$CO_c^{\Delta y} = \frac{\Delta IC_c^{\Delta y}}{IC_c^{y-x}}. \quad (11)$$

2. **Industrial competitiveness,** like the industrial resilience evaluation, can be calculated from the country perspective (Equation 12) or the global industry perspective (Equation 13). These calculations do not incorporate the national contribution factors of industries:

$$COI_c^{\Delta y} = \sum_{i=1}^{45}\left(\frac{\Delta IC_{ci}^{\Delta y}}{IC_{ci}^{y-x}}\right), \quad (12)$$

$$COI_{gi}^{\Delta y} = \sum_{c=1}^{77}\left(\frac{\Delta IC_{ci}^{\Delta y}}{IC_{ci}^{y-x}}\right), \quad (13)$$

where:

$COI_c^{\Delta y}$ is the industrial competitiveness of the observed country during the observed time interval;

$COI_{gi}^{\Delta y}$ is the industrial competitiveness of the observed global industry during the observed time interval.

Other variables are denoted by Equation (10).

2.5.2.1. Selection of the model for measuring national resilience

The national resilience measurement model is developed with the understanding that it should be practical and effective. The following assessment is performed to optimise the relative resilience approach presented by Martin and Gardiner (2019), applying mathematical calculations and insights from linear regression analysis.

The variables denoting national resilience $(RE_c^{\Delta y})$ in Equation (4) and national competitiveness $(CO_c^{\Delta y})$ in Equation (11) are substantially different in composition. $RE_c^{\Delta y}$ is based on the global IC value fluctuations, whereas $CO_c^{\Delta y}$ is a construct of proportional fluctuations in the national IC value. This initial perception proves to be misleading after the implementation of the correlation analysis of the two variables. An OLS regression exercise shows that the resilience and competitiveness variables are directly correlated (Cambridge Dictionary) through a time-specific coefficient (Global factor), the values of which are listed in Table 9.

Table 9. Linear regression results for national resilience and competitiveness on an annual basis (adapted from Montrimas et al., 2024, author's updated definitions and results)

Time interval	Regression Slope (Global factor)	Regression intercept	Time interval	Regression Slope (Global factor)	Regression intercept
1996	78.53	1.001	2009	9.80	1.000
1997	37.93	1.000	2010	12.50	-1.000
1998	32.13	1.000	2011	8.62	-1.000
1999	32.12	-1.000	2012	142.60	-1.000
2000	31.92	-1.000	2013	119.31	-1.000
2001	26.99	1.000	2014	61.97	-1.000
2002	198.24	-1.000	2015	16.72	1.000
2003	8.91	-0.999	2016	36.52	1.000
2004	8.28	-1.000	2017	29.70	-1.000
2005	12.72	-0.999	2018	16.71	-0.999
2006	13.50	-1.000	2019	107.70	1.000
2007	8.86	-1.000	2020	29.83	1.000
2008	14.60	-1.000			

These Global factor values and the intercept results, shown in Table 9, suggest that there is a direct correlation (mathematical equality) between $RE_c^{\Delta y}$ and $CO_c^{\Delta y}$ through a time-specific Global factor value. The direct correlation is expressed by the following equation:

$$RE_c^{\Delta y} = intercept^{\Delta y} + Global\_factor^{\Delta y} * CO_c^{\Delta y}. \qquad (14)$$

Some of the *intercept* values in Table 9 produce minimal errors due to the rounded values in the calculations. Other than that, the regression results show that the value of the *intercept* in this equation is either -1 or 1. The negative *intercept* value corresponds to a positive IC value change $((IC_g^y - IC_g^{y-x}) > 0)$ at the global level. The positive *intercept* value, alternatively, corresponds to a negative change in the IC value $((IC_g^y - IC_g^{y-x}) < 0)$ at the global level during the considered time interval. When the calculations that produce $RE_c^{\Delta y}$ and $CO_c^{\Delta y}$ in Equations (4) and (11) are respectively plugged into Equation (14), the following equations are produced, leading to the equations that produce the Global factor results in Table 9.

When the *intercept* = -1:

$$Global\_factor^{\Delta y} * CO_c^{\Delta y} = RE_c^{\Delta y} - (intercept^{\Delta y}),$$

$$Global\_factor^{\Delta y} = \frac{RE_c^{\Delta y} - (-1)}{CO_c^{\Delta y}}.$$

Inserting the calculations from Equations (4) and (11) produces the following:

$$Global\_factor^{\Delta y} = \left(\frac{IC_c^y * IC_g^{y-x} - IC_g^y * IC_c^{y-x}}{|IC_g^y - IC_g^{y-x}| * IC_c^{y-x}} + 1\right) \div \left(\frac{IC_c^y - IC_c^{y-x}}{IC_c^{y-x}}\right),$$

$$Global\_factor^{\Delta y} = \left(\frac{IC_c^{y} * IC_g^{y-x} - IC_g^{y} * IC_c^{y-x} + |IC_g^{y} - IC_g^{y-x}| * IC_c^{y-x}}{|IC_g^{y} - IC_g^{y-x}| * IC_c^{y-x}}\right) \times \left(\frac{IC_c^{y-x}}{IC_c^{y} - IC_c^{y-x}}\right),$$

$$\begin{cases} Global\_factor^{\Delta y} = \frac{IC_c^{y} * IC_g^{y-x} - IC_g^{y} * IC_c^{y-x} + |\Delta IC_g^{\Delta y}| * IC_c^{y-x}}{|\Delta IC_g^{\Delta y}| * \Delta IC_c^{\Delta y}} \\ \Delta IC_g^{\Delta y} < 0 \end{cases}. \quad (15)$$

When the i*ntercept* = 1, the calculation is the following:

$$Global\_factor^{\Delta y} = \frac{RE_c^{\Delta y} - (1)}{CO_c^{\Delta y}},$$

$$\begin{cases} Global\_factor^{\Delta y} = \frac{IC_c^{y} * IC_g^{y-x} - IC_g^{y} * IC_c^{y-x} - |\Delta IC_g^{\Delta y}| * IC_c^{y-x}}{|\Delta IC_g^{\Delta y}| * \Delta IC_c^{\Delta y}} \\ \Delta IC_g^{\Delta y} > 0 \end{cases}. \quad (16)$$

The presence of a direct correlation between the respective values of resilience and competitiveness at the national level highlights the equivalence of results between the resilience and competitiveness models at the national level, and both are suitable for measuring countries by their resilience. However, it is important to consider time-specifics in both cases. This is because the national resilience measurement model directly includes global health factors for a particular time interval, whereas the national competitiveness model includes global health factors indirectly. Ultimately, the utilisation of the national competitiveness measurement model allows for a simpler comparison of countries based on how they resisted during economic shocks and recovered afterwards. Competitiveness can be evaluated by considering IC value fluctuations at the national level without accounting for the indications of inter-regional, international, or global economic performance. **The reason is that the national competitiveness measurement model extracts "competitiveness"—the essential property of the relative resilience measurement model—and leaves the macro-aggregate global performance indicator behind.** The macro-aggregate indicator—the Global factor—reveals itself to have the same value for any country in the data panel within the defined time interval. The Global factor changes only across time intervals.

Ultimately, when one compares countries by their resilience, this research highlights that it is sufficient to calculate the competitiveness of those countries during economic shocks and the competitiveness during the subsequent recoveries using Equation (11). These results will demonstrate the state of relative resilience of those countries.

The further analysis, therefore, considers national competitiveness as a measure to compare countries by their resilience.

2.5.2.2. Market health identifier

National competitiveness (and, simultaneously, national resilience) results include country-specific industrial portfolio properties that are expressed by the share of the value of IC of the assessed country (S_{ci}^{y-x}) in Equation (10). This property makes national competitiveness (or national resilience) unsuitable for the identification of global market health because the country-specific contribution variables (S_{ci}^{y-x}) distort the global results. The accumulation of IC value fluctuations results in the industrial portfolios of all contributing countries produce balanced performance statistics of the global value chains across countries or industries, which can identify the time intervals of global economic shocks and recoveries.

The assessment of global market health is necessary for the identification of the time intervals of the occurrence of global economic shocks and subsequent recoveries. Previous resilience measurement models have either empirically identified economic shocks and recoveries (Solow, 1956; Swan 1956; Mankiw et al., 1992; Knight et al. 1993; Martin, 2012; Martin et al., 2016; Martin & Gardiner, 2019) by observing the economic performance of the assessed system through the fluctuations of aggregate output or employment, or by registering natural disasters (Earthquake Engineering Research, Network of adaptive capacities, System Resilience, PEOPLES, CoBRA, DYNAMMICs, ECAM) and assigning them to the respective physical damages that cause significant alterations in economic performance.

This research suggests an inverse version of market health identification, stemming from the global economic performance data availability within the ICIO Tables. Global market performance—global IC value increases or reductions—depends on the level of IC value increases or decreases within the countries that comprise the global economy. This suggests that the global market health identifier could be either the aggregate value of industrial resilience, calculated from Equations (8) or (9), or industrial competitiveness, calculated from Equations (12) or (13). The industrial resilience approach to global economic performance during the observed period, from the country perspective, produces the results (from Equation 8) shown in Table 1 in the Annex, whereas the global industry perspective (from Equation 9) is presented in Table 2 in the Annex. The same action of calculating industrial competitiveness from the country perspective (from Equation 12) produces the results shown in Table 3 in the Annex, and from the global industry perspective (from Equation 13) produces the results shown in Table 4 in the Annex. Equations (8) and (9) produce identical aggregated industrial resilience results for the global economy for each year of the observed period, while Equations (12) and (13) respectively produce identical aggregate industrial competitiveness results during the observed period.

Despite their differences, both the industrial resilience and industrial competitiveness models reveal the same time intervals of global economic downturns and subsequent recoveries. The annual periods in Tables 1, 2, 3, and 4 in the Annex with indicated negative total values indicate economic shocks (from onset to trough, following Martin and Gardiner, 2019). The last positive annual periods before the occurrence of the total negative values in these tables indicate the onsets of global economic shocks (Fig. 8).

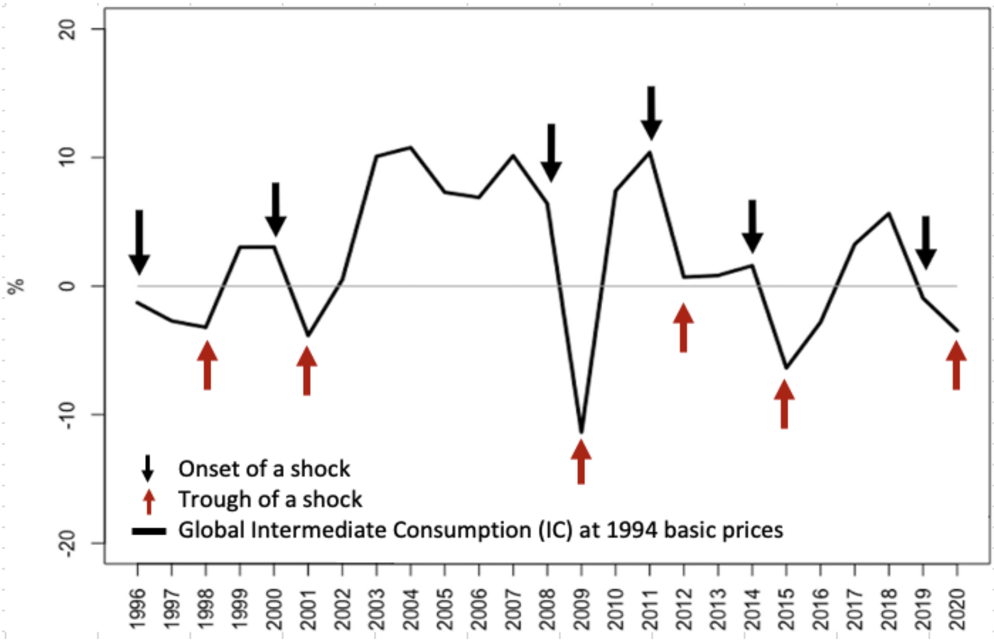


Fig. 8. Onsets and troughs of global economic shocks (adapted from Montrimas et al., 2024; author's updated definitions and results)

The bottom rows of Tables 1, 2, 3, and 4 in the Annex represent the results for global market health identification. The negative total values indicate global economic shocks, and following the findings in the literature analysis, it is necessary to identify the global events that could have triggered these shocks. The following events could be among the main factors that caused the identified global economic shocks:

- Haggard (2000) described the economic consequences on global trade of the Asian financial crisis that occurred in 1997.
- Tseng (2004) indicated the consequences of the global economy induced by the crash of the NASDAQ stock market after the so-called burst of the dot-com bubble in March 2000.
- Kok et al. (2022) described the effects of the Global Financial Crisis that began in September 2008.
- The sovereign debt crisis of the Euro area, which started in May 2010, was also introduced by Kok et al. (2022). This event is described more as a regional recessionary shock in Europe. Tables 1 and 3 (in the Annex) highlight the negative economic performance results of European countries in 2012. Most of the global industries in Tables 2 and 4 (in the Annex) also recorded negative results in 2012. This suggests that in 2012, there were significant disruptions in the global value chains in most global industries, affecting countries on other continents (South Africa, Pakistan, India, Pakistan, Indonesia, Brazil, Hong

Kong). These countries also recorded significant negative results in 2012 (Tables 1 and 3 in the Annex). Other countries, such as China, Vietnam, Laos, Ukraine, Peru, and Nigeria, increased their positions in global trade in 2012. In the context of global economic performance, these countries compensated for a major part of the losses in global IC value in 2012. This shows that a small number of countries can compensate for the losses in the realisation of production of the remaining disrupted global economies, thus resulting in global economic growth in the year 2012 (Fig. 8). The global economy maintained its growth despite the disruptions that occurred in nearly all industries along the value chain (Tables 2 and 4 in the Annex). Meanwhile, the global value chain disruption results imply that the economic shock of 2012 can be categorised at a similar level to other economic shocks during the observed period.

- Van de Graaf and Colgan (2017) described the crisis in the energy market, along with the crisis in Ukraine in 2014, while Scipioni (2018) elaborated on the European migrant crisis of 2015–2016. Tables 1 and 3 (in the Annex) highlight that most EU economies posted negative performance in 2015.
- Kok et al. (2022) described the economic shock caused by the COVID-19 pandemic from 2020 onwards.

Recoveries from economic shocks are considered completed in the analysed literature when economies reach their pre-shock levels. There are instances (hysteretic recessions) when economies recover to alternative growth paths at different growth rates during recoveries (Martin, 2012; Martin & Gardiner, 2019). An empirical assessment of the time intervals of global economic recoveries is portrayed in Fig. 9, constructed based on global peak-to-peak economic performance, as suggested by Martin and Gardiner (2019). Fig. 9 indicates alterations in the growth path and growth rate of the global economy. Fig. 8 identifies the onsets and troughs of the shocks. Thus, recoveries can be considered completed once the value of IC returns to its pre-shock level (2000, 2018 in Fig. 9) or exceeds the pre-shock level (2003, 2011, 2014).

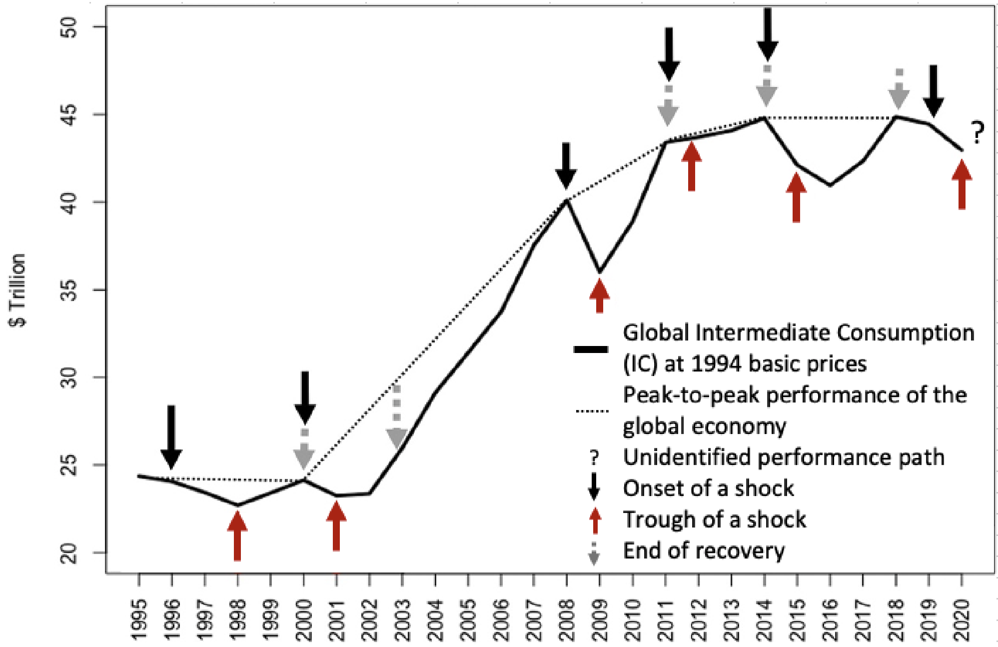


Fig. 9. Peak-to-peak cyclical performance of the global economy between 1995 and 2020 (adapted from Martin & Gardiner, 2019, and Montrimas et al., 2024, author's updated definitions and results)

Fig. 9 also shows steep growth in the global economy from 2003 to 2008. Positive dynamics of the IC value in industries along the global value chains are visible in Tables 2 and 4 in the Annex. These indications highlight the lack of necessity to consider this time interval in further research to maintain focus on the factors of resilience of countries to economic shocks.

The above-described market health identification model could be implemented in several ways—by using one of the industrial resilience or industrial competitiveness equations. However, **the most practical and feasible approach is Equation (13), which produces the industrial competitiveness results from a macro-aggregate perspective that helps determine the time intervals of economic shocks.** The subsequent recovery time intervals of the macro-aggregate market could then be identified empirically by using the IC value dynamics, as shown in Fig. 9. It is important to note that this market health identifier could also be applied to smaller regions to identify regional or local time intervals of economic shocks (e.g., the EU, Latin America, etc.)

2.5.2.3. National industrial portfolio properties and their indicators

The full industrial portfolio of a country is the sum of all its industries. A set of industries in the ICIO Tables aggregates into the full industrial portfolio, which can be expressed by the following equation:

$$IP_c^y = \sum_{i=1}^{45} S_{ci}^y = 100\%, \quad (17)$$

where:
c is the observed country,
i is the observed industry,
y is the observed year,

S_{ci}^y is the IC value share of the observed industry in the industrial portfolio of the observed country in the observed year $(S_{ci}^y = IC_{ci}^y / IC_c^y)$,

IP_c^y is the industrial portfolio of the observed country in the observed year.

The list of industries for all countries in the ICIO Tables is the same according to the standardised nomenclature of the NAs (Eurostat, 2013), and it is listed in Tables 2 and 4 in the Annex. However, the composition of these industries differs by country, as it has dynamic properties over time. These compositions are used as factors for identifying the industrial portfolio properties of a country.

The shares of these industries within the industrial portfolio of a country change constantly, while these industries at the global (macro-aggregate) level undergo significant fluctuations in response to major economic shocks on the international stage. Thus, when explaining why one country is more resilient than another, the industrial portfolio compositions of the compared countries can be evaluated by using the shares of the IC values in every national industry.

2.5.2.4. National resilience properties and their indicators

The productive population and the availability of natural resources are the two main components of the "nation's wealth" concept, as emphasised by Adam Smith in the literature analysed in this research. These components form the basis for the economic well-being of any country.

The productive population constitutes human capital and naturally depends on the level of employment, although the unemployed workforce could also contribute some value to a country's economic performance. Significant population shifts within EU countries followed the accession of new member states into the EU: 10 new member states from Eastern and Southern Europe joined in 2004; Romania and Bulgaria joined in 2007; and Croatia joined in 2013 (EU Timeline). Kairienė et al. (2008) stressed that when EU borders are open, emigration from new EU economies increases significantly, as the receiving economies in Western countries attract the new labour force. The recent significant population shift in the EU began in 2015, triggering an EU-wide crisis (Scipioni, 2018) when migrants from the Middle East and Africa entered EU countries in large numbers. These examples illustrate that migration streams are driven by: 1) the productive population seeking better living conditions, including fair remuneration, and 2) the willingness of employers and, consequently, governments to fill job vacancies. This perspective implies that changes in a country's population volumes essentially reflect changes in the volume of its productive population. When measuring resilience, Martin and Gardiner (2019) used population size and density as proxies to measure the resilience of cities and regions in the UK. This relationship is extended to the national level, incorporating Adam Smith's theory (Manis, 2005; Butler, 2011) that the performance of an economy results from its productive population. The productive population factor is evaluated using four indicators listed in Table 10: Population, Population change, Proportional population change, and Population density. Fluctuations in the values of these indicators illustrate the dynamics of population and population density when a country experiences an economic shock or recovers from one.

There is intense discussion in the literature on regional resilience, focusing on industrial diversification (Conroy, 1975; Brown & Greenbaum, 2016; Doran & Fingleton, 2018) or specialisation (Cuadrado-Roura & Maroto, 2016; Martin et al., 2016; Picek & Schröder, 2018; Hundt & Grün, 2022), localised specialisation (Marshall, 1890; Arrow, 1962; Romer, 1986) or urbanisation (Beaudry & Schiffauerova, 2009). These assessments were primarily conducted using levels of industrial or regional employment. HHI (Hundt & Grün, 2022) or KSI (Krugman, 1992; Martin & Gardiner, 2019) are commonly used instruments to measure industrial distribution within analysed regions. HHI measures regional specialisation based on the sectoral allocation of a region's workforce, whereas KSI can provide insights into differences in national industrial portfolios. Thus, KSI appears to be more suitable for this research.

Both indices are calculated using employment data. Martin and Gardiner (2019) made assumptions about the occupational skill mix to address the constraint of partial employment data availability. Meanwhile, the use of ICIO Tables allows for the utilisation of the shares of the value of IC resulting from a full range of occupational skills in every industry within a country. This approach eliminates possible constraints related to employment data availability. In their study, Montrimas et al. (2023) adopted Leontief's (1936) input-output method to use IC values in national industries. These values represent the resources for generating added value in an economy. According to the input-output logic of Leontief (1936), every product is a resource, either as a good or as a service, within the respective industries. When a product is categorised as a service, it consists of its input resources—labour and equipment/materials (labour-based theory of value of Adam Smith in Table 3). Equipment and materials are also products produced from a combination of labour and other input materials, which in turn are produced by labour and raw materials obtained by the workforce. When tracing a product's value back to its roots, it highlights two sources of the product's value. These two sources are the main elements that constitute the nation's wealth, as proposed by Adam Smith: natural resources and a productive population (Manis, 2005). Activities of the productive population are understood as employment. The value of employment arises from the excavation of raw materials, from to the finalisation and delivery of the product to a customer, thus constituting the value of a product in the form of its price. Consequently, the value of IC reflects the value of employment in developing the product, which, in turn, results from the product's availability and its attractiveness to consumers, including the properties of the local business environment in the ICIO Tables.

In this research, the value of a country's employment is considered the value of the country's IC, as taken from the ICIO Tables. The ICIO Tables allow for the utilisation of shares of the IC value, which resulted from the full set of occupational skills across industries in each country. This approach eliminates the constraint related to the availability of employment data, and the inter-industrial iteration of employment efforts becomes visible within the IC values. Thus, industrial specialisation is measured through the dynamics of two indicators: the KSI value and the proportional change in KSI within the country (Table 10).

Table 10 consolidates the indicators selected for further analysis in this research, serving as the criteria for defining the properties of national resilience.

Table 10. Indicators of national properties when resisting to shocks and recovering from them

Indicator	Code	Description
Observed time interval	year	The observed time interval between 1995 and 2020 in the ICIO Tables during which a shock occurred at the global level or the global economy recovered from a shock. The time intervals are considered from the onset of the shocks to the troughs of the shocks, and for recoveries, from the trough to the end of recovery, as shown in Fig. 9.
Shock year	shock_year	A dummy variable that identifies the year of the occurrence of an economic shock in the panel and the time interval between the onset of a shock to the trough of a shock, as shown in Fig. 9.
Country	Country	One of the countries listed in the ICIO Tables (Table 1 or 3 in the Annex).
Population	pop	Population of a Country (millions) at the beginning of the Observed time interval.
Proportional population change	pdelta_pop	Proportional change in the population count of a Country during the Observed time interval, expressed by the following equation: $pdelta\_pop_c^{\Delta y} = (pop_c^y - pop_c^{y-x})/pop_c^{y-x}$.
Population density	pop_dens	Population density of a Country (persons per 1 square kilometre) at the beginning of the Observed time interval.
Proportional change of population density	pdelta_dens	Proportional change in the population density of a Country during the Observed time interval, expressed by the equation: $pdelta\_dens_c^{\Delta y} = (pop\_dens_c^y - pop\_dens_c^{y-x})/pop\_dens_c^{y-x}$.
Industrial specialisation	KSI	National value of the Krugman specialisation index at the beginning of the Observed time interval (Martin et al., 2016; Martin & Gardiner, 2019; Martini, 2020; Hundt & Grün, 2022), adapted for national industrial specialisation measurement through the ICIO Tables by using the values of IC (as described in Montrimas et al., 2023): $$KSI_c^{\Delta y} = \sum_{i=1}^{45} \lvert s_{ci}^y - s_{gi}^y \rvert, \quad (18)$$ Where: s_{ci}^y – share of the observed national industry in the total value of IC; s_{gi}^y – share of the global industry in the total value of IC in the global industrial portfolio; y – year of the Observed time interval; *i* – one of the 45 industries in Table 11.
Proportional change in industrial specialisation	pdelta_KSI	Percentage change in the value of the national KSI during the Observed time interval, expressed by the following equation: $pdelta\_KSI_c^{\Delta y} = (KSI_c^y - KSI_c^{y-x})/KSI_c^{y-x}$.

Population (*pop*), population density (*pop_dens*), and their respective proportional change indicators (*pdelta_pop* and *pdelta_dens*) are considered endogenous variables. This is because population density values are calculated by dividing the population by the size of the territory of the observed country. Since the considered territory does not change throughout the observed period for all countries, the population and population density variables, along with their proportional change indicators, should not be included in the same regression assessments. In separate regression assessments, these variables can provide distinctive insights because population indicators account for the volume of human resources, whereas population density indicators account for the balance between human and natural resources within the observed countries.

The indicators listed in Table 10 are used in this research as descriptive indicators that may or may not impact changes in the industrial portfolio properties of the analysed economies during economic shocks and recovery time intervals. Their significance in determining the resilience of countries is assessed in the next chapter by applying econometric analysis.

2.5.3. Conceptual model

The conceptual model in this section explains and summarises the use of the indicators as factors, as discussed in the previous section, thus enabling an attempt to systematise national industrial portfolio properties when assessing national resilience to economic shocks through competitiveness in the international market by evaluating their industrial portfolio performance (Fig. 10).

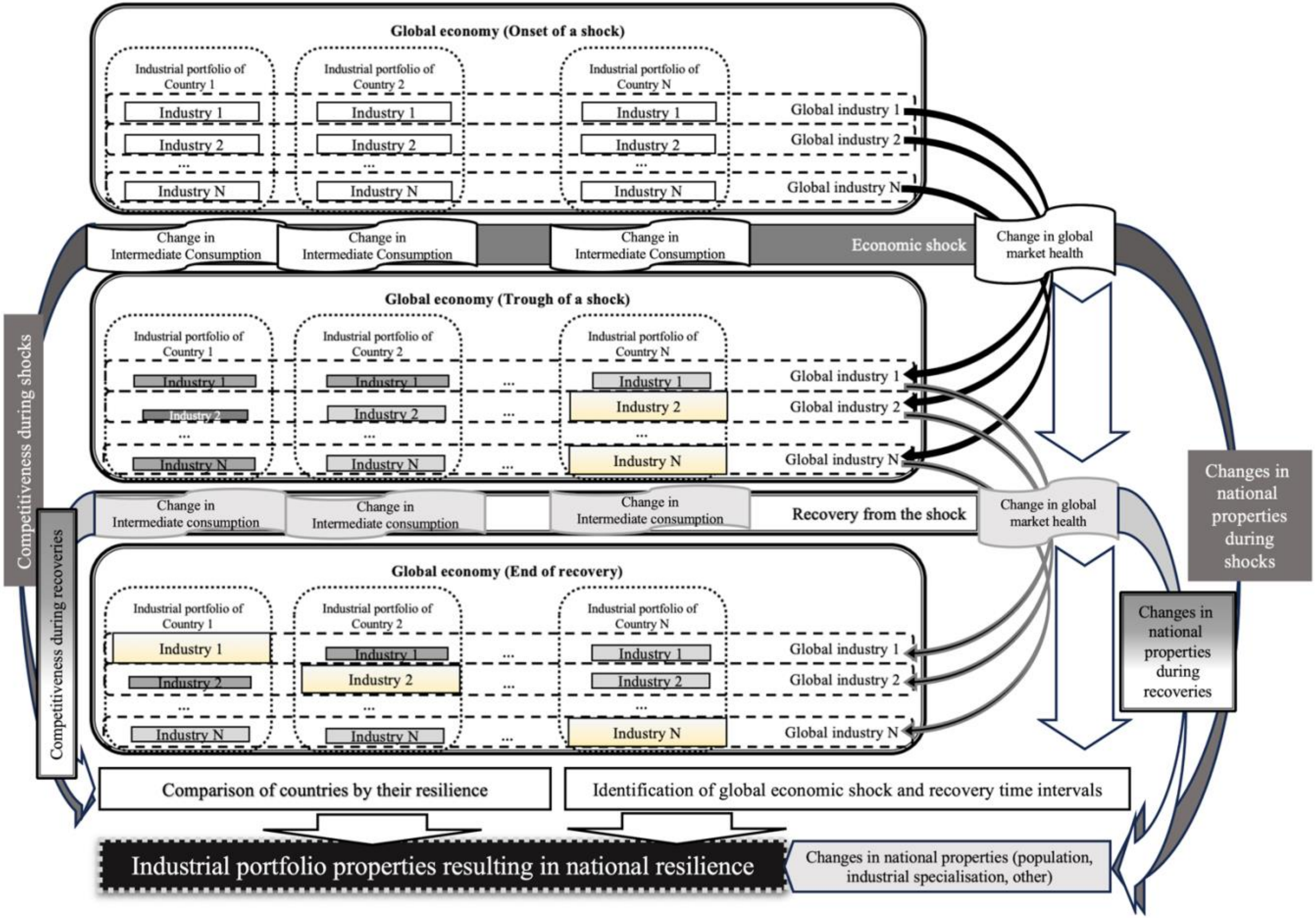


Fig. 10. Conceptual research model

The conceptual model consists of the following steps:

1. **Market health identification.** The exercise of measuring the health of the value chains enables the identification of the time intervals of economic shocks occurrence and recovery from them:
   a) To identify the time intervals of economic shocks, the annual IC input values are used to determine the results of industrial competitiveness at the global level by applying Equation (13):

$$COI_{gi}^{\Delta y} = \sum_{c=1}^{77} \left(\frac{\Delta IC_{ci}^{\Delta y}}{IC_{ci}^{y-x}}\right), \tag{13}$$

   where:
   c is the observed country;
   i is the observed industry;
   Δ*y* is the observed time interval of an economic shock or recovery, from the shock that began in year (*y* – *x*) and ended in year *y*;
   $\Delta IC_{ci}^{\Delta y}$ is the change in the IC value in the observed national industry during the observed time interval;
   IC_{ci}^{y-x} is the IC value of the observed national industry in year *(y – x)*;
   $COI_{gi}^{\Delta y}$ is the industrial competitiveness of the observed global industry during the observed time interval.

   b) To identify the completion of recoveries, an empirical assessment of the observed market is conducted through the development of the aggregate IC value. The recovery from an economic shock is considered complete when the aggregate IC value reaches its pre-shock level.

2. **Comparison of countries by their resilience**. The input values are the IC values for each of the countries selected for comparison from the list of 77 countries of the world in the ICIO Tables. The competitiveness results of the selected countries are calculated by applying Equation (11):

$$CO_{c}^{\Delta y} = \frac{\Delta IC_{c}^{\Delta y}}{IC_{c}^{y-x}}. \tag{11}$$

   where:
   c is the observed country;
   Δ*y* is the observed time interval of an economic shock or recovery from the shock that began in year (*y* – *x*) and ended in year *y*;
   $\Delta IC_{c}^{\Delta y}$ is the change in the IC value in the observed country during the observed time interval;
   IC_{c}^{y-x} is the intermediate consumption value of the observed country in year (y – *x*);

$CO_c^{\Delta y}$ is the competitiveness of the observed country during the observed time interval.

Following the methodology presented in this dissertation, countries can be compared by their resilience through the measure of national competitiveness. The relative resilience of a country is thus expressed by the joint results of $CO_c^{\Delta y}$ for the time interval of an economic shock (equivalent to resistance) and $CO_c^{\Delta y}$ for the subsequent recovery (equivalent to recoverability). This measure within the ICIO Tables data panel enables the comparison of all 77 countries worldwide by their resilience.

3. **Identification of the industrial portfolio properties.** The IC values from the data panel are applied to calculate the national industrial portfolio properties using Equation (17):

$$IP_c^y = \sum_{i=1}^{45} S_{ci}^y = 100\%, \tag{17}$$

where:
c is the observed country;
i is the observed industry;
y is the observed year;
S_{ci}^y is the IC value share of the observed industry in the industrial portfolio of the observed country in the observed year;
IP_c^y is the industrial portfolio of the observed country in the observed year.

The shares of each industry sum to the full industrial portfolio, revealing the level of contribution of each industry to the industrial portfolio of the observed country. The industrial portfolio compositions vary along with changes in the IC values in national industries. A significant change in the share of an industry indicates a level of structural change within the country, which can be linked to respective national events, as described in the scientific literature or official media announcements.

Industrial portfolio properties could also be used for country clustering. Depending on the context, the assessment of industrial portfolio properties could performed in parallel with the identification of the factors that shape national resilience properties.

4. **Identification of factors that shape national resilience properties.** Factors frequently discussed in the scientific literature are used for country clustering and as independent variables in the OLS, fixed effects (FE), and random effects (RE) regressions to identify national properties that have a significant effect on the dependent variables—country competitiveness during economic shocks and subsequent recoveries.
5. **Interpretation of the results and discussion.** This step includes assessing the results of the econometric modelling. In the case of a lack of robust findings in the econometric modelling, countries are clustered based on the most relevant national resilience property (such as population, industrial specialisation, etc.).

Meanwhile, industrial portfolios can be concentrated by shortlisting industries according to their contribution to the overall national IC value. This exercise aims to identify the national properties or the concentrated composition of industries that shape the resilience of countries.

The research path ultimately consists of five steps: 1) Measurement of global market health (health of the global value chains)—identification of the time intervals during which economic shocks occur and the subsequent recoveries from them; 2) calculation of national competitiveness during the shocks and recoveries; 3) identification of national industrial portfolio properties; 4) country clustering, along with OLS, FE, and RE econometric modelling to identify the significant effects on national competitiveness; 5) interpretation of the results and discussion.

3. ASSESSMENT OF THE IMPACT OF CHANGES IN INDUSTRIAL PORTFOLIO ON THE RESILIENCE OF EU ECONOMIES TO ECONOMIC SHOCKS

The previous chapter developed a methodology for assessing the resilience of countries by evaluating their industrial portfolio performance. This chapter consequently assesses the impact of industrial portfolio changes on the resilience of EU economies to economic shocks. This research aims to validate the developed methodology on the EU case. Therefore, it focuses on the economic performance of one region, although the global economic performance data within the ICIO Tables in this research could also be used for other regions of the global economy.

3.1. Identification of EU market health

The dynamics of global market health were assessed in the previous chapter, and the results, reflecting the industrial competitiveness of the world economies, are presented in Tables 3 and 4 in the Annex. The economic shocks and recoveries at the global level are shown in Fig. 9.

The same steps can be applied to identify the health of the EU economy. This research aims to assess the resilience of EU countries. Therefore, it focuses on the economic performance of one region: the EU. The literature review indicated the problem of externalities from other regions of the world causing unpredictability in the economic cycles of the EU market (the presence of externalities is shown in the comparison between Fig. 5 and Fig. 4). To address this issue, the research adopts a holistic approach. The dataset of the global economic performance within the ICIO Tables in this research is used for reference purposes, although the primary focus is on EU countries. The data panel for further research is narrowed down to the 28 EU member states that formed the union up to 31 January 2020 (European Union). The United Kingdom (UK) is included in this research due to its significant contribution to the development of the EU between 1995 and 2020 (the period of which statistics are available in the ICIO Tables).

The previous chapter identified the relationship between the relative resilience of a country and its ability to compete against other countries. More specifically, structural shifts increase between industries in the observed countries during the recoveries, as each country seeks to exploit its comparative advantages in undisrupted industries to compensate for losses in industries that were disrupted during economic shocks. When the IC value in certain industries significantly decreases, these reductions are visible at the international market level. Consequently, the health of industries, as well as the entire international market, can be measured by applying the industrial competitiveness model. Equation (13), in this case, measures the health of the EU market and allows for the identification of EU-wide economic shocks. The systematised results of the EU market health are shown in Table 11.

Table 11. Health of the EU market from 1995 to 2020

Industry		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
01T02	Agriculture, hunting, forestry	-2	-5	-2	-4	-4	-1	1	3	4	-1	1	5	2	-5	0	4	-2	1	-1	-5	0	2	1	-1	0
03	Fishing and aquaculture	-3	-4	-1	-2	-5	3	5	3	3	1	3	3	2	-2	0	6	-3	6	7	-2	0	1	0	0	-1
05T06	Mining and quarrying, energy producing products	-1	-2	-3	-1	0	-1	1	5	3	3	3	3	6	-6	1	11	-3	1	-2	-6	-3	4	3	0	0
07T08	Mining and quarrying, non-energy producing products	-2	-2	-1	-2	-2	-1	2	6	4	2	5	4	2	-6	0	3	-4	1	0	-4	4	6	3	0	-1
09	Mining support service activities	-3	-2	-1	6	-1	1	1	5	5	3	6	25	24	-4	1	11	-2	3	1	-5	5	6	8	3	-3
10T12	Food products, beverages and tobacco	-2	-4	-1	-3	-3	0	1	4	3	1	1	4	2	-4	-1	4	-2	2	-1	-4	0	2	1	1	-1
13T15	Textiles, textile products, leather and footwear	-3	-5	0	-4	-3	-1	0	3	1	-2	1	2	-2	-7	-1	5	-3	0	1	-4	0	1	1	9	0
16	Wood and products of wood and cork	0	-3	0	-1	-3	-1	2	7	5	1	2	5	-1	-6	0	2	-3	0	2	-4	0	2	2	-2	0
17T18	Paper products and printing	-3	-4	0	-2	-1	0	1	5	3	0	2	3	1	-5	-1	1	-3	1	0	-4	0	1	2	-2	-1
19	Coke and refined petroleum products	1	-3	-4	3	9	-4	0	5	9	18	3	370	7	-7	3	8	-1	7	0	-7	-5	5	41	-4	-1
20	Chemical and chemical products	-3	-3	-1	-3	-1	-1	0	5	5	2	3	4	5	-7	2	4	-2	0	0	-3	-1	3	3	-2	0
21	Pharmaceuticals, medicinal chemical and botanical products	0	-3	-1	-1	-1	1	2	5	3	2	2	4	1	-1	2	3	-1	3	1	-2	1	1	1	1	4
22	Rubber and plastics products	-2	-3	1	-2	-1	1	2	7	4	2	3	5	1	-6	1	4	-3	1	2	-3	1	2	2	-2	-1
23	Other non-metallic mineral products	-2	-3	0	-1	-3	-1	2	5	5	2	3	5	1	-7	-2	3	-4	0	1	-3	2	2	3	-1	0
24	Basic metals	-3	-2	1	-4	0	-1	1	6	8	2	5	6	2	-11	7	5	-4	-1	0	-5	-1	5	2	-2	-2
25	Fabricated metal products	-2	-3	0	-2	-1	0	1	7	6	3	4	6	2	-7	-1	4	-3	0	1	-4	1	3	2	-1	-1
26	Computer, electronic and optical equipment	1	1	3	2	0	5	0	7	5	2	4	5	1	0	-1	1	-4	3	-1	-1	2	1	2	0	3
27	Electrical equipment	-2	-3	-1	-1	0	0	1	5	4	3	4	6	1	-5	0	4	-2	-1	0	-3	1	3	1	-1	1
28	Machinery and equipment, nec	-1	-3	-1	-1	-3	2	2	5	5	2	3	7	2	-4	-1	5	-2	1	0	-4	1	2	2	-1	2
29	Motor vehicles, trailers and semi-trailers	1	-1	3	1	-2	1	7	7	7	2	4	7	2	-3	3	5	-2	2	1	-3	2	2	5	-1	1
30	Other transport equipment	1	-2	1	-1	0	3	7	6	11	1	16	5	3	-3	-4	6	-1	3	4	-3	4	3	10	1	-1
31T33	Manufacturing nec; repair and installation of machinery/equipment	-2	-2	0	-2	-1	0	2	5	5	3	1	5	2	-3	1	2	-1	1	1	-3	1	2	2	-1	-1
35	Electricity, gas, steam and air conditioning supply	-1	-4	-1	-2	-2	1	4	7	3	3	4	4	5	-3	0	2	-2	1	-2	-5	-1	1	2	-2	-1
36T39	Water supply; sewerage, waste management and remediation	-1	-3	0	-1	-1	-1	2	7	5	2	3	5	5	-4	2	3	-1	1	1	-4	0	3	2	-1	1
41T43	Construction	0	-2	1	0	-3	0	5	7	8	3	5	6	4	-4	-2	1	-4	1	3	-3	1	1	6	-1	4
45T47	Wholesale and retail trade; repair of motor vehicles	-1	-3	0	-1	-1	0	3	6	5	2	2	5	3	-5	0	2	-2	1	1	-4	1	1	2	0	-1
49	Land transport and transport via pipelines	1	-4	0	-1	0	0	2	6	4	2	2	5	3	-4	0	1	-2	1	0	-4	1	2	3	-1	-2
50	Water transport	1	-5	-1	0	0	-1	1	5	5	1	4	7	5	-5	2	-1	0	-1	2	-5	-3	1	2	-1	-3
51	Air transport	-1	-2	0	0	-2	-1	2	6	6	4	3	4	4	-7	-1	2	0	2	3	-4	2	8	4	-2	-11
52	Warehousing and support activities for transportation	-1	-2	0	0	0	0	2	7	4	3	3	5	3	-5	1	3	-2	0	2	-4	1	3	3	-1	-3
53	Postal and courier activities	-2	-1	1	0	-2	0	2	5	3	2	2	5	2	-4	-1	1	-3	1	1	-4	1	1	3	0	2
55T56	Accommodation and food service activities	-2	-3	1	0	-1	-1	3	5	4	2	2	9	1	-2	-1	2	-1	1	2	-3	1	2	4	-1	-2
58T60	Publishing, audiovisual and broadcasting activities	0	-2	2	-1	-2	0	2	6	3	2	2	4	3	-4	-2	0	-2	1	1	-4	1	2	2	-1	-2
61	Telecommunications	1	-1	3	2	0	1	2	5	3	0	1	3	1	-3	-3	0	-4	-1	0	-4	1	1	1	-1	0
62T63	IT and other information services	3	-1	3	2	1	4	3	7	5	5	5	6	3	0	2	4	1	3	2	-2	2	3	5	1	2
64T66	Financial and insurance activities	-2	-3	1	-1	-3	-1	3	6	5	2	3	6	2	-1	-1	1	-3	1	1	-3	0	0	1	-1	0
68	Real estate activities	0	-1	1	2	-1	2	4	7	7	3	4	7	3	-1	2	2	-2	1	0	-4	2	1	3	-1	1
69T75	Professional, scientific and technical activities	0	-1	1	0	-1	1	3	6	4	3	3	6	3	-3	-2	2	-2	1	2	-3	1	2	3	0	0
77T82	Administrative and support services	0	-2	1	0	-2	2	3	7	4	3	3	6	4	-3	-1	2	-1	2	2	-3	2	3	3	0	-2
84	Public administration and defence; compulsory social security	193	-3	5	1	-1	2	2302	6	8	3	1	6	52	-1	8	2	-1	3	2	-2	3	11	5	-2	0
85	Education	2	-4	2	847	1	13	6	8	5	3	4	7	7	-1	3	2	-1	0	2	-4	2	1	3	-1	-1
86T88	Human health and social work activities	3	-3	1	2	-2	-2	6	7	4	4	5	6	8	0	3	2	-2	1	17	-4	7	5	2	0	2
90T93	Arts, entertainment and recreation	2	-1	2	0	0	0	5	7	6	6	5	6	6	-2	-1	5	-2	1	2	-3	2	3	4	0	-7
94T96	Other service activities	-1	-3	0	-1	-1	-1	3	6	4	1	3	5	5	0	-1	3	-2	1	0	-3	0	1	3	-1	-1
97T98	Activities of households as employers*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EU Industries total		**161**	**-117**	**17**	**825**	**-48**	**21**	**2411**	**255**	**213**	**113**	**149**	**614**	**200**	**-170**	**15**	**140**	**-93**	**57**	**59**	**-158**	**42**	**114**	**164**	**-22**	**-25**

*Undifferentiated goods- and services-producing activities of households for own use

The bottom row of Table 11 indicates the overall health dynamics of the EU market from 1995 to 2020. The orange values in the bottom row represent the economic time intervals of shocks at the regional EU level, while the remaining rows identify the losses (orange) or gains (blue) in the IC value of each EU industry on an annual basis.

The EU market health dynamics from Table 11 are further incorporated into Fig. 11, where the EU-wide economic shocks are indicated, along with the peak-to-peak cyclical performance as suggested by Martin and Gardiner (2019).

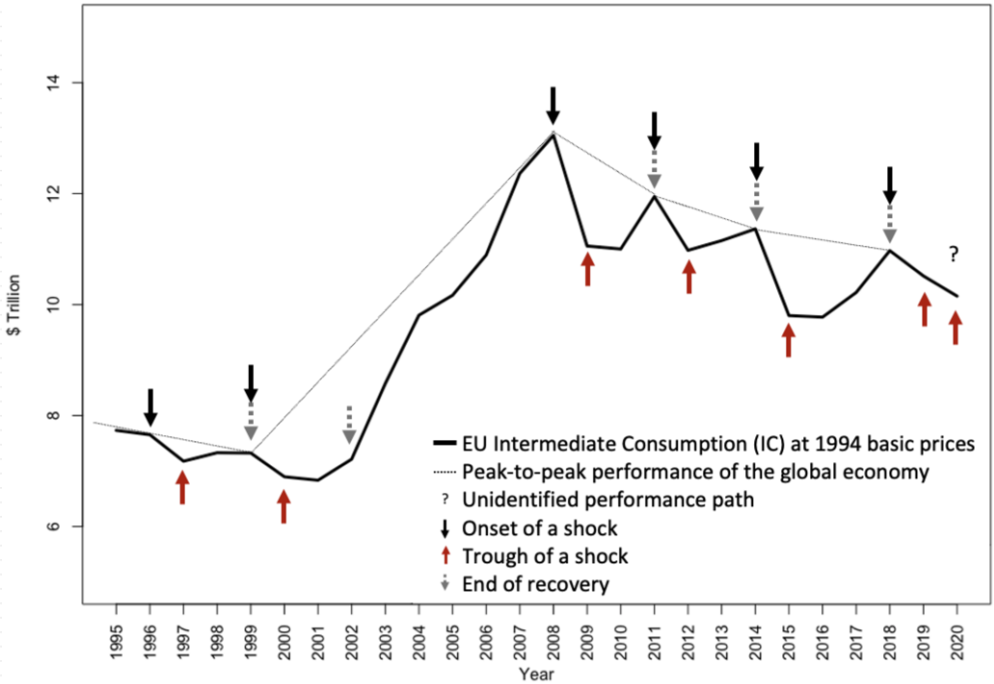


Fig. 11. Peak-to-peak cyclical performance of the EU market, 1995–2020

The time intervals of economic downturns, reflected by the negative total industrial competitiveness values in Table 11, represent the negative results of the aggregate IC value of the EU economy, or troughs, in Fig. 11. The years with the last positive total values in Table 11 are considered the onsets of the EU economy's shocks. Fig. 11 also illustrates the growth path and growth rate changes of the EU economy, suggesting points that could indicate the completions of recoveries. Recoveries are considered complete as soon as the IC value returns to the pre-shock level (e.g., year 2002 in Fig. 11) or at the onset of the next shock (years 1999, 2011, 2014, and 2018).

The time intervals of economic shocks and subsequent recoveries of the EU economy differ from those at the global level (Fig. 9). Fig. 9 reflects the global market health during the observed period. In comparison to the health of the EU economy, global economic shocks up to 2003 occurred with a one-year delay compared to the shocks and recoveries experienced in the EU. During the next turbulent period, starting in 2008, Fig. 11 shows a declining growth rate in the EU economy, while the global economy continued to grow at lower rates until 2018.

From the identification of global and EU-wide disruptions in economic development, the following observations can be drawn from the literature, which identified large-scale recessionary events:

- In 1997, the Asian financial crisis (Haggard, 2000) and the disruptions in the global financial markets in March 2000 (Tseng, 2004) caused disruptions in the EU economy in 1997 and 2000—one year earlier than those in the global economy.
- In 2008, the global financial crisis (Kok et al., 2022) disrupted both the global and EU economies simultaneously, although the EU economy experienced a more challenging recovery than other regions of the world.
- From 2010 to 2013, the sovereign debt crisis in the Euro area (Kok et al., 2022) contributed to an economic shock in the EU, including a significant drop in the IC value in 2012 (Fig. 11). Meanwhile, the global economy in 2012 managed to compensate for the IC value losses of the EU economy (Fig. 9).
- In 2014, the crises in the global energy market and Ukraine (Van de Graaf & Colgan, 2017) are believed to have impacted the global economy, one year earlier than the shock in the EU economy in 2015, which appears to have been the result of several major events. Along with the global energy market crisis and the crisis in Ukraine, this economic shock also included the economic consequences of the migrant crisis in Europe from 2015 to 2016 (Scipioni, 2018).
- The growth path since the peak performance of 2018 is unclear for both the EU and global markets. The economic crisis from 2020 onwards, triggered by the COVID-19 pandemic (Kok et al., 2022), aligns with the trough of the shock at the global level (Tables 3 and 4 in the Annex), while the EU economy has been in decline since 2019 (Table 11). The recovery paths can be identified once the OECD updates the ICIO Tables for the periods after 2020.

The global economic growth from 2003 to 2008 (Fig. 9) and in the EU between 2002 and 2008 (Fig. 11) consists of statistics that show the growth trend of the value of IC in the industries along the value chains, as shown in Table 4 (in the Annex) for the global market and in Table 11 for the EU market. They indicated that this time interval is not needed for further assessing the resilience of EU countries.

3.2. Comparison of the EU countries by their resilience

Focusing on the dynamics of the EU market prompts this research to compare the EU countries by their resilience within the time intervals of economic shocks and recoveries at the EU level (Fig. 11). As highlighted in the methodology section of this research, when measuring national resilience through competitiveness, it is important to consider the same time intervals, as the competitiveness of any country directly correlates with its relative resilience through the time-specific Global factor. When the time interval is consistent, the Global factor is identical for all countries in the global economy. **The relative resilience results can then be reflected through the competitiveness outcomes of any observed country**.

The competitiveness results of the EU countries during the time intervals of the EU-wide economic shocks are presented in Table 12, while the results during the subsequent recovery periods are shown in Table 13. The competitiveness of each country was calculated by applying the national competitiveness Equation (11) for the EU-wide resistance and recovery time intervals, respectively (Fig. 11).

Table 12. Comparison of the EU countries by how they resisted during economic shocks

	Shock '96-'97		Shock '99-'00		Shock '08-'09		Shock '11-'12		Shock '14-'15		Shock '18-'19		Shock '19-'20
GBR	9.5	**LVA**	14.3	**MLT**	6.6	**IRL**	10,7	**IRL**	4.1	**MLT**	4.7	**IRL**	17.0
IRL	7.7	**LTU**	8.1	**CYP**	-1.9	**MLT**	-0.8	**MLT**	0.7	**LTU**	4.1	**LTU**	4.7
LVA	5.0	**LUX**	5.2	**GRC**	-9.7	**GBR**	-2.1	**LUX**	-2.2	**LUX**	1.0	**LUX**	3.4
EST	2.4	**MLT**	3.2	**LUX**	-10.4	**LVA**	-3.2	**CYP**	-3.6	**HRV**	0.4	**SWE**	1.1
LUX	1.2	**EST**	0.1	**NLD**	-11.0	**LTU**	-3.3	**GBR**	-6.7	**POL**	0.0	**DEU**	-0.9
SVK	-2.3	**SWE**	-1.9	**IRL**	-11.5	**SWE**	-4.5	**POL**	-10.3	**ROU**	-0.2	**PRT**	-1.0
LTU	-3.4	**FIN**	-2.7	**AUT**	-12.3	**LUX**	-4.8	**SVK**	-10.7	**BGR**	-1.2	**FIN**	-1.7
FIN	-4.6	**GBR**	-3.1	**FRA**	-12.8	**DNK**	-5.6	**BGR**	-12.2	**EST**	-1.3	**CYP**	-2.5
HRV	-4.9	**POL**	-3.4	**PRT**	-13.5	**EST**	-5.6	**SVN**	-13.2	**PRT**	-1.6	**MLT**	-2.6
ITA	-5.8	**IRL**	-4.7	**BGR**	-14.1	**AUT**	-6.8	**CZE**	-13.2	**ESP**	-1.8	**LVA**	-2.6
SWE	-6.5	**ESP**	-4.8	**DEU**	-14.2	**SVK**	-7.1	**HUN**	-13.8	**HUN**	-2.5	**BGR**	-2.6
PRT	-7.4	**CZE**	-4.9	**BEL**	-14.7	**NLD**	-7.1	**HRV**	-14.0	**DNK**	-2.9	**SVN**	-2.7
ESP	-7.6	**FRA**	-5.6	**DNK**	-16.1	**FRA**	-7.6	**ESP**	-14.6	**GBR**	-3.4	**HRV**	-2.8
FRA	-8.6	**DNK**	-5.8	**ESP**	-16.2	**BGR**	-8.5	**LTU**	-14.8	**BEL**	-3.4	**DNK**	-3.4
MLT	-8.6	**NLD**	-5.8	**SVK**	-16.4	**FIN**	-8.7	**ROU**	-14.8	**SVN**	-3.6	**FRA**	-3.8
BEL	-8.6	**AUT**	-6.5	**GBR**	-17.1	**POL**	-8.9	**DEU**	-14.9	**AUT**	-3.7	**ROU**	-3.9
NLD	-9.3	**SVK**	-6.5	**SVN**	-17.4	**DEU**	-9.0	**SWE**	-15.0	**ITA**	-4.2	**NLD**	-4.4
AUT	-9.7	**ITA**	-6.6	**ITA**	-17.7	**BEL**	-9.3	**NLD**	-15.1	**DEU**	-4.3	**EST**	-4.7
CYP	-10.1	**PRT**	-7.6	**HRV**	-18.1	**ROU**	-9.9	**PRT**	-15.2	**FIN**	-4.4	**BEL**	-4.9
DNK	-10.2	**CYP**	-7.7	**FIN**	-18.5	**HRV**	-12.2	**DNK**	-15.2	**FRA**	-4.5	**POL**	-5.2
DEU	-10.7	**BGR**	-7.7	**SWE**	-19.6	**SVN**	-12.4	**AUT**	-15.5	**LVA**	-4.5	**ITA**	-5.7
GRC	-11.2	**DEU**	-8.0	**ROU**	-20.3	**ESP**	-12.5	**FRA**	-15.6	**CYP**	-4.8	**AUT**	-6.0
CZE	-11.7	**BEL**	-8.5	**CZE**	-21.0	**GRC**	-12.7	**EST**	-15.9	**GRC**	-5.0	**ESP**	-7.0
POL	-12.7	**HUN**	-9.6	**HUN**	-22.9	**ITA**	-12.8	**BEL**	-16.8	**CZE**	-5.1	**GBR**	-7.1
SVN	-12.9	**GRC**	-10.2	**EST**	-24.7	**CZE**	-13.6	**FIN**	-16.9	**NLD**	-7.1	**SVK**	-9.7
HUN	-14.5	**HRV**	-12.0	**POL**	-25.4	**CYP**	-14.4	**ITA**	-17.6	**SVK**	-7.4	**CZE**	-10.6
ROU	-64.5	**SVN**	-13.5	**LVA**	-28.6	**HUN**	-14.7	**LVA**	-18.3	**SWE**	-7.5	**HUN**	-11.7
BGR	-90.1	**ROU**	-31.9	**LTU**	-30.4	**PRT**	-14.8	**GRC**	-19.3	**IRL**	-8.1	**GRC**	-13.6

Table 13. Comparison of EU countries by how they recovered during recovery time intervals

	Recovery '97-'99		Recovery '00-'02		Recovery '09-'11		Recovery '12-'14		Recovery '15-'18
LUX	27.0	**CZE**	24.1	**EST**	29.8	**LUX**	25.0	**MLT**	39.9
IRL	14.1	**LTU**	22.4	**SWE**	26.4	**MLT**	17.4	**IRL**	32.3
CYP	9.1	**HUN**	18.5	**LTU**	23.1	**IRL**	11.2	**CYP**	29.3
ESP	6.3	**EST**	17.6	**POL**	19.2	**ROU**	10.2	**EST**	27.1
GBR	4.1	**HRV**	17.0	**LVA**	17.7	**BGR**	9.0	**LTU**	25.6
FRA	3.9	**ESP**	15.8	**CZE**	17.7	**EST**	8.9	**SVN**	25.2
LVA	3.3	**IRL**	10.8	**ROU**	16.8	**LTU**	8.5	**POL**	24.8
FIN	3.1	**GRC**	10.6	**LUX**	14.2	**GBR**	7.4	**CZE**	23.4
AUT	3.0	**CYP**	9.8	**DEU**	13.7	**GRC**	6.9	**HRV**	22.7
BEL	2.8	**BGR**	9.1	**SVK**	13.2	**POL**	5.3	**SVK**	22.5
MLT	2.8	**POL**	8.7	**BEL**	12.8	**SVK**	4.9	**HUN**	22.0
NLD	2.2	**LVA**	7.9	**FIN**	11.2	**SVN**	4.7	**BGR**	19.3
SWE	1.8	**AUT**	7.2	**BGR**	11.0	**HUN**	4.6	**FIN**	19.3
DEU	1.7	**DNK**	5.8	**NLD**	11.0	**DEU**	4.0	**PRT**	19.0
DNK	0.6	**SVK**	5.7	**AUT**	9.5	**FRA**	3.2	**NLD**	16.7
EST	-0.5	**FRA**	5.4	**ITA**	8.3	**DNK**	3.0	**DNK**	16.6
ITA	-0.9	**GBR**	4.8	**FRA**	7.2	**BEL**	2.8	**ESP**	15.9
PRT	-1.3	**ITA**	4.5	**HUN**	6.2	**ESP**	2.4	**ROU**	15.7
GRC	-5.8	**DEU**	2.2	**SVN**	4.3	**PRT**	2.3	**DEU**	14.6
SVN	-8.2	**NLD**	1.8	**GBR**	3.9	**LVA**	1.9	**AUT**	14.5
CZE	-9.1	**BEL**	1.6	**DNK**	3.8	**NLD**	1.5	**LVA**	14.1
LTU	-9.8	**PRT**	0.9	**PRT**	1.5	**SWE**	1.2	**FRA**	13.2
POL	-11.1	**FIN**	-0.4	**HRV**	-2.6	**AUT**	0.8	**ITA**	12.1
HUN	-15.2	**LUX**	-0.5	**CYP**	-3.7	**ITA**	0.3	**LUX**	11.6
HRV	-21.6	**SVN**	-2.1	**ESP**	-6.3	**FIN**	0.0	**BEL**	11.2
BGR	-22.1	**MLT**	-5.1	**MLT**	-8.8	**CZE**	-2.0	**GRC**	10.9
SVK	-23.3	**SWE**	-5.9	**GRC**	-16.3	**HRV**	-4.0	**SWE**	8.4
ROU	-61.4	**ROU**	-24.1	**IRL**	-19.3	**CYP**	-4.5	**GBR**	-4.8

When comparing the EU economies based on how they resisted economic shocks between 1995 and 2020, Table 12 highlights a small number of countries that managed to increase their competitiveness during these time intervals. Great Britain increased its competitiveness during the shock of 1996–1997; however, during the remaining shocks, its economy experienced contractions ranging from 3.1% to 17.1%. Ireland (IRL), Malta (MLT), Luxembourg (LUX), and Lithuania (LTU) recorded positive competitiveness results in four of the seven different economic shocks. However, Ireland (IRL) showed the worst resistance during the shock of 2018–2019, while Lithuania (LTU) experienced the worst resistance during the shock of 2008–2009. Latvia (LVA) and Estonia (EST) increased their competitiveness during two economic shocks prior to joining the EU in 2004. Their competitiveness became negative during the subsequent economic shocks. Croatia (HRV), Poland (POL), and Sweden (SWE) increased their competitiveness during one of the last two economic shocks, while their remaining competitiveness results varied significantly from shock to shock.

Other EU countries have experienced economic contractions of varying extents during the economic shocks. Throughout all the intervals of the economic shocks, large countries such as Germany (GER) were able to maintain some stability in their economic performance, as its largest economic contraction was recorded at 14.9% during the shock of 2014–2015.

Table 13 shows how the EU economies were able to recover from the economic shocks during the observed period. The majority of them managed to increase their competitiveness results by up to 39.9% (Malta in 2015–2018).

Table 13 also shows that most countries in Southern and Eastern Europe recorded negative competitiveness results during the recovery period of 1997–1999. Great Britain was the only country with a negative competitiveness result during the recovery period of 2015–2018.

The research has revealed that the economies of Bulgaria (BGR) and Romania (ROU) defaulted during the time interval between 1996 and 1997. Significant value chain disruptions are visible in the data panel of these two countries during this period, as all their industries experienced dramatic losses in IC value. Between 1996 and 1997, Bulgaria's (BGR) IC value dropped by 90% (from \$3.443 billion to \$0.341 billion at the 1994 price level). This collapse of the Bulgarian (BGR) economy was documented by Berlemann and Nenovsky (2003) as the Bulgarian financial crisis, which spread from a banking crisis to a currency crisis. After this crisis, the Bulgarian (BGR) economy gradually recovered to a peak of \$0.682 billion in 2018, accounting for 20% of the national IC value before 1996. The ICIO Tables data panel reveals that Romania (ROU) experienced a nationwide contraction of 64% during 1996–1997 (from \$24.153 billion down to \$8.576 billion in IC value at the 1994 price level), and the contraction continued gradually until 2002, reaching 7% (\$1.712 billion in IC value at the 1994 price level). Doltu and Duhaneanu (2012) identified the causes of this prolonged contraction of the national economy as the consequence of the structural transition from a centralised to a market-oriented economy between 1990 and 1996. During 1997–1999, the country reshaped its macroeconomic and structural policies to meet the conditions for EU accession. The ICIO Tables data panel shows that since the trough in 2002, the Romanian (ROU) economy recovered to 17% of its pre-1996 IC value in 2008 ($4.154 billion in IC value at the 1994 price level). The Bulgarian (BGR) case of national IC value contraction between 1996 and 1997 suggests an overall uncontrolled economic collapse, after which the economy re-started its current development. On the other hand, in Romania (ROU), the steep yet somewhat gradual economic contraction between 1996 and 1999 appears to have been a controlled overall national structural reform with strong negative consequences (Doltu & Duhaneanu, 2012).

When considering all seven recessionary instances listed in Table 12 and the time intervals of subsequent recoveries listed in Table 13, there are tendencies suggesting that national resilience could depend on geographical location (Southern European countries tend to be less resilient: Greece (GRC), Hungary (HUN), Croatia (HRV), Slovenia (SVN), Spain (SPN)), the size of the country (small countries tend to be more resilient: Ireland (IRL), Luxembourg (LUX), Estonia (EST), Lithuania (LTU)), or the nature of the shock (the least resilient economies during and after the Asian financial crisis of 1997 were the Central European and Balkan countries). There are exceptions to all of these tendencies, though: Great Britain (GBR) joined the less resilient economies in three of the six recessionary time intervals; Slovenia (SVN) and Cyprus (CYP) posted lesser resilience results despite being small nations; Lithuania (LTU), Germany (DEU), and Denmark (DNK) were significantly impacted by the global market disruptions during and after the Asian financial crisis of 1997.

These are the preliminary perceptions that provide an idea for further detailed examination of the national industrial portfolio and other factors that could shape more resilient national economies. The competitiveness results of the EU countries during economic shocks and subsequent recoveries could also be compared to the respective competitiveness results of other countries outside the EU because within the data panel of the ICIO Tables, all countries are benchmarked against fluctuations in the global economy.

3.3. Resilience of EU countries based on national properties

The comparison of countries by their resilience, measured through their competitiveness during the time intervals of economic shocks and subsequent recoveries, provides an understanding of where EU countries rank relative to one another in terms of resilience. Further analysis investigates the national properties that could define a country’s competitiveness during shocks and recoveries, and the measures that together indicate the level of resilience when compared with other countries in the panel. An initial assessment of all EU countries, considering the indicators in Table 10 (*KSI*, *pdelta_KSI*, *pdelta_pop*, and *pdelta_dens*) that could impact national competitiveness during economic shocks and subsequent recoveries, has been performed using separate OLS and covariate OLS regressions, incorporating two regressors of different properties:

- *Country* – a time-invariant explanatory variable to account for country specifics.

- *year* – a time-series explanatory variable to account for the specifics of time intervals.

The panels in this assessment are balanced and short, with many individuals and few time intervals (seven intervals in the panels of economic shocks and five intervals in the panels of recoveries). According to Baltagi (2008), cross-sectional dependence could be an issue in long time-series panels, potentially leading to serial correlation issues, but this is not the case in this assessment.

A risk of potential inaccuracy in the regression results is noted when competitiveness is regressed on the population and population density independent variables.

There are substantial differences in the number of people living across different EU countries. For example, the population of Germany varies between 80.2 and 83 million, while, France, the second-largest country by population, has a population that varies between 59.5 and 67.2 million during the observed period. The differences in population counts within and between countries are significantly larger than the population count of the smallest EU nations; the population of Malta and Luxembourg ranged between 0.4 and 0.6 million, respectively, from 1995 to 2020.

A similar situation can be observed when evaluating the population density values of different countries. Malta's population density stands out in the panel, varying between 1,181 and 1,595 persons per square kilometre, while the second-highest population density is recorded in the Netherlands, with just 458 to 507 persons per square kilometre, making the difference approximately three times larger between the most and second-most dense countries in the EU. The least dense countries, Finland and Sweden, have population densities between 17–18 and 22–25 persons per square kilometre, respectively. Thus, when countries that are substantially different in population sizes and population densities are evaluated together, the population and population density variables could lead to an inaccurate interpretation of the results, posing a risk of endogeneity.

Industrial specialisation (KSI) is an index variable, recorded at the onset of the economic shocks. This measure shows how much the industrial portfolio of a country deviates from the global average. There are clusters of the least and most specialised countries that significantly differ in their KSI values in the panel. For example, the lowest KSI scores at the onset of the shocks, ranging between 26 and 44, are produced by a mix of seven countries (Germany, Italy, France, Portugal, Spain, Austria, and Hungary), with the lowest (26) and the highest (44) KSI scores recorded by France. The highest KSI scores are produced by the smallest EU nations, Luxembourg, which ranges between 91 and 110, although Cyprus and Malta fall within the KSI range of 72–93 and 77–97, respectively.

Thus, when clustered by the values of KSI, the research is effective in searching for greater robustness in the regression analyses.

The interest of this research is to identify the slope of the linear regression, which is produced based on the robust correlation results between the independent variables (indicators listed in Table 10) and the dependent variable (Competitiveness) during the time intervals of the EU-wide economic shocks (indicating the level of resistance) and their subsequent recoveries (indicating the level of recoverability).

A highly significant correlation with high variance of Competitiveness (*comp*) and industrial specialisation (*KSI*) in an EU country could serve as statistical evidence that the distribution of human resources within EU countries at the onset of economic shocks has a significant impact on their subsequent economic performance in terms of competitiveness during economic shocks and recoveries. Furthermore, highly significant correlation results with high variance of competitiveness (*comp*) and the variables that denote the proportional changes of the previously mentioned independent variables—proportional change of industrial specialisation (*pdelta_KSI*), proportional change of population of a country (*pdelta_pop*), or proportional change of its density (*pdelta_dens*)—could lead to an understanding that changes in the availability of human resources or their distribution within or among the EU countries during economic shocks and their subsequent recoveries have a significant impact on the economic performance of those countries in terms of their competitiveness. This interpretation of the statistical results leads to the formulation of the following hypotheses:

H1: The distribution of human resources within the EU countries before economic shocks has a significant impact on their economic performance during the shocks and recoveries.

H2: Changes in the distribution of human resources within the EU countries during economic shocks and recoveries have a significant impact on their economic performance during the shocks and recoveries.

H3: Changes in the availability of human resources in the EU countries during economic shocks and recoveries have a significant impact on their economic performance during the shocks and recoveries.

The initial integral assessment results are presented in Tables 5, 6, 7, and 8 (in the Annex). The linear regression results indicate low variance (adjusted R^2) in all four regressions (Table 5 in the Annex). The variance increases to 29.8%–30.8% when controlled for the specifics of the *shock_year* dummy variable (Table 6 in the Annex). The variance of all four regressions increases to 46.2%–46.9% when the independent variables are controlled for time specifics (Table 7 in the Annex), showing positive correlation results of competitiveness with KSI (at 95% confidence level), with proportional population change (at the 90% confidence level), and with proportional population density change (at the 99% confidence level). The variance (adjusted R^2) of all four regressions increases, producing robust correlation results with the variance ranging between 51.8%–56.9% when the independent variables are controlled for time and country specifics (Table 8 in the Annex). However, the results of competitiveness indicate a negative correlation with KSI (at the 99% confidence level) and with proportional population change (at the 90% confidence level), while the remaining correlation results are insignificant.

These statistics show KSI as the only independent variable whose significance increases along with the variance of the results when adding time- and country-specific controls to the regression. The correlation slope between competitiveness and

KSI, however, changes from positive to negative when including country specifics in the correlation. The other independent variable—proportional population change—which initially indicated significance in correlation with the dependent variable decreased when time and country specifics were gradually added. The variance of the observations in the regressions of competitiveness with KSI and proportional population change, when controlled for time and country specifics, is 56.9% and 52.4%, respectively, suggesting sufficient variance of the observations, as more than 50 percent of the observed independent variables explain the linear distribution results of the correlation with the dependent variable. However, the changes in the correlation slopes from positive to negative in different compositions of control variables prompt the need for more detailed analysis.

A linear regression analysis was consequently performed for the observations of the independent variables that indicated correlation significance with the dependent variable by splitting the data set into two panels: the first includes the observations during the time intervals of economic shocks, and the second includes the time intervals of recoveries. The results presented in Table 9 (in the Annex) indicate significant negative correlations between the competitiveness of countries with KSI during economic shocks and recoveries, whereas the correlation of competitiveness with proportional KSI changes and proportional population changes is significant only during economic shocks. While the tendency among the EU countries in these OLS regressions shows negative correlations during economic shocks and subsequent recoveries, the variance of all results has declined to a level between 27.1% and 39%, suggesting a low level of dependent variables explained by the variance of the independent ones. These results consequently imply that separate clusters of countries with similar properties are needed to produce more robust correlation results. However, when they are evaluated together, the individual differences lead to more significant error terms than the general trends.

3.4. Identification of clusters through the effect of industrial specialisation

In search for more robustness in the correlation between competitiveness and the indicators of national properties, the countries were clustered based on the level of their industrial specialisation and how it impacted their competitiveness during subsequent economic shocks and recoveries (Table 14). The clustering of countries was performed by regressing the competitiveness of the EU countries on their industrial specialisation (KSI).

Table 14. Clusters of EU countries by the effect of industrial changes on competitiveness during economic shocks and recoveries

1. EU countries with diversified portfolios	Range of KSI	Population in 2020, million	Population % change during 1995–2020
AUT (Austria)	31–41	8.9	12%
BEL (Belgium)	38–48	11.5	14%

CZE (Czech Republic)	32–47	11	3%
DEU (Germany)	34–41	83	2%
ESP (Spain)	33–39	46.9	19%
FRA (France)	26–44	67.2	13%
ITA (Italy)	32–35	59.8	5%
NLD (The Netherlands)	37–47	17.3	13%
PRT (Portugal)	38–42	10.3	3%
SWE (Sweden)	34–48	10.2	17%
2. EU countries with diversification effect	**Range of KSI**	**Population in 2020, million**	**Population % change during 1995–2020**
GBR (Great Britain)	34–60	66.6	16%
POL (Poland)	43–51	38	-2%
HRV (Croatia)	42–57	4.1	-13%
ROU (Romania)	42–82	19.4	-15%
BGR (Bulgaria)	45–73	7	-18%
LTU (Lithuania	60–84	2.8	-23%
LVA (Latvia)	72–80	1.9	-24%
EST (Estonia)	52–67	1.3	-8%
FIN (Finland)	39–50	5.5	8%
LUX (Luxembourg)	91–110	0.6	54%
3. EU countries with specialisation effect	**Range of KSI**	**Population in 2020, million**	**Population % change during 1995–2020**
CYP (Cyprus)	72–93	0.9	38%
DNK (Denmark)	39–57	5.8	12%
GRC (Greece)	49–62	10.7	2%
HUN (Hungary)	37–42	9.8	-5%
IRL (Ireland)	62–82	4.9	38%
MLT (Malta)	77–97	0.5	37%
SVK (Slovakia)	47–59	5.5	2%
SVN (Slovenia)	38–53	2.1	5%

The following subsections describe the properties of the clusters of countries identified in Table 14, focusing on the similarities in the correlation results between their KSI prior to the shocks and their competitiveness during the shocks and recoveries.

3.4.1. Cluster of EU countries with diversified industrial portfolios

The first cluster of EU countries with diversified industrial portfolios, as shown in Table 14, lists ten EU countries that have either recorded minimal changes in their industrial specialisation or whose level of competitiveness has not changed despite the experienced changes in their industrial specialisation during the observed period (Fig. 12). All these countries are large economies, with populations ranging from 8.9 million to 83 million in 2020. Table 14 reveals that the population of all these countries increased between 1995 and 2020.

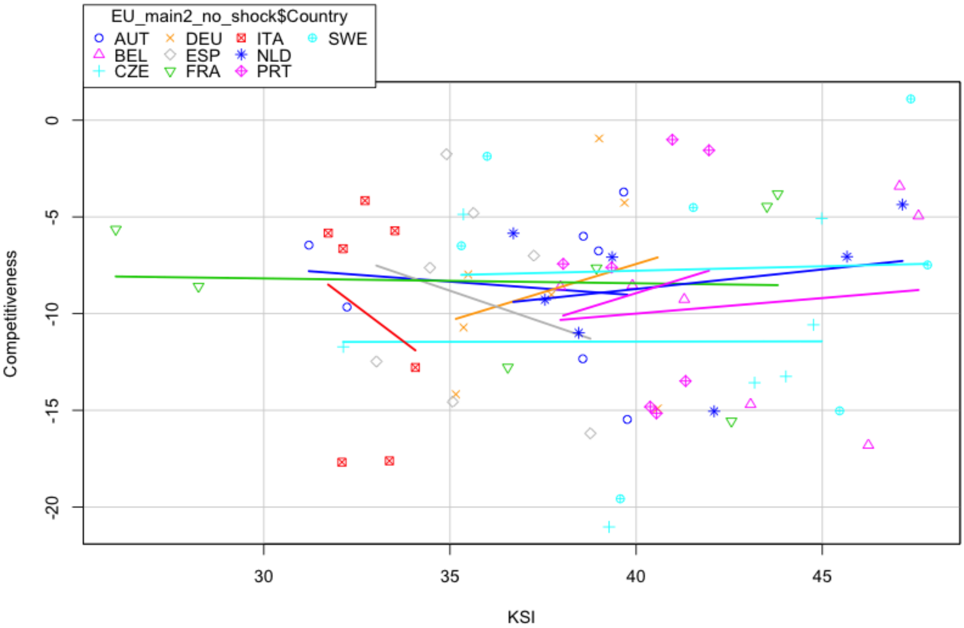


Fig. 12. Distribution of correlation results between industrial specialisation and competitiveness of EU countries' diversified portfolios during EU-wide economic shocks

The countries in this cluster share a common property: strongly diversified industrial portfolios. The industrial specialisation index (KSI) in this cluster is between 26 and 48 (Table 14).

Germany, Italy, Portugal, and Spain have undergone insignificant changes in terms of their industrial specialisation (low variation of KSI in Table 14, Fig. 12), whereas the differences in the industrial specialisation of Austria, Belgium, the Czech Republic, France, the Netherlands, and Sweden did not result in significant variations in their competitiveness during economic shocks (Fig. 12). During economic shocks, the competitiveness of all these countries decreases in nearly all observed cases. The only exception was in 2020 when the competitiveness of Sweden increased while entering the shock with the highest industrial specialisation index recorded in this cluster. However, the correlation results of the competitiveness of these countries regressed on industrial specialisation in Table 10 (in the Annex), did not produce any significant results.

A generally positive tendency of the countries in the cluster can be noted during the recoveries in Fig. 13. The OLS regression analysis in Table 11 (in the Annex) shows a positive and significant result (at the 90% confidence level) for the industrial specialisation effect with low variance. This result is mainly driven by more significant positive results (at the 95% confidence level) with 17.7% variance from Belgium, the Czech Republic, the Netherlands, and Portugal.

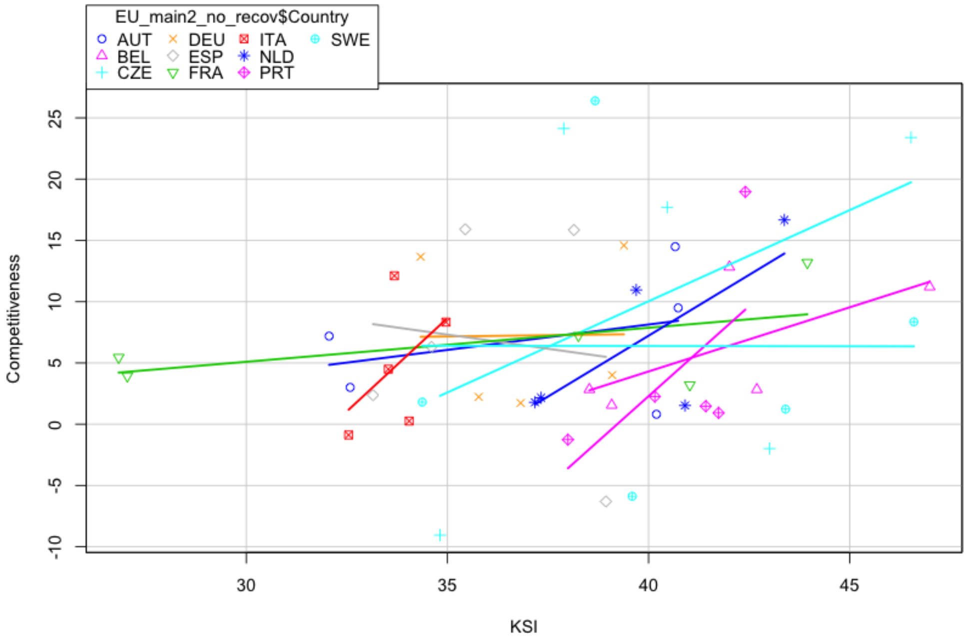


Fig. 13. Distribution of correlation results between industrial specialisation and competitiveness of EU countries with diversified portfolios during recoveries

The majority of the competitiveness observations in Fig. 13 fall within the range between 0 and 20, revealing that most of the countries in this cluster increased their competitiveness during the recoveries. Overall, the distribution of correlation results during the economic shocks (Fig. 12) and the subsequent recoveries (Fig. 13) suggests that the industrial specialisation of the countries of this cluster generally does not impact their competitiveness during economic shocks. However, there is a tendency that a more specialised industrial portfolio setup prior to an economic shock might help countries recover more effectively.

An OLS covariate regression assessment between the competitiveness and industrial specialisation of this cluster of countries unsurprisingly produces either insignificant or low-variant correlation results for the time intervals of economic shocks and recoveries (as shown in Table 10 and Table 11 in the Annex), despite the attempt to group the countries in this cluster by similarities in tendencies. These results suggest that the industrial specialisation level prior to economic shocks does not impact the competitiveness of the large, stable, and highly diversified EU economies in this cluster.

3.4.2. Cluster of EU countries with the industrial diversification effect

The second cluster in Table 14 includes ten countries from the Balkan region (Bulgaria, Romania, Croatia), the Baltic countries (Estonia, Latvia, and Lithuania), as well as Poland, Finland, and Great Britain. Most of these countries (except for Great Britain, Luxembourg, and Finland) have experienced losses in their population throughout the observed period. However, the countries in this cluster have undergone more significant changes in their industrial structure compared to the first cluster of countries, and all of them have recorded a KSI of 50 or more.

The distribution of the correlation results between competitiveness during economic shocks and industrial specialisation in these countries is shown in Fig. 14.

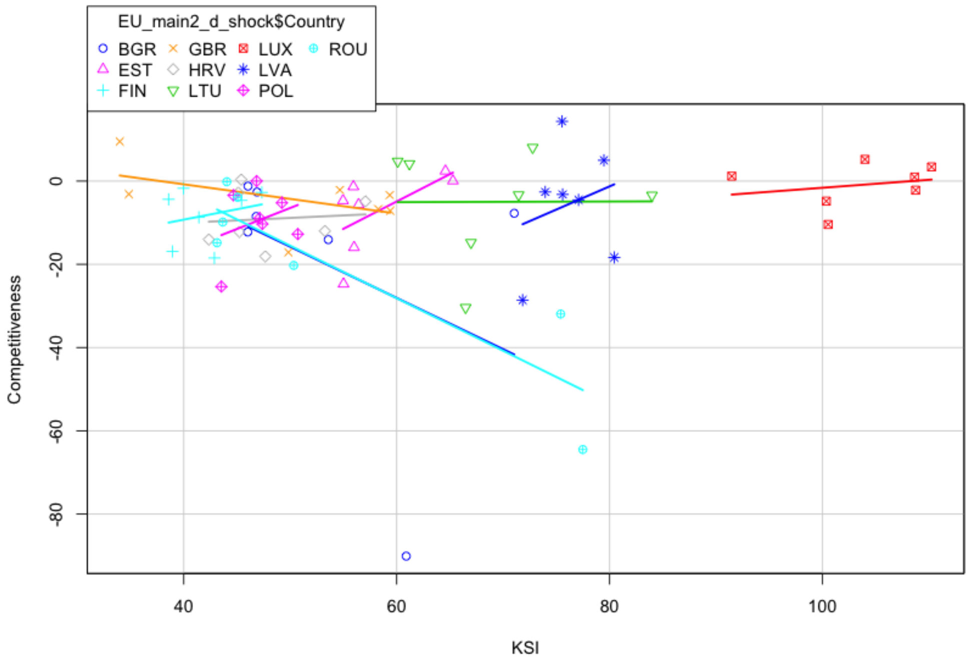


Fig. 14. Distribution of correlation results between industrial specialisation and competitiveness during economic shocks of EU countries with the industrial diversification effect

The OLS covariate regression modelling in Table 12 (Annex) shows a negative significant regression slope between the competitiveness of all countries in the cluster during economic shocks and their industrial specialisation, with a low variance of

33%. However, there are two cases (the competitiveness results of Bulgaria and Romania during the economic shock of 1996–1997) that significantly deviate from most of the observations (Fig.14)—the collapse of the Bulgarian (BGR) economy (Berlemann & Nenovsky, 2003) and the economy-wide contraction in Romania (Doltu & Duhaneanu, 2012) during 1996–1997. When these cases are eliminated from the panel (middle column in Table 12), the slope remains negative and significant, but the variance increases to a high level of 61%. Additionally, the assessment was performed by eliminating the observations of Great Britain, as its economy stands out from the group of remaining countries in this cluster due to its location (in Western Europe, whereas the other countries, except for Luxembourg, are in Central-Eastern side of the EU) and economic capabilities (Great Britain is one of the dominant economic powers of the world). The regression results do not significantly change when Great Britain is excluded from the panel (the right column of Table 12).

Economic performance and industrial specialisation data for Great Britain show a good fit within this cluster of countries when assessing the correlation between the competitiveness of these countries during recoveries and their industrial specialisation (Fig. 15, Table 13 in the Annex).

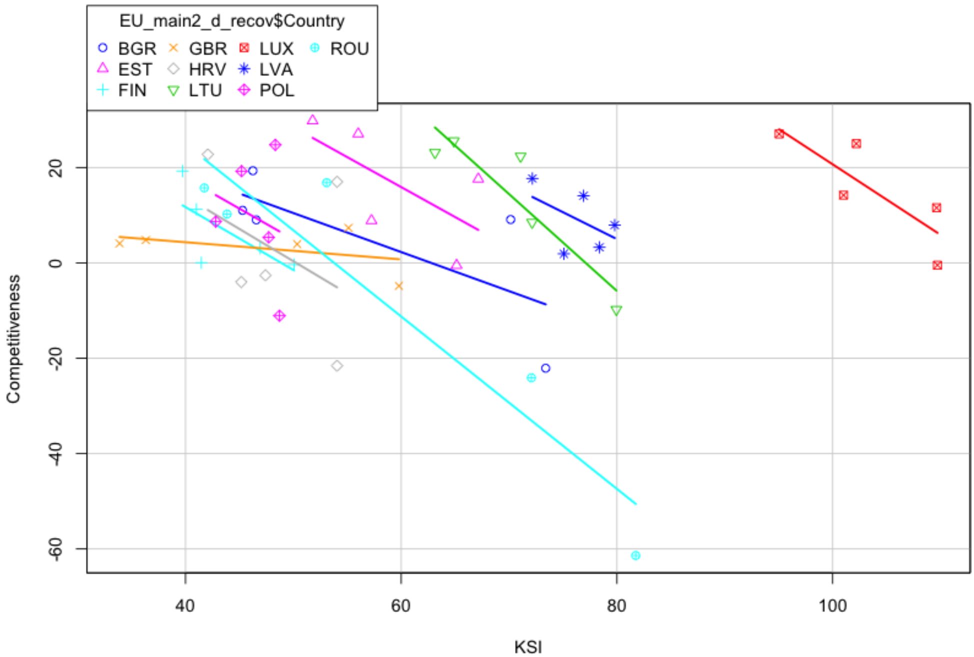


Fig. 15. Distribution of correlation results between industrial specialisation and competitiveness during recoveries of EU countries with the industrial diversification effect

The negative slope is significant, with a high variance of 66.1%. It changes slightly when eliminating Romania's competitiveness result during the recovery of 1998–1999 (which stands out from the remaining observed values) and the observations for Great Britain (Fig. 15). This observation suggests that the correlation between competitiveness during economic shocks and recoveries with industrial specialisation in Great Britain aligns with the general tendency of this cluster of countries, as the industrial diversification effect for each country in this cluster is visible in Fig. 15.

3.4.3. Cluster of EU countries with the industrial specialisation effect

The third cluster in Table 14 consists of eight small-to-medium EU countries with better competitiveness results, as their industrial specialisation is at a higher level when entering turbulent time intervals. This cluster mainly includes Central and Balkan countries (Slovenia, Slovakia, Hungary, Greece) and Mediterranean islands (Cyprus and Malta), accompanied by Belgium and Ireland. The population of this cluster ranges from 0.5 million (Malta) to 10.7 million (Greece), with all countries, except Hungary, experiencing population growth between 1995 and 2020. Hungary is the only country in this cluster with a population reduction of 5% over the period.

The OLS regression results of competitiveness of these countries during economic shocks and their industrial specialisation show a generally positive tendency (Fig. 16). Table 14 (Annex) reveals that this cluster of countries is significantly correlated (at a 99% confidence level), with a low variance of 32.6%.

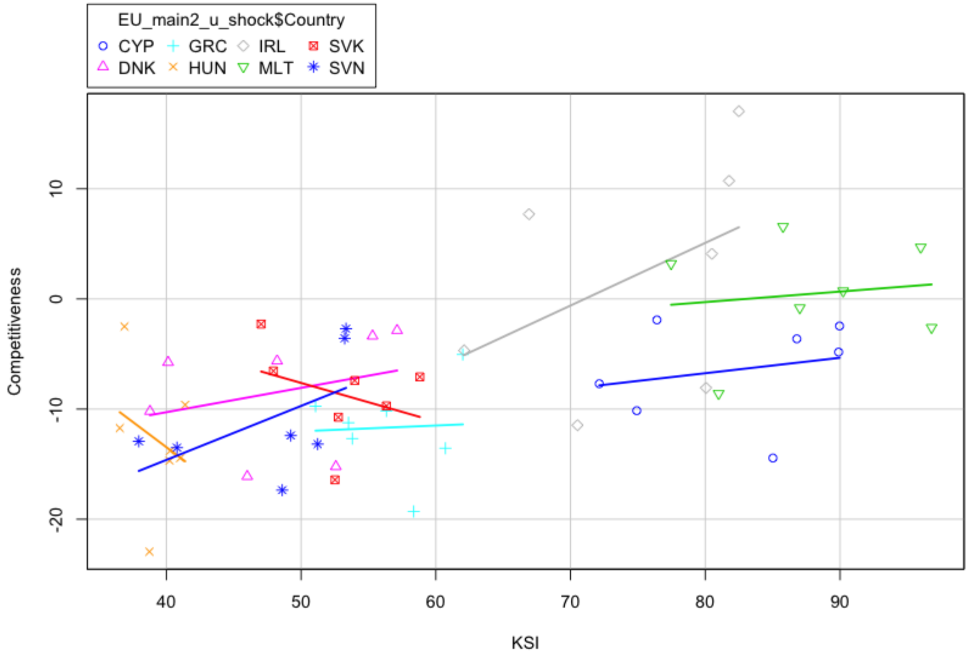


Fig. 16. Distribution of correlation results between industrial specialisation and competitiveness during economic shocks of EU countries with industrial specialisation effect

Highly specialised countries—Ireland, Malta, and Cyprus—are positioned on the right side of Fig. 16, separated from the remaining countries. Their competitiveness results during economic shocks are generally better than those of the countries with lower industrial specialisation levels.

Significant and positive correlation results (at a 90% confidence level) between competitiveness during recoveries and industrial specialisation are recorded for all countries in the cluster (Table 15 in the Annex). However, the variance is low due to the relatively large error terms (Fig. 17). The variance in both panels increases when the correlation is controlled for country and time specifics, albeit at the expense of reduced correlation significance.

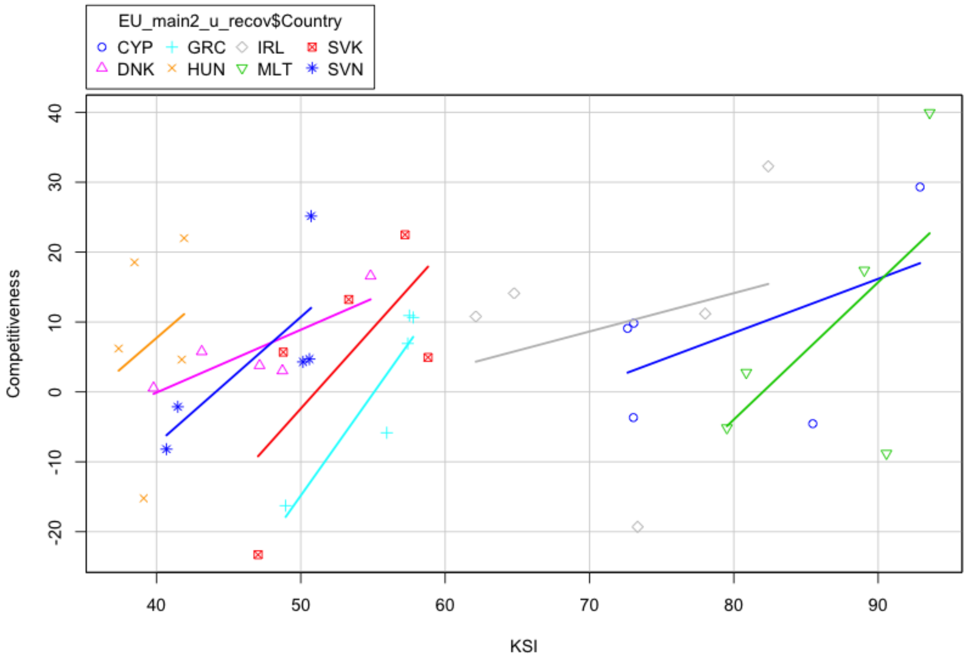


Fig. 17. Distribution of correlation results between industrial specialisation and competitiveness during recoveries of EU countries with the industrial specialisation effect

The country-specific tendencies of highly specialised countries (Cyprus, Malta, and Ireland), shown in Fig. 17, indicate that these countries could fit in a larger panel for correlation assessment, where the results demonstrate a positive correlation trend between competitiveness and industrial specialisation during recoveries.

The overall result of the effect of industrial specialisation set up prior to economic shocks on the competitiveness of countries during the shocks and subsequent recoveries provides the following insights when accounting for time and country specifics:

- The first cluster consists of large and economically influential EU countries with low KSI values and minimal variations in KSI values during the observed period.

Their industrial specialisation prior to economic shocks has no significant impact on competitiveness during economic shocks or recoveries, although there are some indications that industrial specialisation may contribute to better competitiveness during recoveries.

- The second cluster includes EU countries of various sizes and different levels of industrial specialisation, with differences in geographical locations. Altogether, these countries result in robust correlation results that highlight better national competitiveness during economic shocks and subsequent recoveries when their industrial portfolios are more diversified.
- The third cluster includes small-to-medium-sized EU economies with various industrial specialisation levels. Altogether, they demonstrate a general tendency that industrial specialisation prior to economic shocks could increase the competitiveness of countries during recoveries.

These insights help explain that the robustness of the results for the group of countries with the industrial diversification effect (the second cluster) outweighs the results of the other clusters in the overall correlation results for the EU countries, as shown in Tables 8 and 9. The results of the effect of industrial specialisation changes (*pdelta_KSI*) on the competitiveness of countries, on the other hand, showed no significance in the overall assessment (Tables 5, 6, 7 and 8), but were significant when the economic shock time intervals were evaluated separately. Thus, the following subsection analyses the significance of these effects for the separate clusters of countries.

3.5. Effects of changes in industrial specialisation on national competitiveness

The analysis of the correlation effect of industrial specialisation changes during economic shocks and subsequent recoveries (pdelta_KSI) on the competitiveness of countries by clusters should provide insights into the best direction for changing industrial specialisation during shocks and recoveries to maintain or enhance national competitiveness.

3.5.1. Industrial specialisation changes in countries with diversified portfolios

Positive proportional changes in industrial specialisation during the economic shocks for the first cluster of EU countries are significant at the 90% confidence level (Table 16 in the Annex). However, Fig. 18 suggests that the competitiveness results of nearly all observations in this cluster are below 0. This indicates that, despite the positive tendency, the competitiveness of the countries in this cluster is bound to decrease regardless of the changes in industrial specialisation during the economic shocks.

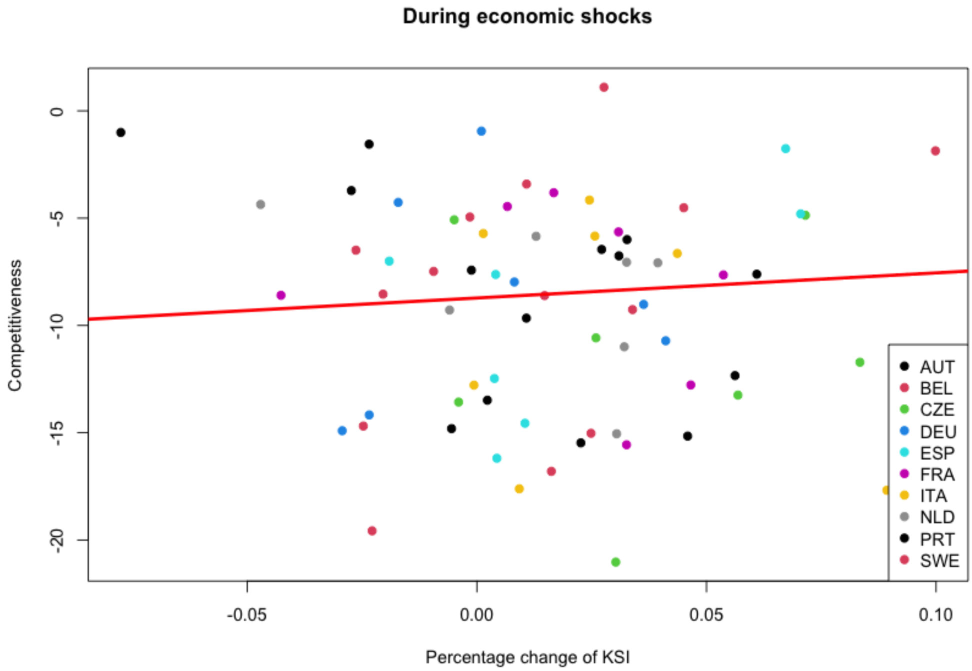


Fig. 18. Correlation between percentage change in industrial specialisation and competitiveness of EU countries with diversified portfolios during economic shocks

Despite the small range of proportional changes in industrial specialisation during the economic shocks, the correlation for this cluster records a high variance of 76%, mainly driven by the significant fit of the observations from Germany, Spain, Sweden, and the Netherlands, which increase the correlation significance to the 95% confidence level with a variance of 76.5% (Table 16 in the Annex). The positive slope is significant at the 99% confidence level, with a high variance of 67.2%, for this cluster of countries when their competitiveness is regressed on the change in industrial specialisation during the recoveries (Fig. 19, Table 17 in the Annex).

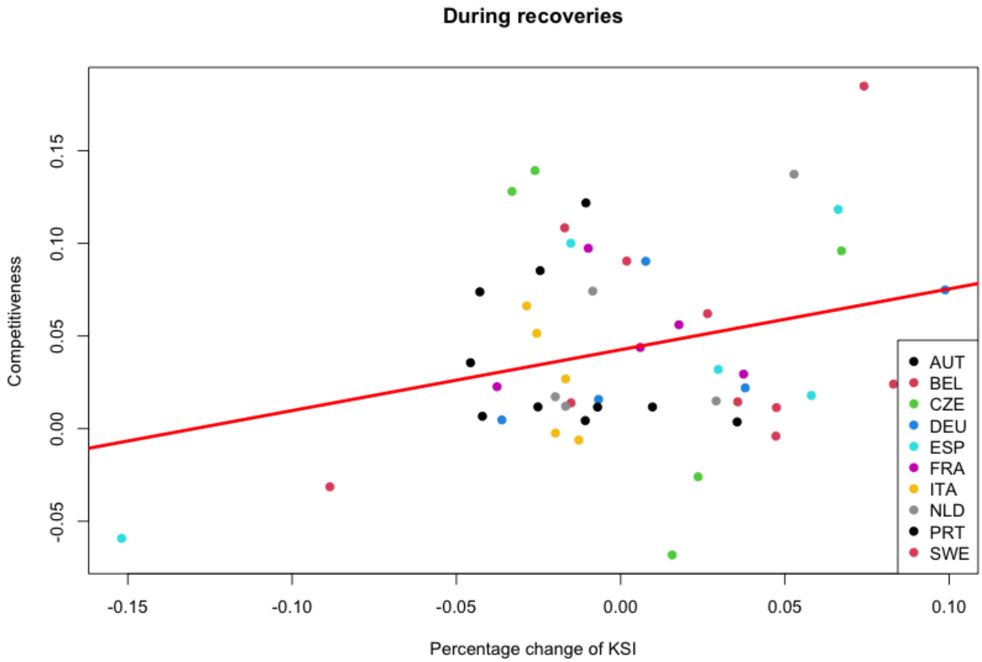


Fig. 19. Correlation between percentage change in industrial specialisation and competitiveness of EU countries with diversified portfolios during recoveries

Fig. 19 also shows that most competitiveness results are above 0, especially when the proportional change in industrial specialisation exceeds -0.05%. This insight suggests that countries in the first cluster face resistance issues during economic shocks but recover well by reorienting their industrial structures during the recoveries.

3.5.2. Industrial specialisation changes in countries with a diversification effect

Positive proportional changes in industrial specialisation and competitiveness during economic shocks are recorded for the second cluster of EU countries when the impact of the irregular cases of the economic collapse in Bulgaria (Berlemann & Nenovsky, 2003) and the economy-wide contraction in Romania (Doltu & Duhaneanu, 2012) during 1996–1997 are eliminated from the panel (Fig. 20, Table 18). The significance of the positive correlation between the proportional changes in industrial specialisation and competitiveness during economic shocks increases to a 99% confidence level, with the variance rising to 61.7% when the observation of Bulgaria's results from the 2008–2009 global financial crisis is removed (Table 18 in the Annex). This observation documents the irregularities in the behaviour of the Bulgarian economy during the 2008–2009 global financial crisis, which should be examined in future studies.

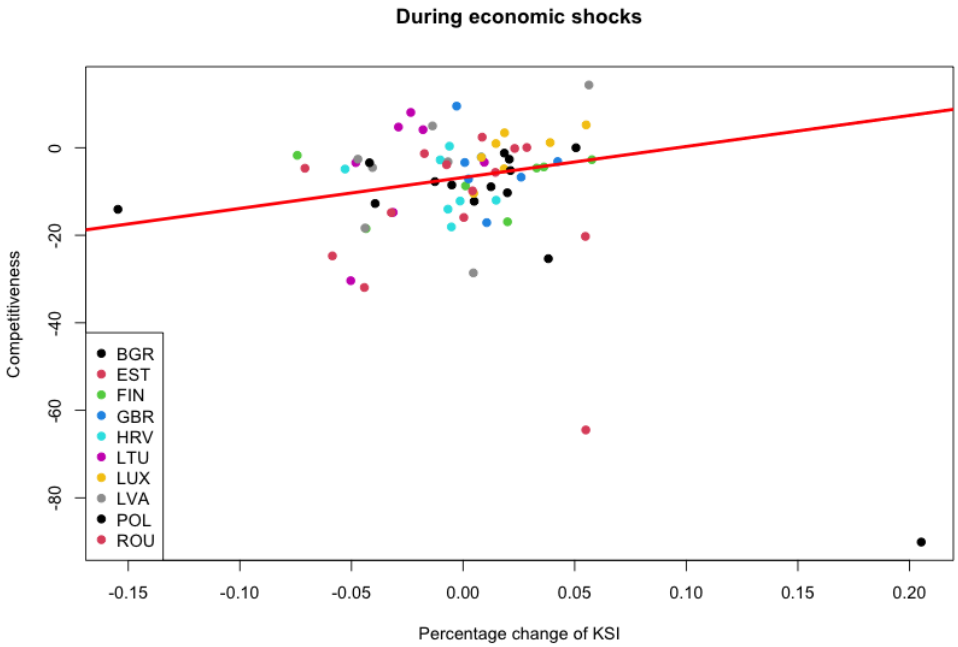


Fig. 20. Correlation between the percentage change in industrial specialisation and competitiveness of EU countries with an industrial diversification effect during economic shocks

Fig. 20 demonstrates the regression slope when the irregular cases of the Bulgarian economy from 1996 to 1997 and 2008 to 2009, along with the case of the Romanian economy in 1996–1997, are removed from the panel. The large variation in the competitiveness results of the countries in this cluster suggests high volatility in their resistance to economic shocks (Fig. 20). Although there is a significant number of positive competitiveness results during economic shocks, implying a significant number of cases when the countries experienced negative economic effects during economic shocks.

A positive slope of the regression between the proportional changes in industrial specialisation and competitiveness during recoveries is recorded for the second cluster of countries as well (Table 19 in the Annex).

The economic performance observations (in terms of competitiveness) of Romanian recoveries in 1997–1999 and 2009–2011 produce lower significance and variance rates in the panel (Table 19). However, when they are eliminated from the panel, a significant positive regression slope can be seen (Fig. 21) at a variance rate of 57.6% (Table 19).

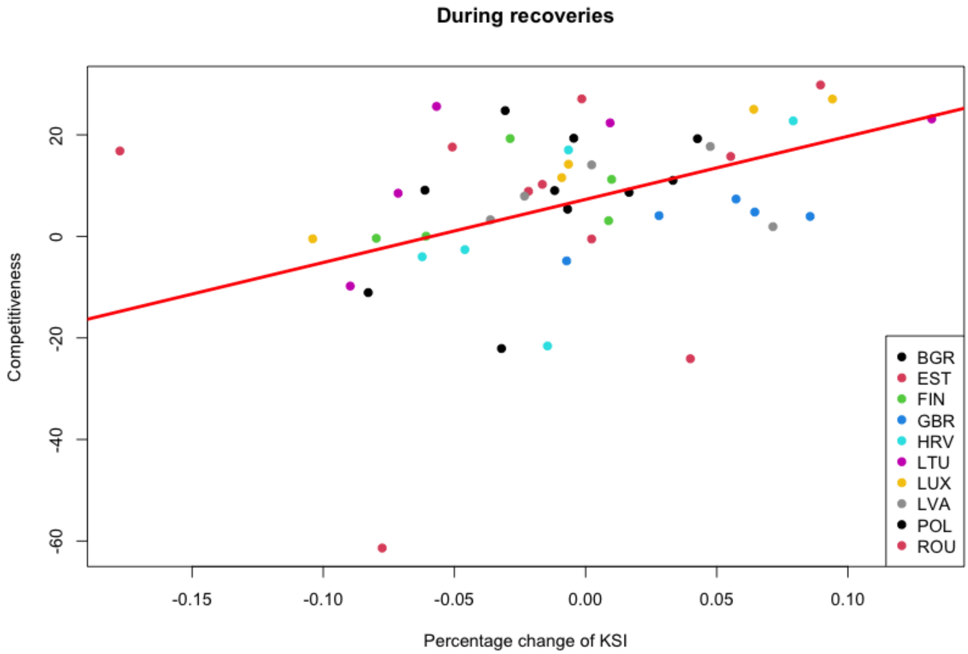


Fig. 21. Correlation between the percentage change in industrial specialisation and competitiveness of EU countries with an industrial diversification effect during economic shocks

Fig. 21 also shows high volatility in the competitiveness results of this cluster. However, most competitiveness results are above 0, suggesting that these countries have a good chance of effectively reorienting their economic structures towards industrial specialisation to recover from economic shocks. This insight suggests that the countries in the first cluster have resistance issues during economic shocks but recover well by reorienting their industrial structures during recoveries.

3.5.3. Industrial specialisation changes in countries with a specialisation effect

The cluster of EU countries with an industrial diversification effect does not produce significant correlation results between the proportional changes in industrial specialisation and competitiveness during economic shocks in any combination of countries (Table 20 in the Annex).

Most of the competitiveness results in this cluster are below 0, with high volatility, implying the expected low resistance cases despite the chosen direction of industrial portfolio reorientation by the countries.

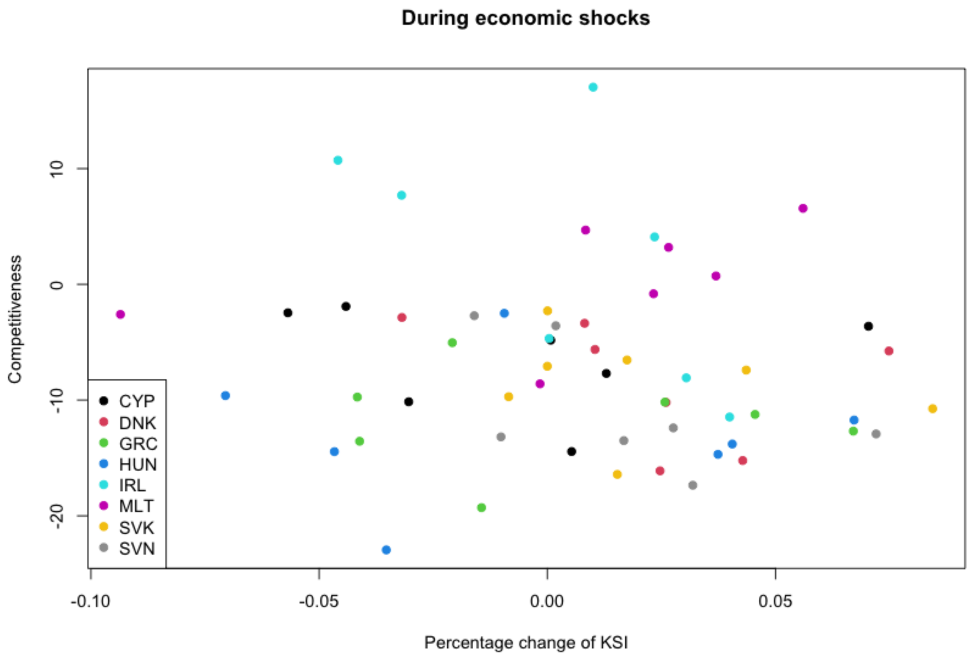


Fig. 22. Correlation between the percentage change in industrial specialisation and competitiveness of EU countries with an industrial specialisation effect during economic shocks

There are more similarities in the correlation of the proportional changes in industrial specialisation with competitiveness during the recoveries (Fig. 22, Table 21 in the Annex). The countries in the cluster altogether produce a significant negative correlation slope at a 90% confidence level but with a low variance of 6.4%.

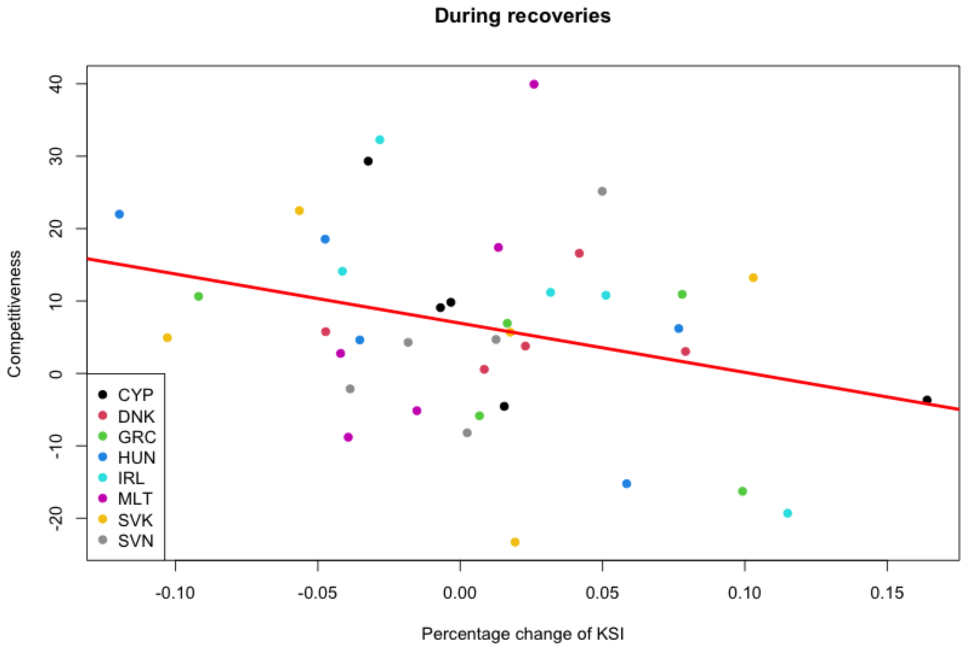


Fig. 23. Correlation between the percentage change in industrial specialisation and competitiveness of EU countries with an industrial specialisation effect during recoveries

The best combination of countries (Cyprus, Greece, Hungary, and Ireland) results in a significant negative regression outcome at a 99% confidence level, but the variance remains below 50% (Table 21 in the Annex). The remaining countries of the cluster exhibit an opposite (positive), yet insignificant tendency in the correlation between industrial specialisation change and competitiveness. Fig. 23 reveals high volatility in competitiveness results, with many of them being above 0. This observation implies that, despite the general tendency towards diversification changes, there are individual specific influences driving industrial specialisation to improve competitiveness during recoveries.

The assessment of the changes in industrial specialisation and their effect on the competitiveness of the clusters of countries in this subsection provides the following insights:

- EU countries that are better off with a diversified industrial portfolio structure prior to an economic shock increase their competitiveness by reorienting their industrial portfolios towards specialisation during economic shocks and recoveries.
- EU countries that are better off with a specialised industrial portfolio structure prior to an economic shock generally tend to recover by diversifying their industrial portfolios.

Changes in the industrial portfolio structure, whether towards diversification or specialisation, are possible when sufficient human capital is available for distribution across industries in the observed economy. Industrial specialisation and its changes were based on the quantities of the labour force, as discussed by Martin and Gardiner (2019) and Hundt and Grün (2022). The availability of the labour force was linked to the effects of migration in the EU by Kairienė et al. (2008) and Scipioni (2018), which can be accounted for through changes in the national population. Therefore, the next subsection assesses the effects of the distribution of population across EU countries on the competitiveness of their economies during the observed period.

3.6. Effects of population changes on national competitiveness

Population changes during economic shocks or recoveries are expressed through the proportional changes in the population count of countries (*pdelta_pop*). Robust correlation results between competitiveness and proportional population changes should provide insights into whether changes in the population of countries during economic shocks or recoveries impact their competitiveness.

3.6.1. Population changes in countries with diversified portfolios

Large and strong economies of the EU listed in this cluster show no correlation between changes in their population levels and their competitiveness, neither during economic shocks nor during recoveries (Figs. 24, 25 and Table 22 in the Annex).

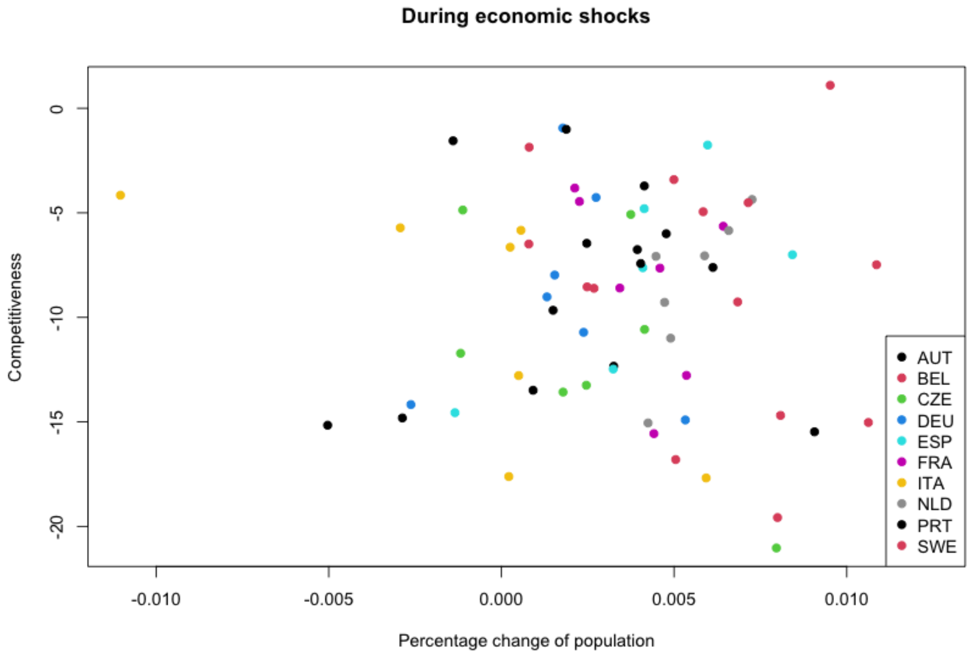


Fig. 24. Correlation between the percentage change in population and competitiveness of EU countries with diversified portfolios during economic shocks

Fig. 24 demonstrates that these countries have mostly been increasing their population levels during economic shocks, despite the decrease in competitiveness. Meanwhile, Fig. 25 shows the inverse picture, where this cluster of countries has generally been increasing their population count despite the increase in competitiveness during recoveries.

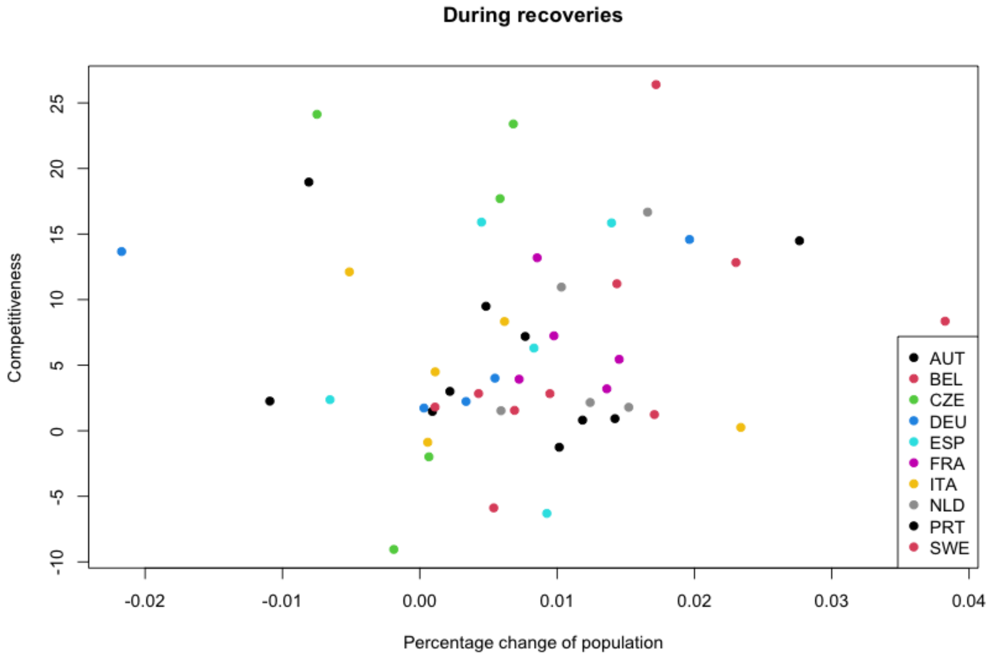


Fig. 25. Correlation between the percentage change in population and competitiveness of EU countries with diversified portfolios during recoveries

Nevertheless, Figs. 24 and 25 both demonstrate no effect of population changes on the competitiveness of these countries.

3.6.2. Population changes in countries with a diversification effect

The proportional percentage change in the population of this cluster does not affect the competitiveness of the countries (Table 23 in the Annex). The regression assessments do not produce significant results, even when the cases of economic collapse in Bulgaria and Romania in 1997 are eliminated from the panel, or when the countries are separated by their similarities into distinct groups (Fig. 26).

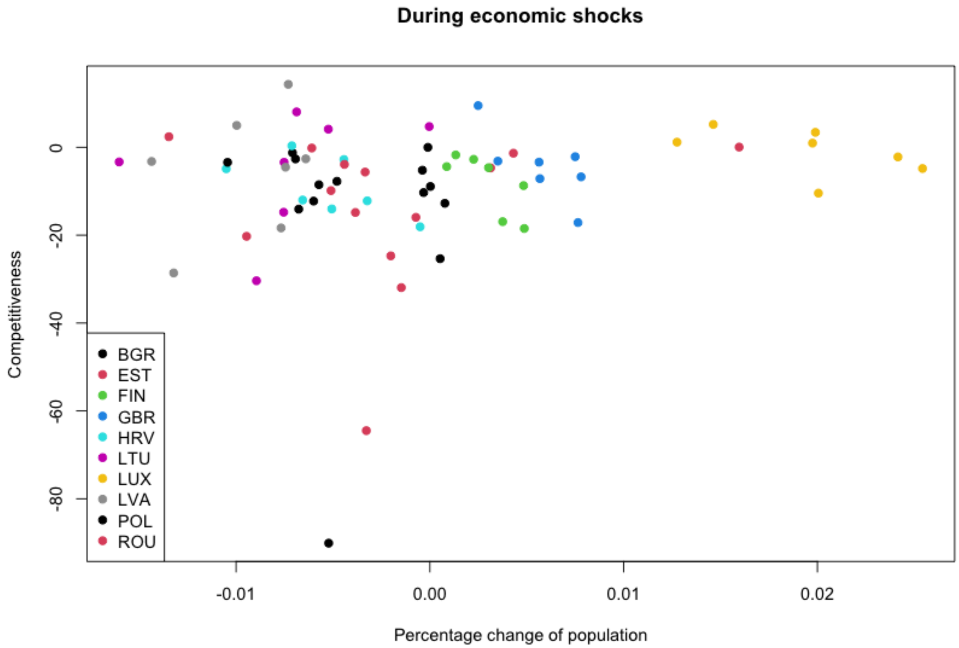


Fig. 26. Correlation between the percentage change in population and competitiveness of EU countries with an industrial diversification effect during economic shocks

The cases of the Bulgarian and Romanian economic collapse of 1997 are demonstrated in the lower part of Fig. 26, and their elimination does not change the overall correlation results in this cluster.

The observations that stand out in the panel of recoveries of this cluster affect the robustness of the results (Tables 24 and 25 in the Annex). All countries in the cluster together result in a negative significant outcome (at the 95% confidence level) with 43.5% variance. The variance increases to 48.4% when the result of the Romanian recovery in 2011 is removed from the panel (Table 24 in the Annex). When the countries are grouped by their similarities, the first group of countries is shown in Fig. 27, and the second group is shown in Fig. 28.

The first group of countries (Fig. 27) suggests a negative impact of the proportional population change on competitiveness during recoveries. Table 25 (in the Annex) indicates that the variance of this group increases to 54.6% when the result of the Romanian recovery in 2011 is removed from the panel. However, a wider distribution of observations led to less significance (90% confidence level).

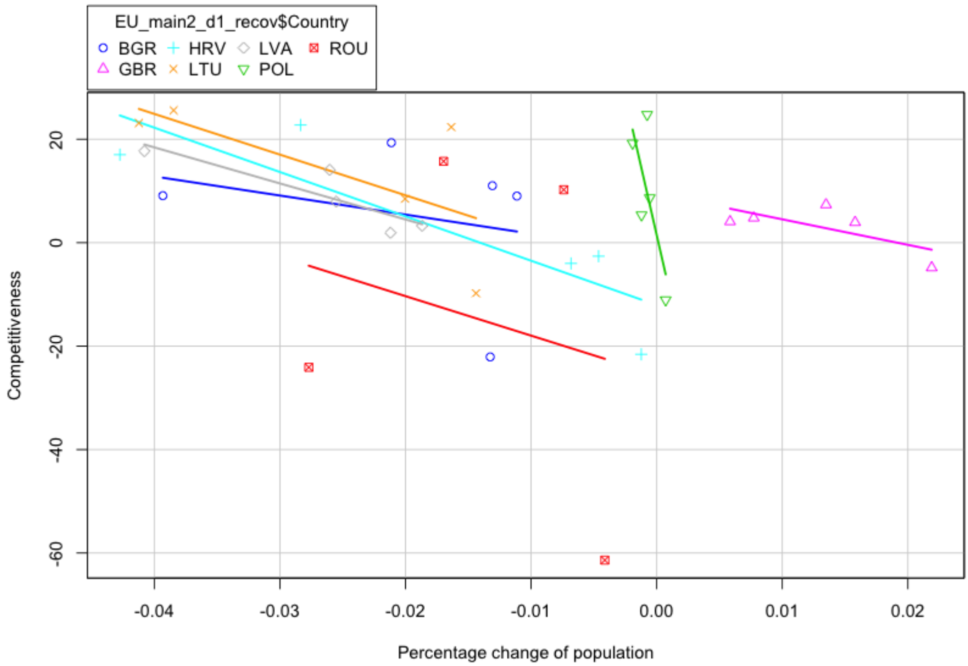


Fig. 27. Correlation between the percentage change in population and competitiveness of the first group of EU countries with an industrial diversification effect during economic shocks

Fig. 27 and the results in Tables 24 and 25 (in the Annex) suggest that the group of countries, consisting of Bulgaria, Great Britain, Croatia, Lithuania, Latvia, Poland, and Romania, recovered better from the economic shocks in the presence of greater emigration during these time intervals.

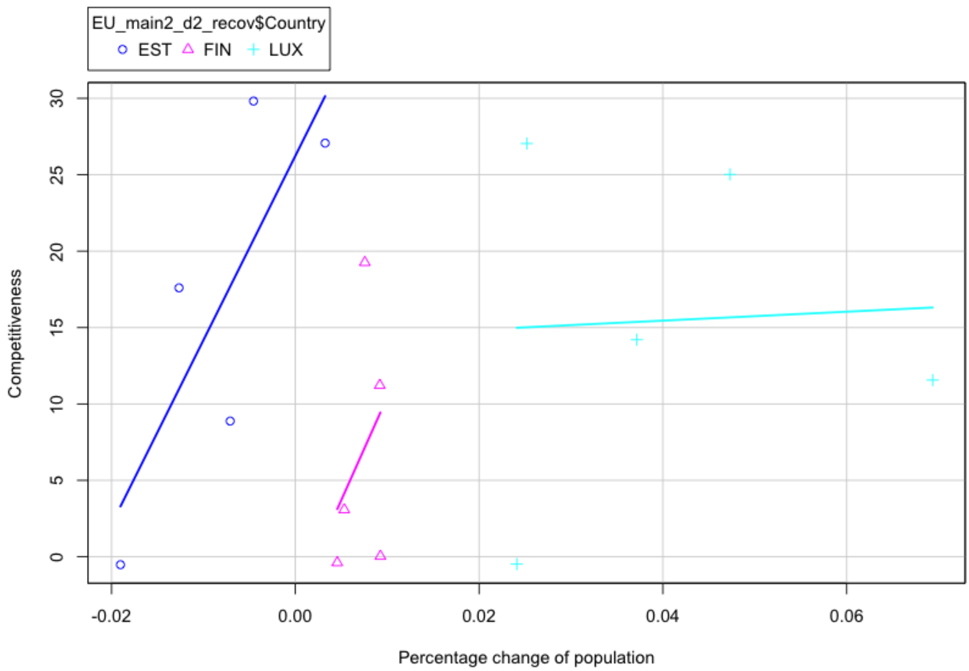


Fig. 28. Correlation between the percentage change in population and competitiveness of the second group of EU countries with an industrial diversification effect during economic shocks

The second group of countries in this cluster—Estonia, Finland, and Luxembourg (Fig. 28)—indicates a positive impact of proportional population change. However, the mixed results for this group in Tables 24 and 25 (in the Annex) reveal no significant correlation. This group is very small, and the statistical analysis suggests a larger panel.

These results call for further investigation in the same format, with a larger list of similar countries available in the ICIO Tables.

3.6.3. Population changes in countries with a specialisation effect

During economic shocks, the general tendency of this cluster of countries indicates a positive correlation between proportional population change and competitiveness (Fig. 29). The significant correlation result for all countries together in Table 26 (Annex) shows a low correlation of 10.3%.

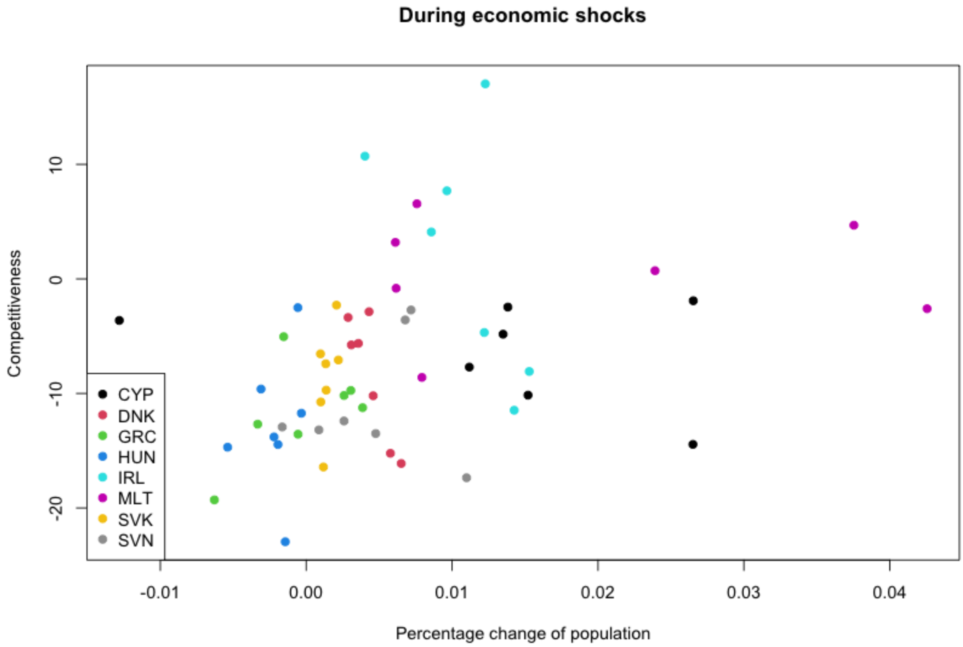


Fig. 29. Correlation between the percentage change in population and competitiveness of EU countries with an industrial specialisation effect during economic shocks

However, during recoveries, the results indicate a positive significant slope (at the 95% confidence level) with a variance of 49.6% (Fig. 30, Table 27 in the Annex). The variance increases to a high value of 83.7% when Denmark, Greece, Hungary, Slovakia, and Slovenia are evaluated separately from Cyprus, Malta, and Ireland.

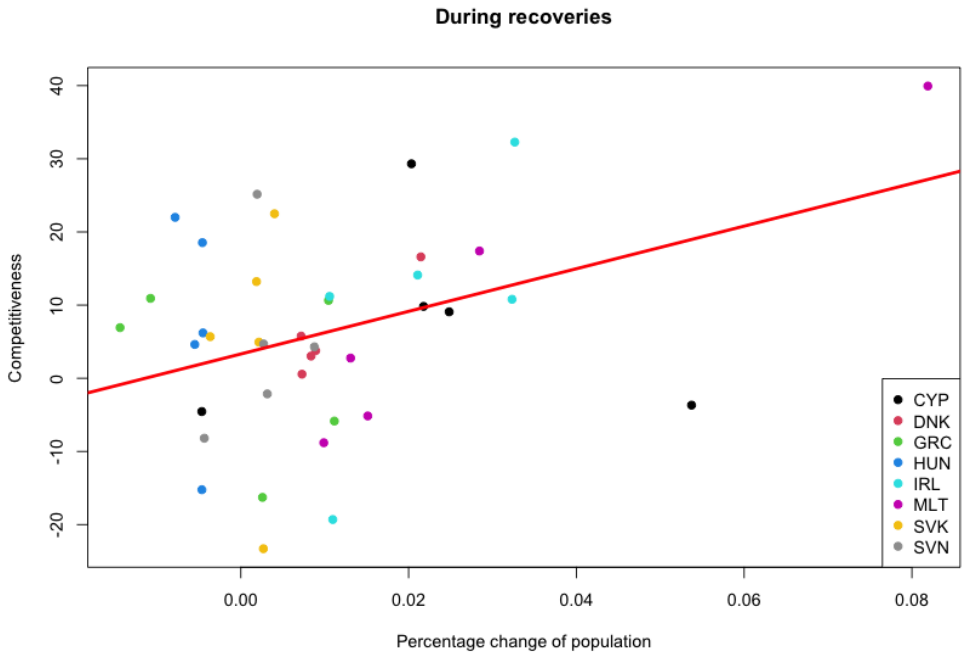


Fig. 30. Correlation between the percentage change in population and competitiveness of EU countries with an industrial specialisation effect during recoveries

The correlation results for Cyprus, Malta, and Ireland separately indicate a positive tendency, but it is not significant (Table 27 in the Annex). The observations in the cluster as a whole result in a positive correlation between proportional population change and competitiveness (Fig. 30). This suggests that for EU countries with an industrial specialisation effect, the competitiveness results during recoveries are better with larger immigration.

Assessment of the changes in population and their effect on the competitiveness of the clusters of countries in this subsection provides the following insights:

- Large and strong EU economies do not experience the impact of population changes on their competitiveness during economic shocks or recoveries.
- EU countries that are better off with a diversified industrial portfolio structure prior to an economic shock show a tendency to increase their competitiveness in the presence of emigration during recoveries.
- EU countries that are better off with a specialised industrial portfolio structure prior to an economic shock recover better when larger immigration is present during recoveries.

The results of the econometric analyses described in this subsection are summarised in Table 15. They show different economic behaviours of the EU countries during the time intervals of economic shocks and recoveries that occurred between 1995 and 2020.

Table 15. Aggregated results of the econometric modelling by clusters

Cluster	**EU countries with diversified portfolios**	**EU countries with diversification effect**	**EU countries with specialisation effect**	**Time intervals**
Countries	AUT, BEL, CZE, DEU, ESP, FRA, ITA, NLD, PRT, SWE	GBR, POL, HRV, ROU, BGR, LTU, LVA, EST, FIN, LUX	CYP, DNK, GRC, HUN, IRL, MLT, SVK, SVN	
Impact of KSI prior to economic shocks	No impact on competitiveness	**Significant, high variance** – industrial diversification better for competitiveness (excluding BGR '97 and ROU '97)	Significant, low variance (general) – industrial specialisation better for competitiveness	**During economic shocks**
	Significant, low variance – industrial specialisation better for competitiveness (mainly BEL, CZE, NLD, PRT)	**Significant, high variance** – industrial diversification better for competitiveness	Significant, low variance (general) – industrial specialisation better for competitiveness	**During recoveries**
Impact of KSI changes	**Significant, high variance** – industrial specialisation better for competitiveness (mainly DEU, ESP, SWE, NLD)	**Significant, high variance** – industrial specialisation better for competitiveness (excluding BGR '97 and ROU '97)	Insignificant (general) – industrial diversification better for competitiveness	**During economic shocks**
	Significant, high variance – industrial specialisation better for competitiveness (mainly DEU, ESP, SWE, NLD)	**Significant, high variance** – industrial specialisation better for competitiveness (excluding ROU '11)	Significant, low variance (general) – industrial diversification better for competitiveness of CYP, GRC, HUN, and IRL	**During recoveries**
Impact of population changes	No impact on competitiveness	Insignificant – decrease in population better for competitiveness	No impact on competitiveness	**During economic shocks**

	No impact on competitiveness	**Significant, high variance** – decrease in population better for competitiveness (mainly BGR, GBR, HRV, LTU, LVA, POL, ROU, except ROU '11)	**Significant, high variance** – increase in population better for competitiveness (mainly DNK, GRC, HUN, SVK, SVN)	**During recoveries**

The following section provides an interpretation of the results of the econometric modelling (summarised in Table 15) obtained by applying the methodology presented in this research.

3.7. Interpretation of results, discussion, and future research possibilities

The assessment of EU countries, conducted to validate the newly developed methodology for comparing countries by their resilience, has indicated national characteristics that significantly influence how countries resist and recover from economic shocks. It is important to note that these results are subject to further studies, which should include additional factors that could impact national competitiveness and, consequently, national resilience.

Large and impactful EU economies are generally diversified, implying self-sufficiency of the economic systems. Table 15 reveals that the level of diversification does not significantly affect their competitiveness during economic shocks, although some of these countries may recover better when they are more specialised prior to the shocks. Population changes also do not impact the competitiveness of these countries. However, during economic shocks and recoveries, these countries can increase their competitiveness by reorienting towards more specialised industrial portfolios. The high diversification of industrial portfolios and the insignificance of changes in industrial portfolios have led to similar economic performance reactions in these countries: similar decreases in competitiveness during economic shocks (Fig. 12) and a majority of cases of similar increases in competitiveness during recoveries (Fig. 13). An interest arises here in assessing hypothetical scenarios where these countries enter economic shocks while being more specialised, such as Great Britain from the cluster of countries with an industrial diversification effect, which, by size and economic capacity, could also fit among the countries with diversified industrial portfolios. Such an analysis could be performed in future studies: a) by extending the list of countries with diversified industrial portfolios to a global level (e.g., US, China, Japan, etc.); b) by increasing the analysed period to include a larger number of economic shocks; or/and c) by analysing the impact of other national properties of these countries that shape the factor of industrial specialisation.

Table 15 identifies a group of countries that exhibit a significant industrial diversification effect. Countries with diversified industrial portfolios prior to economic shocks tend to have better economic performance during the shocks and subsequent recoveries. Their economic performance is also enhanced when they are able to shift towards industrial specialisation during the shocks and recoveries. These effects align with the observation that, during recoveries, these countries perform better when their shift towards industrial specialisation coincides with a decrease in population. The correlation between the effects of competitiveness and population changes for this group of countries should be analysed in future studies. It is important to note that these countries, except for Great Britain, are new EU member states that received substantial amounts of EU funding for economic cohesion purposes (European Commission, 2024) during the analysed period. On the other hand, the emigration of the Eastern European working population to Western European countries (with Great Britain being one of the receiving countries) has created positive effects, such as money inflows from emigrants' earnings to their families in home countries, reduced unemployment rates in both Western and Eastern European economies, and the improvement of skills of Eastern European emigrants to the Western European level. Competitiveness is an integral variable that encompasses these and many other factors, which were capitalised to produce the results of competitiveness in the observed economies. Thus, these questions prompt for in-depth elaboration in future research.

The third cluster of small- to medium-sized countries of the EU, identified in Table 15 as the cluster of countries with the specialisation effect, reveals a general tendency that industrial specialisation prior to economic shocks could be beneficial for economic performance during turbulent periods. However, the statistical evidence does not confirm this tendency because of the small number of countries assessed and the large error terms. The empirical evidence of this research, however, encourages further research by expanding the list of countries under consideration. The statistical evidence, nevertheless, shows that these economies rely on their population. With increases in population during recoveries, these countries can expect increases in their economic performance.

These results lead to the following assessment of the hypotheses:

H1: The distribution of human resources within the EU countries before economic shocks has a significant impact on their economic performance during the shocks and recoveries – confirmed for the countries with a diversification effect (Cluster 2). A tendency for a possible significant impact has been revealed for the countries with a specialisation effect (Cluster 3), yet it requires further analyses with an extended list of similar countries.

H2: Changes in the distribution of human resources within the EU countries during economic shocks and recoveries have a significant impact on their economic performance during the shocks and recoveries – confirmed for the countries with diversified portfolios (Cluster 1) and for those with the diversification effect (Cluster 2). A tendency for possible significance has been revealed for the countries with a specialisation effect (Cluster 3), but this prompts further studies with an extended list of similar countries.

H3: Changes in the availability of human resources in the EU countries during economic shocks and recoveries have a significant impact on their economic performance during the shocks and recoveries – confirmed for the countries that have more significantly altered their industrial portfolios (Cluster 2 and Cluster 3), and during the recoveries only. This result prompts further in-depth research involving more determinants of migration of human resources across the EU countries.

The findings provide more specific statistical evidence for the conclusions of Davies and Tonts (2010), which state that regions with a narrow economic base are more prone to economic volatility, decline, and marginalisation than diversified economic systems. The findings highlight the importance of timing in decision-making aimed at controlling the industrial structure at the national level through the implementation of fiscal or monetary policies. This research highlights economies with more significant changes in their industrial specialisation (Cluster 2), i.e., countries with the diversification effect, suggesting that the more they are diversified prior to economic shocks, the better they resist during shocks and recover afterwards. Innate capabilities and adaptive capacity that shape the resilience of economies, as highlighted by Rose (2004), are reflected in the highly significant correlation between competitiveness and proportional changes in industrial specialisation in Cluster 1 and Cluster 2. The diversified economies of the EU better resist and recover from shocks if they reorient their industrial portfolios towards specialisation (Table 15). Moreover, the resilience of EU countries is shaped not only by the structure of the national economy and reorientation skills but also by human resources, as highlighted by Simmie and Martin (2010), Martin (2012), and Martin et al. (2016). Table 15 indicates the significance of the correlation between national competitiveness and changes in population during recoveries.

Differing from the mainstream of diversified EU economic structures, a group of EU countries (Cluster 3) is shown to exhibit the opposite industrial specialisation effect in this research. These results lack robustness, although the findings suggest optimism that, with an extended list of countries, the results could fit into the theory of Davies and Tonts (2010), which posits that, in some cases, specialisation is seen as an important source of competitive advantage. The countries in Cluster 3 have shown a tendency to be more competitive during economic shocks and subsequent recoveries when they enter the shocks with a more specialised industrial portfolio.

The above-described results serve as evidence for the validation of the methodology presented in this dissertation. However, the research could be expanded in future studies to obtain more accurate findings. The methodology can be applied in a wide variety of ways to develop more specific statistical evidence regarding the importance of the size or geographical location of economies on regional resilience.

The industrial portfolio structure in this research is presented as an instrument for identifying the level of competitiveness of countries and their specialisation, independent of the combination of their main strengths, as stressed by Davies and Tonts (2010). The main strengths of national economies could also be expressed through the disaggregation of national industrial portfolios by applying the proposed methodology in further research.

The research has identified different properties of the EU economies that may contribute to understanding the current state of national resilience, including the possibilities of developing their competitive positions in international trade, which depend on the available human resources and their distribution within the economy.

The econometric modelling (the results of which are presented in Table 15) was performed by considering that economic shocks impact countries differently, with each country's economy reacting uniquely to the consequences of these shocks. The common property that was critical in the assessment was that economic shocks affect the same components of the economy—industrial portfolios, which are disrupted in various ways. The industrial portfolio within each country incorporates a compensation mechanism (Davies & Tonts, 2010) that takes effect in cases of disruptions in one or more industries, meaning that other industries within the economy or other economies can compensate for sudden losses within the disrupted industries.

The empirical evidence of the development of the global economy during the period between 1995 and 2020, shown in Tables 1, 2, 3, and 4 (in the Annex), aligns with the scientific literature on global events that triggered global or EU-wide economic shocks. This evidence supports the general trend in previous resilience research, which states that economic shocks vary in their nature, duration, severity, and effects across different regions (Martini, 2020). Different shocks can generate different reactions and resilience levels (Martin et al., 2016). Economic shocks can easily spread to other industries and countries (Pilinkienė et al., 2021). The analysis of the dynamics of the development of the global value of IC from several perspectives, demonstrated in Tables 1, 2, 3, and 4 (in the Annex), provides the opportunity to capture disruptions within global value chains and regions. This approach allows for the identification of source industries and regions/countries responsible for global economic disruptions stemming from disruptive environmental, economic, and political events on the international stage.

Despite the nature of the source of an economic shock or any other disruption in the global economy, this research highlights that a country's ability to compete in international trade (national competitiveness) is an essential factor of its resilience, i.e., when resisting economic shocks or recovering from them. As global demand for products and services gradually increases alongside the growing global population, the question of resilience becomes how steady and stable the global supply of goods and services can be in the presence of various environmental, geopolitical, and other issues on the global stage that impact global supply chains to varying extents. The global economy consists of countries and their industries. When some of them fail, others compensate because the goal of every entity (whether it is a company, an industry, or a country) is growth, or in other words, to improve its position in local or international trade.

4. CONCLUSIONS

1. The literature analysis enabled the integration of the concepts of resilience to economic shocks with those of industrial portfolios for a deeper analysis of the effects of economic shocks on countries' economic performance. The literature reveals a cyclical shift in the causal effects between economic shocks and internal and external events in the development of economies, with externalities playing a key role in determining economies' resilience. The responses of economies to shocks are identified in the literature through reorientation, with efforts to enhance the properties of their economic structure (industrial portfolio); however, these responses may become the causes of subsequent economic shocks. Open economies are exposed to external influences in times of evolving globalisation, and the problem of mixed results in economic resilience research appears to stem from the necessity of an economy to engage in trade with other economies. The externalities from events in surrounding economies may distort economic development cyclicality. However, the effects of externalities could be contained in the resilience assessment of a closed (global) economy.

2. The analysis of the methods directed the research towards an in-depth analysis of the construction of resilience assessment models. The analysis of the models and their indicators reveals the following key points to consider when assessing resilience at the national level:
   a) the strong interdependence between environmental studies and economics requires an integrated solution for resilience assessment;
   b) most models require a complex resilience assessment, although the straightforward, proportional relative resilience model of Martin et al. (2016) and Martin and Gardiner (2019) is more universal and has shown similar results;
   c) intermediate consumption is more sensitive to economic shocks than conventional indicators (such as output or GDP), making it more attractive for resilience assessment. Intermediate consumption could also replace employment variables in resilience measurement models when applied to the labour-based theory of value of Adam Smith.

3. As today's goal is to ensure the sustainable development of global society, including economic, social, and environmental aspects, the significant presence of externalities presents a challenge in measuring economies' resilience. The analysis from a holistic perspective enables the approach that all other regions, with their business cycles, are internal to the global economy, whereas the complex and multifaceted nature of humans and their behaviour aligns with the theories of Adam Smith and many subsequent economists. Furthermore, the level of detail in the current statistical data within the ICIO Tables allows the research to perform industrial portfolio performance assessments at the global level using data panels with microeconomic-level precision.

4. This research developed a methodology to measure countries' resilience to economic shocks through the industrial portfolio approach. To minimise the effects of externalities on the cyclicality of economic development, the methodology applies a holistic theory that perceives the global economy as one closed economy. The methodology is based on statistics from the OECD's inter-country input-output tables and is constructed to measure changes in intermediate consumption within national industrial portfolios, which define the ability of economies to compete in international trade. Thus, competitiveness is an essential property of the relative resilience measurement model and can be derived from global economic performance. Therefore, the comparison of countries by their competitiveness proves to be sufficient to represent the comparison of countries by their resilience.

   The analysis of the dynamics in the development of the global intermediate consumption value from multiple perspectives allows for capturing disruptions within global value chains and regions. This information enables the statistical determination of the time intervals of economic shocks and subsequent recoveries. Additionally, it enables the identification of source industries and regions/countries responsible for global economic disruptions caused by disruptive environmental, economic, and political events on the international stage.

5. The validation of the developed methodology was performed by assessing the impact of national properties on the competitiveness of EU economies during their resistance to and recovery from the EU-wide economic shocks. The results contribute to the existing scientific literature by providing more specific statistical evidence on the advantages of industrial diversification in EU economies. They also emphasise the importance of timing in national-level decision-making, particularly in fiscal and monetary policies aimed at adapting industrial portfolio structures to the ever-changing economic environment. Many EU countries demonstrate better resistance to and recovery from economic shocks when their industrial portfolios are more diversified prior to the shocks. These countries also show improved performance when they reorganise their industrial portfolios towards specialisation during the shocks and recoveries. The research has revealed a tendency for some small- and medium-sized EU economies to resist and recover more effectively when their industrial portfolios are more specialised before economic shocks. A growing population also helps these countries recover more effectively from economic shocks. The assessment has revealed the potential for countries to identify, predict, and direct their policies towards a more effective industrial portfolio setup before the occurrence of economic shocks, which could enhance their ability to resist and recover.

   This research shows an economic reality, suggesting that the optimal industrial portfolio composition is a flexible industrial portfolio that can quickly adapt to the constantly changing global economic environment.

5. SANTRAUKA

Temos aktualumas. Pasaulio ekonomika patiria vis dažnesnius ir vis sunkesnes pasekmes sukeliančius ekonominius šokus. Šiuolaikinės ekonomikos raida mokslinėje literatūroje aprašoma kaip ekonominių nuosmukių, kuriuos sukėlė ekonominiai šokai, raida (Hundt & Grün, 2022). Nuo 2008 m., prasidėjus pasaulinei finansų ir ekonomikos krizei, mokslinėje literatūroje pastebimas išaugęs ekonomistų susidomėjimas ieškant sprendimų, kaip suvaldyti neigiamus ekonominių šokų padarinius. Martini (2020) pažymėjo, kad po 2008 m. įvykusios pasaulinės finansų krizės labai išaugo ekonominio atsparumo temos populiarumas tarp ekonomistų atliekamų tyrimų. 2020 m. pasaulį apėmusi COVID-19 pandemija dar labiau padidino mokslo ir viešojo sektoriaus pastangas tirti atsparumą ekonominiams šokams. Mascaretti ir kt. (2022) atkreipė dėmesį į tai, kad COVID-19 pandemijos metu apribojus daugelį ekonominių veiklų, valstybių institucijoms tapo itin aktualu sukurti priemones ir sistemas, kurias naudojant būtų galima sušvelninti galimas ekonominių šokų rizikas ir pasekmes.

Pasauliniai geopolitiniai pokyčiai ir stichinės nelaimės vis stipriau paveikia pasaulio ekonomiką, sudarytą iš įvairaus dydžio ekonominių sistemų. Ekonominės sistemos šiame kontekste yra valstybės, regionai, įmonės, organizacijos ar kitos apimties ekonominės struktūros, susidedančios iš tarpusavyje sąveikaujančių ekonominių veiklų. Ekonominiai šokai ir jų pasireiškimas yra daugialypiai ir sunkiai nuspėjami. Pasak Martini (2020), ekonominiai šokai skirtinguose regionuose yra skirtingi pagal savybes, trukmę ar poveikį. Martin ir kt. (2016) pabrėžė, kad įvairūs ekonominiai šokai gali sukelti įvairias šalių ekonominės aplinkos reakcijas. Ekonominiams šokams taip pat būdinga savybė lengvai migruoti iš pramonės šakos į pramonės šaką ir iš valstybės į valstybę (Pilinkienė et al., 2021). Sušvelninti arba suvaldyti galimas ekonominio šoko pasekmes yra sudėtingas iššūkis, apimantis daugybę veiksnių. Atsparumas ekonominiams šokams mokslinėje literatūroje suprantamas kaip priemonė, įvertinanti, kaip ekonominiai šokai veikia ekonominių sistemų raidą (Martin, 2012).

Ekonominė raida susideda iš nuolat besikeičiančių ekonomikos augimo ir nuosmukių laikotarpių. Iššūkis suvaldyti ekonomikos nuosmukį yra užkoduotas pačioje „ekonomikos“ sąvokoje, kuri kartu apibūdina ribotų išteklių paskirstymą ir valdymą. Ankstyvieji moksliniai tyrimai ir pradinės šiuolaikinės ekonomikos teorijos, tokios kaip Adamo Smitho (Manis, 2005), Johno Stuarto Millo (Pelsa & Balina, 2021) arba Davido Ricardo (Ricardo, 1821), buvo paremtos įrodymais iš vietinių ekonominių sistemų ir orientuotos į vietinių ekonominių sistemų efektyvumą bei veiksmingumą. Būtinybę dėti pastangas suvaldyti ekonominius nuosmukius pasauliniu lygmeniu iškėlė Neff (1949), nes bandymai atskiroje ekonominėje sistemoje išspręsti šias problemas buvo neefektyvūs. Pasak Martini (2020), mokslinės diskusijos apie atsparumą ekonominiams šokams tarp ekonomistų įgavo pagreitį po 2008 m. pasaulinės finansų krizės.

Martin ir Sunley (2015) apibūdino atsparumą ekonominiams šokams kaip labai sudėtingą ir daugialypį procesą, kurį sudaro daug tarpusavyje susijusių veiksnių.

Priklausomai nuo ekonominio šoko savybių, vienu laikotarpiu atspari ekonominė sistema gali tapti neatspari kitu laikotarpiu (Martini, 2020). Europos šalių ekonominis atsparumas nevienodas (Cuadrado-Roura ir Maroto, 2016), tačiau Vakarų Europos valstybių atsparumui vertinti atlikta daug tyrimų, o Rytų Europos šalių atsparumas ekonominiams šokams literatūroje vertinamas retai (Oprea et al., 2020).

Po COVID-19 sukeltos pandemijos mokslinėje literatūroje atsiranda vis daugiau ekonominio atsparumo vertinimo modelių, skirtų vienos ar kelių ekonominės veiklos sričių poveikiui vietos ar regiono ekonominės raidos rezultatams tirti (Hundt & Grün, 2022; Pamucar et al., 2023; Delgado-Bello et al., 2023). Ekonomika vystosi ciklais, o ekonominiai tyrimai nuolat tobulinami remiantis vis naujesne informacija, surinkta iš praeities įvykių. Tačiau pasaulinė ekonominė aplinka nuolat keičiasi didėjant pasaulio gyventojų skaičiui (UNESCO, 2010; Carneiro Freire et al., 2019) ir sparčiai tobulėjant technologijoms (Veseth, 2014; Milgrom, 2017; Loungani et al., 2017). Todėl šiuo metu aktualu įvertinti anksčiau sukurtų pagrindinių atsparumo ekonominiams šokams vertinimo metodų ir modelių, tokių kaip Solow (1956), Swan (1956), Romer (1986) arba Mankiw ir kt. (1992) atnaujinimo poreikį, naudojant šiuolaikinę regionų ekonominės raidos statistinę informaciją. Tie metodai buvo sukurti naudojant siauresnės apimties informaciją. Juos galima atnaujinti naudojantis daug detalesne ir didesnės apimties statistine informacija, kurią šiandien jau turime. Suvienodinta įvairių pasaulio šalių ekonominės raidos rezultatų informacija (OECD, 2023) pateikiama tarptautiniu mastu standartizuotų nacionalinių sąskaitų (NA; Eurostat, 2023c) detalumo lygiu ir sukuria prielaidas įžvelgti platesnį veiksnių, sukeliančių ekonominių sistemų atsparumo ekonominiams šokams lygį.

Mokslinė problema ir jos išnagrinėjimo lygis. Tyrime analizuojama mokslinė problema įvardyta Martin ir Gardiner (2019) atliktoje mokslinėje analizėje, kurioje atkreiptas dėmesys į augančią mokslinę literatūrą apie atsparumą ekonominiams šokams, tačiau iki šiol nėra sukurtos ir vieningai naudojamos metodikos, kaip jį išmatuoti. Briguglio ir kt. (2009), Fingleton ir kt. (2012), Béné (2013), Martin ir Gardiner (2019), Martini (2020), Hundt ir Grün (2022) tyrimai išryškino ekonominių, socialinių, politinių, geografinių, kultūrinių, teritorinių skirtumų specifiką, atsparumo gausą ir įvairovę lemiančias galimybes ir veiksnius. Ekonominių šokų savybių skirtumai didina ir atsparumo vertinimo sudėtingumą. Ekonomikos augimas paprastai analizuojamas plačiai naudojamuose ekonominio atsparumo vertinimo modeliuose (Solow, 1956; Swan, 1956; Hundt & Grün, 2020; UNDRR, 2022a; UNDRR, 2022b) vertinant pasirinktų pramonės šakų ekonominės veiklos pokyčius.

Europos šalys yra nevienodai atsparios ekonominiams šokams (Cuadrado-Roura & Maroto, 2016), tačiau, esant didelei Vakarų Europos valstybių atsparumo ekonominiams šokams nagrinėjimo mokslinės literatūros įvairovei, Rytų Europos šalių atsparumas ekonominiams šokams mokslinėje literatūroje vertinamas retai (Oprea et al., 2020).

Mokslinė darbo problema. Randama daug mokslinės literatūros apie atsparumo tyrimus regioniniu lygiu (Martin, 2012; Martin ir Sunley, 2015; Martin et al., 2016; Martini, 2020; Di Pietro et al., 2020; Ženka et al., 2021), organizacijų lygmeniu (Mehta et al., 2024) arba tiekimo grandinių mikroekonominiu lygmeniu (Echefaj et al., 2024).

Sukurti atsparumo ekonominiams šokams matavimo modeliai, skirti bendruomenių atsparumui ekonominiams šokams įvertinti, kai jos susiduria su stichinėmis nelaimėmis (Tierney & Bruneau, 2007; Norris et al., 2008; Cutter et al., 2010; Renschler et al., 2010; UNDP, 2016). Sudėtingi atsparumo ekonominiams šokams matavimo modeliai sukurti regionams ar šalims (Solow, 1956; Swan, 1956; Mankiw et al., 1992; Martin & Gardiner, 2019; UNDRR, 2022a; UNDRR, 2022b) ir jie vertina ekonominės sistemos augimą bei vartojimą. Pelningumas, užimtumas, ekonomikos augimas – tai pagrindiniai veiklos rodikliai, o kokybiniai ekonominės aplinkos veiksniai naudojami tik bendruomenės lygmeniu. Pasak Feldman ir kt. (2016), ekonominio vystymosi samprata dažnai maišoma su ekonomikos augimu ir tai kelia sumaištį mokslininkų ir oficialių institucijų diskusijose apie atsparumą ekonominiams šokams. Pelsa ir Balina (2021) pabrėžė, kad vis daugėja mokslininkų, kurie savo studijas grindžia ekonomikos augimo tempais, pavyzdžiui, BVP augimu, ir nevertina tikrosios ekonomikos ir visuomenės būklės.

Mokslinėje literatūroje aptariama ekonominė geografija vis labiau orientuota į ekologišką gamybą ir paslaugas, tačiau ji vis dar daugiausia remiasi tradicinėmis augimo paradigmomis (Schulz & Bailey, 2014). Gamtinių anomalijų sukeltoms krizėms stiprėjant, Lange ir kt. (2021) pabrėžė klimato krizių klausimą kaip ypač svarbų viešose diskusijose.

Šioje analizėje įžvelgiama atsparumo tyrimų spraga – nėra metodikos, kuri leistų palyginti šalis pagal tai, kokį poveikį daro šalių pramonės struktūros pokyčiai tų šalių atsparumui ekonominiams šokams. Tokia metodika padėtų efektyviau siekti ekonomikos vystymosi ir tvarumo tikslų.

Mokslinio tyrimo objektas – pramonės struktūros pokyčių poveikis įvairių ekonomikų atsparumui ekonominiams šokams.

Mokslinio tyrimo tikslas – sukurti atsparumo ekonominiams šokams įvertinimo metodiką atsižvelgiant į valstybių pramonės struktūros pokyčius ir empiriškai patvirtinti ją ES atveju.

Mokslinio tyrimo uždaviniai:

- Išanalizuoti atsparumo ekonominiams šokams koncepcijas ir pramonės struktūros bei kitų susijusių veiksnių poveikio atsparumui ekonominiams šokams teorines įžvalgas.
- Įvertinti šiuo metu taikomus atsparumo ekonominiams šokams vertinimo metodus.
- Įvertinti pramonės struktūros prieigos pritaikomumą nacionaliniam atsparumui ekonominiams šokams matuoti.
- Sukurti skirtingų šalių atsparumo ekonominiams šokams vertinimo metodiką.
- Taikant sukurtą metodiką įvertinti ES šalių atsparumą ES įvykusių ekonominių šokų metu.

Tyrimo metodas ir duomenys. Tyrimas pagrįstas tarptautinių sąnaudų ir produkcijos lentelių duomenų rinkiniu (EBPO, 2023). Lentelės rengiamos ir periodiškai atnaujinamos remiantis Leontief (1936 m.) sąnaudų ir produkcijos teorija ir plačiai naudojamos Ekonominio bendradarbiavimo ir plėtros organizacijos (EBPO) šalyse, įskaitant visą ES (Eurostat, 2013) ir kitose pasaulio šalyse. ICIO lentelėse įvertinti suderinti 77 valstybių ir 45 pramonės šakų duomenys, perkelti iš šių šalių nacionalinių sąskaitų (Eurostat, 2023c). ICIO lentelių duomenų rinkinys apima beveik visos pasaulinės ekonomikos veiklos rezultatus per analizuojamą laikotarpį nuo 1995 iki 2020 m.

Tyrimo naujumas pasižymi tuo, kad jo metu sukurta nauja metodika, leidžianti palyginti įvairias pasaulio valstybes pagal jų atsparumą ekonominiams šokams, remiantis Martin ir Gardiner (2019) santykinio atsparumo modeliu. Pasiūlyta metodika įvertina pasaulinės ekonominės plėtros perspektyvą, pagrįstą holistine teorija, taip sumažinant išorinių veiksnių, kurie gali iškreipti vietinės ekonomikos vystymosi cikliškumą, poveikį (Martini, 2020; Hundt & Grün, 2022; Delgado-Bello et al., 2023).

Pramonės struktūros rodikliai šioje metodikoje yra ICIO lentelių tarpinio vartojimo vertės, perskaičiuotos 1994 m. kainų lygiui. Tarpinis vartojimas nacionalinėse sąskaitose rodo išteklius, kurie naudojami bendrajai pridėtinei vertei arba BVP sukurti. Todėl tarpinis vartojimas yra pusiausvyros tarp gamybos ir vartojimo kiekvienoje konkrečios ekonomikos šakoje rodiklis, o jo proporcingi svyravimai atskleidžia pramonės konkurencingumo lygį. Be to, šiame tyrime nustatyta, kad šalys pagal atsparumą gali būti lyginamos pagal jų konkurencingumą, apskaičiuojamą remiantis proporcingais tarpinio vartojimo pokyčiais.

Mokslinio tyrimo naujumas ir metodas. Šiame moksliniame darbe pasiūlyta metodika, leidžianti įvertinti šalis pagal jų atsparumą ekonominiams šokams.

Atsparumas ekonominiams šokams mokslinėje literatūroje paprastai vertinamas analizuojant BVP (Martin et al., 2016; Martini, 2020), užimtumo (Martin & Sunley, 2015; Oprea et al., 2020; Hundt & Grün, 2022) ir produkcijos statistinius duomenis (Martin & Gardiner, 2019), akcentuojant ekonomikos augimą. Mokslinėje literatūroje randamų tyrimų apimtis apsiriboja bendruomenės (Cutter et al., 2010; Renschler et al., 2010; UNDP, 2016) arba regioniniu / nacionaliniu lygmeniu (Solow, 1956; Swan, 1956; Martin & Gardiner, 2019; UNDRR, 2022a; UNDRR, 2022b). Pramonės struktūros mokslinėje literatūroje vertinamos pasirenkant vieną ar kelias dominančias pramonės šakas ir jas analizuojant atskirai nuo likusių pramonės struktūros šakų veiklos rezultatų (Martin & Gardiner, 2019; Picek & Schröder, 2018; Hundt & Grün, 2022; Pamucar et al., 2023). Integrali visos pramonės struktūros analizė atlikta Lewis ir kt. (2021) tyrime, tačiau jame buvo analizuojami suminiai prekių ir paslaugų sektorių rezultatai. Ekonominių šokų ir atsigavimo laikotarpiai, atliekant įprastinius atsparumo vertinimus, nustatomi empiriškai (Friedman, 1988; Hamilton, 1989). Ryšys tarp regioninio ar nacionalinio atsparumo ekonominiams šokams ir konkurencingumo mokslinėje literatūroje nagrinėjamas teoriniu lygmeniu (Bristow, 2010; Davies & Tonts, 2010), o statistiškai – organizaciniu (Romer, 1986).

Kitaip nei ankstesniuose tyrimuose, šiame tyrime metodika sukurta siekiant išmatuoti tarpinio vartojimo (IC) pokyčius valstybių pramonės šakose, kurie atskleidžia valstybių gebėjimą konkuruoti tarptautinėse rinkose įvairiuose vertės grandinių segmentuose. Kiekviena pramonės šaka turi savo svorį integralioje valstybių pramonės struktūroje, o toks pramonės šakų ekonominės veiklos vertinimas gali būti išplėstas iki pasaulinės apimties. Statistinės ir matematinės analizės metu nustatyta, kad konkurencingumas yra pagrindinė santykinio atsparumo ekonominiams šokams matavimo modelio savybė ir ji gali būti statistiškai išskirta iš pasaulio ekonomikos santykinio atsparumo ekonominiams šokams rezultatų. Todėl šalių palyginimas pagal jų konkurencingumą atspindi tų šalių palyginimo pagal atsparumą ekonominiams šokams rezultatus. Šis tyrimas galiausiai leidžia nustatyti pasaulinių ar regioninių ekonominių šokų ir atsigavimo laikotarpius taikant statistinius skaičiavimus. Be to, tampa įmanoma statistiškai nustatyti pramonės šakas, regionus ar šalis, iš kurių kyla pasauliniai ekonominiai šokai dėl gamtos anomalijų, ekonominių ir tarptautinių politinių įvykių.

Vertinant globaliai, pasaulio ekonomika suvokiama kaip vientisas vienetas, o regionui, valstybei ar pramonės šakai būdingi išoriniai veiksniai tampa vidiniais pasaulio ekonomikos veiklos komponentais.

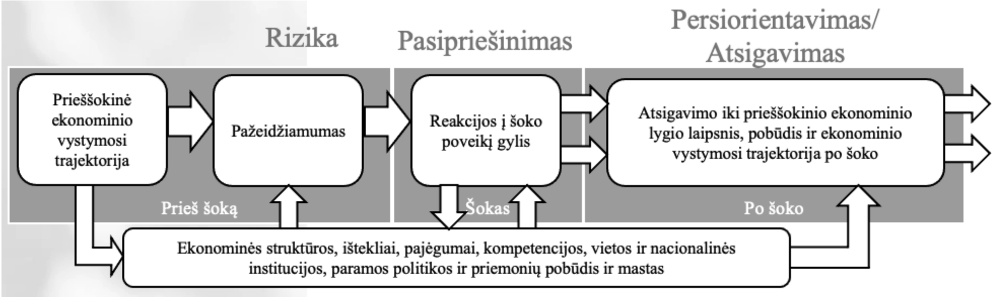
Tyrimas parodo, kad valstybės atsparumas ekonominiams šokams iš esmės yra jos gebėjimas konkuruoti tarptautinėse rinkose, nepaisant ekonominio šoko ar bet kokių kitų pasaulio ekonomikos sutrikimų šaltinio pobūdžio. Pagrindinis konkurencingumo veiksnys yra žmogiškos elgesio savybės, kurios išnaudojamos tam, kad šalyse veikiantys ūkio subjektai užsitikrintų geresnes pozicijas tarptautinėje prekyboje. Žlungančius ar bankrutuojančius ūkio subjektus ar ekonomines sistemas sutrikusiose vertės grandinėse pakeičia jų konkurentai.

Valstybių tarpusavio palyginimui pagal jų atsparumą ekonominiams šokams, šiame tyrime taikomas Martin ir Gardiner (2019) metodas ekonominių sistemų santykiniam atsparumui vertinti.

Pramonės struktūros pokyčiai matuojami per tarpinio vartojimo apimties pokyčius, taip atspindint tiek kokybinę, tiek kiekybinę ekonomikos sistemų puses.

Tarpinis vartojimas šiame tyrime yra bendra valstybės vidaus ir užsienio produktų sąnaudų vertė, atspindėta tarptautinių sąnaudų ir produkcijos lentelių *produktas x produktas* pjūviu (OECD, 2023). Nacionalinėse sąskaitose bei sąnaudų ir produkcijos lentelių struktūroje vartojamas terminas „produkcija“ – tai bendra šalies produktų suma, sukurta per ataskaitinį laikotarpį (Eurostatas, 2013).

Atsparumo ekonominiams šokams procesas Martin ir Sunley (2015) analizėje yra suskirstytas į keturis nuoseklius (ir pasikartojančius) etapus regioniniu lygiu. 31 pav. pateikta adaptuota atsparumo ekonominiams šokams proceso schema, atsižvelgiant į šio tyrimo metu atliktos teorinės analizės rezultatus.



31 pav. Atsparumo proceso schema (pritaikyta iš Martin ir Sunley, 2015; autoriaus patikslintos sąvokos ir schemos struktūra)

Atlikus mokslinės literatūros analizę ir sumodeliavus siūlomą valstybių atsparumo ekonominiams šokams vertinimo metodiką, šiame tyrime vartojamos šios sąvokos:

- *Rizika* – stadija prieš ekonominį šoką, vertinama, kiek valstybės subjektai ar institucijos yra pažeidžiami.

- *Ekonominis šokas* apibūdinamas kaip išorinis ar vidinis gamtinis, ekonominis ar kitas įvykis, turintis įtakos valstybių tarpinio vartojimo vertės dydžiui. Ekonominis šokas atitinkamai gali būti įvardytas kaip staigaus ir ženklaus valstybės tarpinio vartojimo vertės kritimo procesas, nulemtas vidinių ar išorinių įvykių, kurie sutrikdė vertės grandines tarptautinėje prekyboje.

- *Recesija*, kaip pasiūlė Martin (2012), yra ekonominio šoko forma, tai netikėtas ir nenuspėjamas įvykis, sutrikdantis normalią ekonomikos augimo trajektoriją.

- *Atsparumas*, remiantis Simmie ir Martin (2010), laikomas vietinės socialinės ir ekonominės sistemos gebėjimu atsigauti po ekonominio šoko ar sutrikimo. *Atsparumo* sąvoka, remiantis Martin ir kt. (2016), vartojama siekiant įtvirtinti, kaip subjektas ar sistema reaguoja į ekonominį šoką ir atsigauna po jo. Ši koncepcija tyrime suprantama kaip procesas, vadovaujantis Simmie ir Martin (2010), Martin (2012), Béné ir kt. (2014), kurį sudaro šie kiekybiniai aspektai, nustatyti Martin ir kt. (2016), Martin ir Gardiner (2019) tyrimuose, o šiame tyrime išreikšti tarpinio vartojimo vertės svyravimais valstybių ekonomikose:

- Tyrime pasiūlyta nauja *pasipriešinimo* sąvoka, apibrėžiama pramonės struktūros aspektu. Pasipriešinimas – nacionalinės pramonės reakcijos į ekonominio šoko poveikį gylis, priklausantis nuo šoko masto, pobūdžio ir trukmės.
- Tyrime pasiūlyta nauja *atsigavimo* sąvoka, apibrėžiama pramonės struktūros aspektu. Atsigavimas – valstybės vystymosi trajektorija po ekonominio šoko, nurodanti šalies pramonės šakų atsigavimo laipsnį ir pobūdį iki ekonominio lygio, buvusio prieš šoką. Integruota Martin ir Gardiner (2019) atsigavimo trajektorijų sistema, adaptuota šiame tyrime (žr. 32 pav.), leidžia nagrinėti atsigavimo trajektorijas (tempus) tiek ekvilibriumo, tiek ekologinio atsparumo modeliuose.
- Tyrime pasiūlyta nauja *persiorientavimo* sąvoka, apibrėžiama pramonės struktūros aspektu. Persiorientavimas – nacionalinių pramonės šakų gebėjimas

persiorientuoti arba prisitaikyti, siekiant atnaujinti pagrindines ekonomines funkcijas ir veiklos rezultatus. Perorientavimas laikomas lygiagrečiu atsigavimui procesu (31 pav.). Remiantis Martin (2012), persiorientavimas vyksta tada, kai didelis šokas sukelia arba paspartina jau esamus nacionalinės ekonomikos struktūrinius pokyčius.

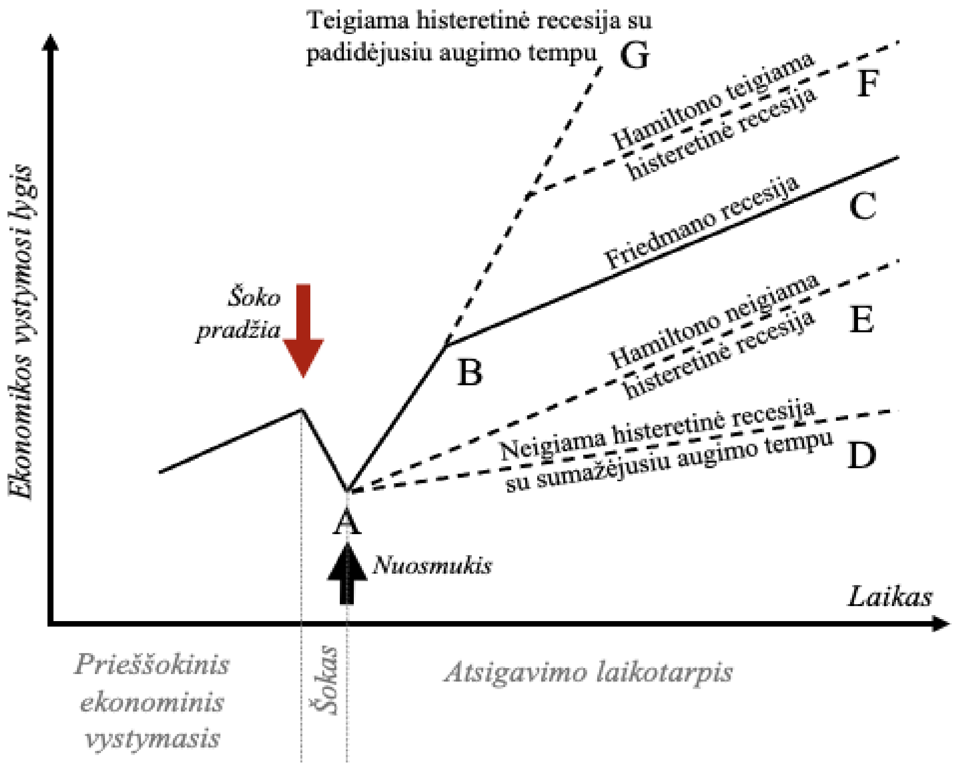
- Tyrime pasiūlyta nauja *santykinio atsparumo* sąvoka, apibrėžiama pramonės struktūros aspektu. Santykinis atsparumas – nacionalinių pramonės šakų ekonominiai rodikliai, lyginami su pasaulio ekonomikos rezultatais, stebimais pasaulinių ekonominių šokų ir atsigavimo laikotarpiais. Vadovaujantis Martin ir Gardiner (2019) logika, kai valstybės lyginamos tarpusavyje esant dideliam pasauliniam ekonominiam šokui, logiškas kontrafaktinis lūkestis yra tas, kad kiekviena šalis, prisidedanti prie pasaulio ekonomikos rezultatų, turėtų reaguoti taip pat kaip ir pati pasaulio ekonomika. Taigi lyginant valstybes pagal Martin ir Gardiner (2019) santykinio atsparumo koncepciją, pašalinama būtinybė vertinti regionų atsparumo ar atsigavimo trukmę, nes šokų ir atsigavimo laikotarpių trukmė vertinama visos pasaulinės ekonomikos lygmeniu.

- Tyrime pasiūlyta nauja *konkurencingumo* sąvoka, apibrėžiama pramonės struktūros aspektu. Konkurencingumas – valstybės ar jos pramonės gebėjimas konkuruoti prekiaujant savo produkcija su kitomis šalimis ar pramonės šakomis tarptautinėje rinkoje.

- *Pramonės struktūra* (angl. *industrial portfolio*) šiame tyrime vartojama Conroy (1975) ir Martin ir kt. (2016) kaip apibendrinta sąvoka, apibūdinanti tam tikrą pramonės šakų derinį ir jų tarpusavio ryšius, galinčius turėti įtakos ekonomikos reakcijai į ekonominius šokus.

- *Struktūriniai pokyčiai* (Lewis et al., 2021) – išlaidų prekėms ir paslaugoms kaip visų išlaidų dalies pokytis laikui bėgant, atsižvelgiant į ekonominio atsparumo proceso perorientavimo dimensiją (Martin et al., 2016), galėtų būti išreikštas konkurencingumu (Pike et al., 2006).

Tačiau moksliniuose tyrimuose atsparumas paprastai vertinamas pagal dvi pagrindines charakteristikas: pasipriešinimą ir atsigavimą (Martin et al., 2016; Martin & Gardiner, 2019; Martini, 2020; Oprea et al., 2020; Hundt & Grün, 2022) ir visuotinai suprantamas kaip gebėjimas atsigauti po šoko arba grįžti į lygį iki jo. Taigi šiame tyrime pagrindinis dėmesys skiriamas šalių ekonominiam atsparumui šoko ir atsigavimo laikotarpiais. Ekonominio vystymosi ciklas atitinkamai vertinamas nuo šoko pradžios (32 pav.) iki atsigavimo po šoko pabaigos (Martin et al., 2016; Martin & Gardiner, 2019).



32 pav. Atsigavimo trajektorijų sistema (pritaikyta iš Martin ir Gardiner, 2019; autoriaus patikslintos sąvokos ir schemos struktūra)

32 pav. atvaizduota adaptuota Martin ir Gardiner (2019) ekonominės plėtros integruota sistema, apimanti ekonominių šokų sukeltus ekonomikos nuosmukius ir atsigavimo trajektorijas valstybių atsparumo proceso kontekste:

- Atsigavimo trajektorija A–B–C yra Friedmano (1988 m.) modelis, kai ekonomika atsigauna po šoko ir tęsia ekonominį augimą tokiu pat tempu kaip anksčiau.

- Atsigavimo trajektorijos A–E ir A–F yra atitinkamai neigiamos ir teigiamos histeretinės Hamiltono (1989) recesijos, kai ekonomika atsigauna į žemesnį arba aukštesnį (atitinkamai) augimo lygį, bet išlaiko tokį patį augimo tempą kaip ir etape iki šoko.

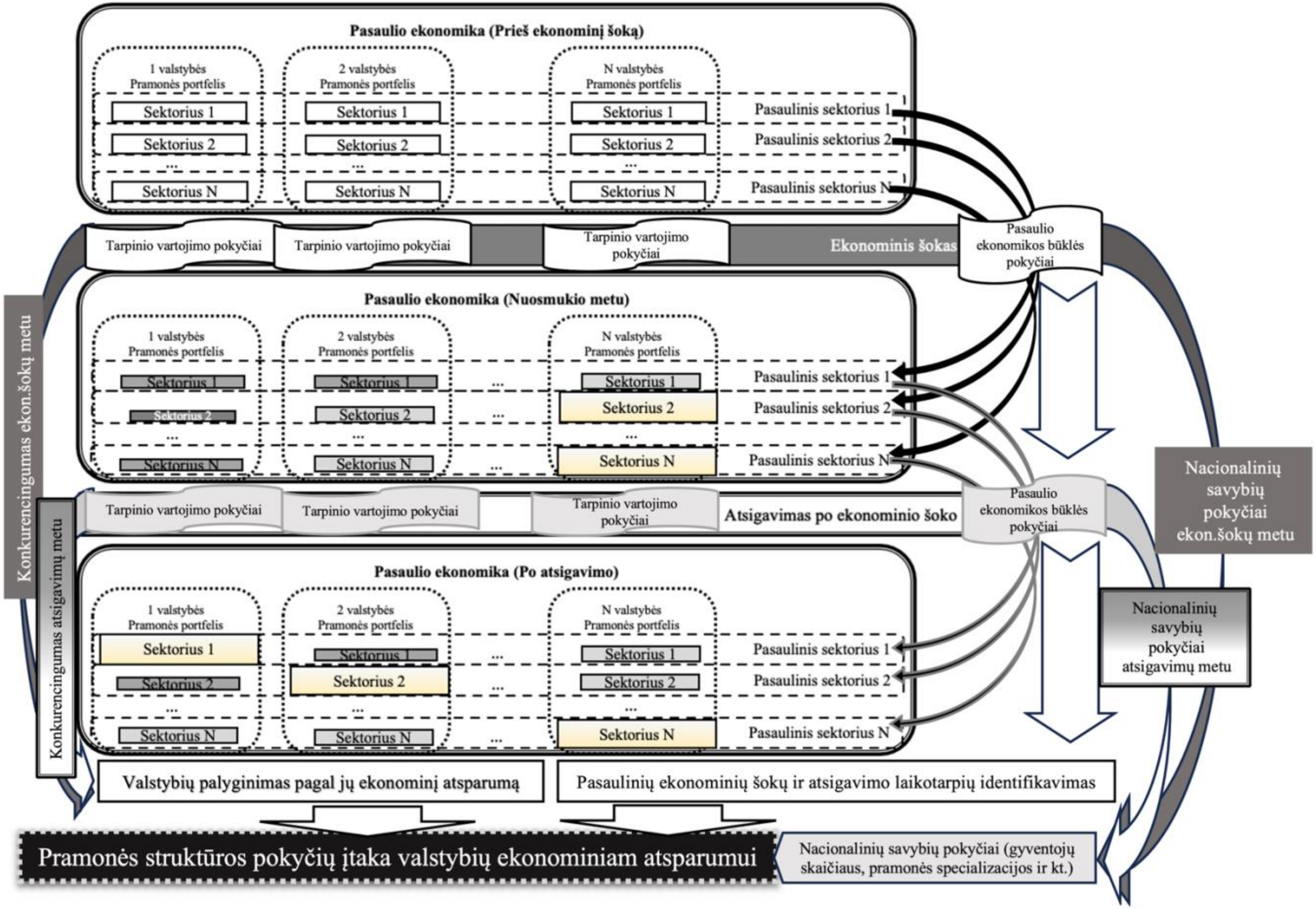
- Teigiama ir neigiama histeretinė recesija (Simmie & Martin, 2010; Martin & Gardiner, 2019) atitinkamai padidina (A–G) arba sumažina (A–D) augimo tempą po šoko ir tęsia ekonomikos augimą nauja trajektorija.

Šios sąvokos vartojamos kuriant metodą ir konceptualų modelį, skirtą įvertinti pramonės struktūros pokyčių poveikiui, daromam valstybių ekonomikų atsparumui.

Valstybių atsparumo ekonominiams šokams matavimo modelio pagal Martin ir Gardiner (2019) santykinio atsparumo vertinimo metodą rezultatai prilyginti valstybių konkurencingumo matavimo modelio rezultatams. Atlikus dviejų šių modelių rezultatų koreliacinę analizę, nustatyta, kad santykinio atsparumo ir konkurencingumo rezultatai tarpusavyje tiesiogiai koreliuoja (Kembridžo žodynas) pasaulinės ekonomikos būklės koeficientu, kuris kinta laikui einant, bet yra vienodas visose valstybėse.

Tiesioginė koreliacija tarp atitinkamų atsparumo ir konkurencingumo rodo, kad valstybių palyginimo rezultatai tiek vienu, tiek kitu būdu gaunami tokie patys ir kad abu modeliai yra tinkami valstybėms vertinti pagal jų atsparumą ekonominiams šokams. Tačiau abiem atvejais svarbu atsižvelgti į laiko parametrus. Taip yra todėl, kad valstybių atsparumo matavimo modelis tiesiogiai į tyrimą įtraukia pasaulinės ekonomikos rodiklius konkrečiu laikotarpiu, o valstybių konkurencingumo modelis pasaulinės ekonomikos būklę įvertina netiesiogiai. Galiausiai valstybių konkurencingumo modelis leidžia paprasčiau palyginti šalis pagal tai, kaip jos pasipriešino ekonominių šokų metu ir atsigavo po jų. Konkurencingumas gali būti vertinamas atsižvelgiant į tarpinio vartojimo vertės pokyčius nacionaliniu lygmeniu, neatsižvelgiant į tarpregioninius, tarptautinius ar pasaulinius ekonominius rodiklius. Priežastis ta, kad valstybių konkurencingumo modelis išskiria „konkurencingumą“ – esminę santykinio atsparumo matavimo modelio savybę ir nevertina pasaulinės ekonomikos būklės. Pasaulinės ekonomikos būklės rodiklis rodo, kad jis turi tą pačią reikšmę bet kuriai šaliai duomenų bazėje tam tikru laikotarpiu.

Galiausiai, lyginant šalis pagal jų atsparumą, šis tyrimas rodo, kad pakanka apskaičiuoti tų šalių konkurencingumą ekonominių šokų metu ir konkurencingumą vėlesnio atsigavimo metu ir rezultatai parodys tų šalių santykinio atsparumo būklę pasirinktose šalyse. Šiame tyrime valstybių konkurencingumas atitinkamai vertinamas kaip įrankis, leidžiantis palyginti šalis pagal jų atsparumą. Aprašytomis prielaidomis ir mokslinės literatūros bei statistinės analizės rezultatais pagrįsta valstybių atsparumo ekonominiams šokams vertinimo metodika parengta siekiant išmatuoti tarpinio vartojimo pokyčius valstybių pramonės šakose, kurie parodo šalių gebėjimą konkuruoti tarptautinėse rinkose įvairiuose vertės grandinių segmentuose. Koncepcinis tyrimo modelis pateiktas 33 pav.



33 pav. Koncepcinis tyrimo modelis

Koncepcinis tyrimo modelis susideda iš šių etapų:

1. **Rinkos ekonominės būklės nustatymas.** Rinkos ekonominei būklei nustatyti vertinama, kiek sklandžiai veikia pasaulinės vertės grandinės atskirais laikotarpiais:
   a. Ekonominių šokų laikotarpiams nustatyti naudojamos metinės visų vertinamų pasaulio valstybių tarpinio vartojimo vertės atskirų pramonės šakų konkurencingumui nustatyti pagal (13) formulę:

$$COI_{gi}^{\Delta y} = \sum_{c=1}^{77} \left(\frac{\Delta IC_{ci}^{\Delta y}}{IC_{ci}^{y-x}} \right), \tag{13}$$

čia:

c – vertinamoji valstybė;

i – vertinamoji pramonės šaka;

Δy – vertinamasis ekonominio šoko arba atsigavimo laikotarpis, kuris prasidėjo ($y - x$) metais ir baigėsi *y* metais;

$\Delta IC_{ci}^{\Delta y}$ – tarpinio vartojimo vertės pokytis vertinamosios valstybės pramonės šakoje vertinamuoju laikotarpiu;

IC_{ci}^{y-x} – tarpinio vartojimo vertė vertinamosios valstybės pramonės šakoje ($y - x$) metais;

$COI_{gi}^{\Delta y}$ – pasaulio pramonės šakos konkurencingumas vertinamuoju laikotarpiu.

   b. Atsigavimo laikotarpių pabaigai nustatyti, atliekamas suminių tarpinio vartojimo verčių pokyčių empirinis vertinimas. Atsigavimas po ekonominio šoko pasibaigia tuomet, kai bendra pasaulinė tarpinio vartojimo vertė pasiekia prieš ekonominį šoką buvusį lygį.

2. **Valstybių palyginimas pagal jų ekonominė atsparumą**. Kiekvienai vertinamai valstybei taikomos tarpinio vartojimo vertės iš tarptautinėse sąnaudų ir produkcijos lentelėse esančio 77 valstybių sąrašo. Vertinamų valstybių konkurencingumo rezultatai skaičiuojami pagal (11) formulę:

$$CO_{c}^{\Delta y} = \frac{\Delta IC_{c}^{\Delta y}}{IC_{c}^{y-x}}. \tag{11}$$

čia:

c – vertinamoji valstybė;

Δy – vertinamasis ekonominio šoko arba atsigavimo laikotarpis, kuris prasidėjo ($y - x$) metais ir baigėsi *y* metais;

$\Delta IC_{c}^{\Delta y}$ – tarpinio vartojimo vertės pokytis vertinamojoje valstybėje vertinamuoju laikotarpiu;

IC_c^{y-x} – tarpinio vartojimo vertė vertinamojoje valstybėje *(y – x)* metais;
$CO_c^{\Delta y}$ – vertinamosios valstybės konkurencingumas vertinamuoju laikotarpiu.

Vadovaujantis šioje disertacijoje pateikta metodika, valstybės pagal atsparumą ekonominiams šokams gali būti palyginamos vertinant jų konkurencingumą. Taigi valstybės atsparumas ekonominio šoko metu ir po jo atitinkamai gali būti įvertintas pagal jos konkurencingumą $CO_c^{\Delta y}$ ekonominio šoko metu (atitinka pasipriešinimą) ir valstybės konkurencingumą $CO_c^{\Delta y}$ po ekonominio šoko (atitinka atsigavimą). Tokiu būdu ši priemonė leidžia palyginti visas 77 pasaulio šalis, esančias tarptautinių sąnaudų ir produkcijos lentelių duomenų bazėje, ir jų atsparumą ekonominiams šokams.

3. **Pramonės struktūros savybių identifikavimas.** Duomenų bazėje esančios tarpinio vartojimo vertės taikomos valstybių pramonės struktūros savybėms identifikuoti pagal (17) formulę:

$$IP_c^y = \sum_{i=1}^{45} S_{ci}^y = 100\%, \quad (17)$$

čia:
c – vertinamoji valstybė;
i – vertinamoji pramonės šaka;
y – vertinamieji metai;
S_{ci}^y – vertinamosios valstybės pramonės šakos tarpinio vartojimo vertės dedamoji valstybės pramonės struktūroje vertinamaisiais metais;
IP_c^y – vertinamosios valstybės pramonės struktūra vertinamaisiais metais.

Atskirų pramonės šakų indėliai sumuojami pagal bendrą valstybės pramonės struktūrą. Kiekvienos pramonės šakos indėlis atskleidžia tos pramonės šakos svarbą vertinamos valstybės pramonės struktūroje. Pramonės struktūros sandara nuolat kinta kartu su kintančiomis tarpinio vartojimo vertėmis atskirose pramonės šakose. Dideli pramonės sektoriaus indėlio pokyčiai valstybės pramonės struktūroje informuoja apie valstybėje vykstančius struktūrinius pokyčius, kuriuos gali nulemti valstybinio ar regioninio lygmens įvykiai, aktyviai aptariami mokslinėje literatūroje ir žiniasklaidos pranešimuose.
Pramonės struktūros savybės taip pat gali būti palyginamos siekiant klasterizuoti šalis. Priklausomai nuo konteksto, pramoninio portfelio savybių vertinimas taip pat gali būti atliekamas kartu nustatant nacionalinio atsparumo savybes formuojančius veiksnius.

4. **Veiksnių, formuojančių nacionalines atsparumo savybes, nustatymas.** Veiksniai, dažniausiai aptinkami mokslinėje literatūroje, naudojami šalims klasterizavimui ir OLS, fiksuotų efektų (FE) ir atsitiktinių efektų (RE) regresijose kaip nepriklausomi kintamieji, siekiant nustatyti nacionalines savybes, darančias didelį poveikį priklausomiems kintamiesiems – šalies konkurencingumui ekonominių šokų ir šalies konkurencingumui vėlesnio atsigavimo metu.

5. **Rezultatų vertinimas ir diskusija.** Šis žingsnis apima ekonometrinio modeliavimo rezultatų įvertinimą. Trūkstant patikimų ekonometrinio modeliavimo išvadų, šalys sugrupuojamos pagal tinkamiausią nacionalinio atsparumo savybę (gyventojų skaičių ar pramonės šakų specializaciją), o pramonės struktūra gali būti integruojama įtraukiant tik tas pramonės šakas, kurių indėlis į bendrą valstybės tarpinio vartojimo vertę didelis. Šis žingsnis turėtų nustatyti nacionalines savybes arba koncentruotą pramonės šakų sudėtį, kuri formuoja šalių atsparumą.

Taigi tyrimą sudaro penki žingsniai: 1) rinkos ekonominės būklės (pasaulinių vertės grandinių ekonominės būklės) matavimas – ekonominių šokų pasireiškimo laikotarpių ir vėlesnio atsigavimo po jų nustatymas; 2) valstybių konkurencingumo ekonominių šokų ir atsigavimo metu įvertinimas; 3) valstybių pramonės struktūros savybių identifikavimas; 4) šalių grupavimas bei OLS, FE ir RE ekonometrinis modeliavimas, siekiant nustatyti reikšmingą poveikį valstybių konkurencingumui; 5) rezultatų įvertinimas ir diskusija.

Tyrimo pritaikomumas.

Konkurencingumas – pagrindinė santykinio atsparumo matavimo modelio savybė, kurią galima išskirti iš pasaulinės ekonomikos veiklos rezultatų. Todėl šalių atsparumui ekonominiams šokams palyginti galima naudoti jų konkurencingumo statistinius duomenis ekonominių šokų metu ir per ekonominio atsistatymo laikotarpius. Tai smarkiai sumažina atsparumo ekonominiams šokams klausimo sudėtingumą, nes mokslinėje literatūroje yra daug įvairių konkurencingumo didinimo metodų, pritaikytų organizacijoms.

Siūloma metodika galėtų būti plačiai taikoma valdžios institucijų sprendimų priėmimo procesuose.

Tyrimo apribojimai ir galimos būsimų tyrimų kryptys.

Šiame tyrime siūloma metodika turi keletą apribojimų.

Pirma, EBPO tarptautinių sąnaudų ir produkcijos lentelių statistika, kai buvo baigta ši disertacija, buvo prieinama tik 1995–2020 m. laikotarpiu. EBPO paskelbus atnaujintus duomenų rinkinius, bus galima vertinti vėlesnius pasaulinės ekonomikos veiklos laikotarpius. Taip pat vėlesniuose tyrimuose galima išmatuoti dominančių šalių konkurencingumą naudojant tų šalių nacionalines sąskaitas tiesiogiai iš viešai prieinamų atitinkamų nacionalinių institucijų, atsakingų už oficialių statistinių duomenų skelbimą, šaltinių.

Antra, šiame tyrime siūloma metodika ignoruoja kokybinius nacionalinio atsparumo rodiklius. Atsparumo matavimo metodų ir modelių analizė išryškino kokybinių rodiklių įtraukimo į vertinimą svarbą, nes jie labai prisideda prie ekonomikos plėtros ir tvarumo. Vertinant ekonomines sistemas vietos (bendruomenės ar miesto) lygmeniu, išties svarbu suprasti tokius kokybinius rodiklius kaip oro kokybė, biologinė įvairovė, teisinės paslaugos, sveikatos apsauga, sociokultūrinis kapitalas ir kt. Literatūros analizė parodė, kad tokie rodikliai prieinami vietos lygmeniu ir gali būti sunku palyginti kelis regionus ar šalis, nes aplinkos sąlygos skirtinguose regionuose gali labai kontrastuoti. Kita vertus, siūlomoje metodikoje naudojami nacionalinių sąskaitų duomenų rinkiniai, apimantys nagrinėjamų šalių ūkio subjektų metinių ataskaitų rezultatus. Ūkio subjektų metinėse ataskaitose, pateikiant mokesčių administratoriui, kaupiami jų metiniai finansiniai rezultatai, pasiekti didelėmis pastangomis, išnaudojant galimybes, turimus išteklius, vietinės aplinkos privalumus finansiniams rezultatams gauti. Socialinės, teisinės ar kitokio pobūdžio aplinkos pasikeitimas gali atitinkamai paveikti įmonių finansinius rezultatus. Tai reiškia, kad vietinės aplinkos kokybinės savybės netiesiogiai įtraukiamos į subjektų metines finansines ataskaitas, kurios savo ruožtu kaupiasi nacionalinėse sąskaitose. Todėl tarpvalstybinės sąnaudų ir produkcijos lentelės apima ir netiesiogiai parodo visas šalių kokybines savybes kaip tarpinio vartojimo vertės svyravimus jų pramonės šakose. Iš tiesų ši metodika neskiria ekonominius šokus sukeliančių ekonominių nuosmukių tipų. Tačiau atliekant šį tyrimą buvo nustatyta tiesioginė santykinio atsparumo ir konkurencingumo rodiklių koreliacija ir daroma išvada, kad santykinis atsparumas gali būti matuojamas konkurencingumu. Konkurencingumas – savybė, apimanti kokybinius ekonominės veiklos veiksnius. Šiame tyrime galiausiai nagrinėjami kokybiniai vietinės aplinkos veiksniai, netiesiogiai įtraukiami į tarpinio vartojimo vertės svyravimus.

Trečia, *konkurencingumo* sąvoka yra labai plati mokslinėje literatūroje. Tačiau organizacijų atsparumo ekonominiams šokams tyrimuose ji yra glaudžiai susijusi su atsparumu. Šis tyrimas susiaurina *konkurencingumo* sąvoką iki statistinį proporcinių tarpinio vartojimo pokyčių rezultatą apibūdinančios sąvokos pramonės, šalies ar pasauliniu lygmeniu. Šis supratimas kyla iš holistinio požiūrio, kai tarpinio vartojimo pokyčiai nacionalinėse sąskaitose atspindi bendras kapitalizuotas vietos subjektų pastangas maksimaliai padidinti savo įplaukas (pajamas, pelną), išnaudojant visus įmanomus pranašumus, konkuruojant su kitais subjektais vietinėje ar tarptautinėje rinkoje. Šis supratimas atitinka konkurencingumo apibrėžimą, vartojamą ES teisėje. Čia konkurencinga ekonomika yra tokia, kurios tvarus našumo lygis gali paskatinti augimą ir atitinkamai pajamas bei gerovę (EUR-Lex, EU). Vėlesniuose tyrimuose tikslinga palyginti šiame tyrime vartojamos *konkurencingumo* sąvoką su mokslinėje literatūroje vartojamomis *konkurencingumo* sąvokomis. Toks palyginimas atskleistų šiame tyrime taikomą konkurencingumo aprėptį.

Ketvirta, diskutuotinas klausimas, ar šalys, kurios skiriasi dydžiu, gali būti lyginamos viena su kita pagal jų atsparumą. Pirmaujančių pasaulio šalių ekonomikų, tokių kaip Vokietijos ar Prancūzijos, pramonės struktūros skiriasi kaip ir kelių mažų šalių, tokių kaip Estija ar Slovėnija. Siūlomoje metodikoje visų šių šalių atsparumas matuojamas pagal jų pačių proporcingus tarpinio vartojimo vertės pokyčius. Taigi vieno procento tarpinio vartojimo vertės pokyčio dalis Prancūzijoje ar Vokietijoje gali būti didesnė nei visos Estijos ar Slovėnijos ekonomikos tarpinio vartojimo vertė. Šiame tyrime buvo tikrinama prielaida, kad didžiosios ekonomikos elgiasi kitaip nei mažosios, nes yra labiau savarankiškos, taigi mažiau priklausomos nuo išorės poveikio, nes jų pramonės struktūra subalansuotai veikia visuose tiekimo grandinių segmentuose. Mažos ekonomikos yra tokios, kurios tam tikrose pramonės šakose veikia kaip papildančios arba efektyvinančios tiekimo grandines. Ši prielaida ekonometriniame šio darbo tyrime nepasiteisino, nes mažųjų ir didžiųjų ES valstybių elgsena buvo panaši pagal pramonės specializacijos ir gyventojų skaičiaus pokyčių koreliaciją su šių šalių konkurencingumu. Šiuo atveju arba mažos ES ekonomikos funkcionuoja savarankiškai, arba didžiosios ES šalys labai priklauso nuo savo pasaulinių partnerių ekonominių rezultatų. Šiuos klausimus būtų galima tirti būsimuose tyrimuose, taikant šioje disertacijoje pristatytą metodiką.

Galiausiai šis tyrimas apsiriboja ES šalimis. Kyla klausimas, kurioje vietoje atsiduria ES valstybės konkurencijoje su likusio pasaulio šalimis. Tolesnis tyrimas šiuo klausimu gali padėti nustatyti ES šalių lyginamuosius pranašumus pasaulinėje rinkoje ir kartu tolesniais šios krypties tyrimais galima būtų siekti nustatyti optimalią ES šalies pramonės struktūrą, leidžiančią ekonomikai išlaikyti stabilias pozicijas arba ją pagerinti pasaulinėje prekyboje.

Tyrimo rezultatai atveria plačių galimybių tolesniems moksliniams tyrimams atlikti nagrinėjant valstybių atsparumą ekonominiams šokams. Tiesioginės santykinio atsparumo ir konkurencingumo sąsajos įrodymas perkelia diskusiją apie šalių atsparumą link veiksnių, gerinančių ekonomikų konkurencingumą įmonių ar organizacijų kontekste. Tai labai sumažina atsparumo klausimo sudėtingumą, nes mokslinėje literatūroje yra daug įvairių konkurencingumo didinimo metodų organizacijų lygmeniu.

Tyrimo rezultatai.

Taikant sukurtą metodiką, ES šalys palygintos tarpusavyje pagal jų atsparumą ES įvykusių ekonominių šokų metu. Iškeltos hipotezės buvo iš dalies patvirtintos statistinės analizės rezultatais:

H1: Žmogiškųjų išteklių pasiskirstymas ES šalyse, prieš prasidedant ekonominiams šokams, reikšmingai veikia jų ekonominę raidą šokų ir atsigavimo metu – patvirtinta grupei valstybių, kurios geriau priešinasi ir atsigauna po ekonominių šokų su labiau diversifikuota pramonės struktūra. Galimos reikšmingos įtakos tendencija buvo atskleista šalims, kurios geriau priešinasi ir atsigauna po ekonominių šokų su labiau specializuota pramonės struktūra. Ši įžvalga reikalauja tolesnių tyrimų su didesne panašių valstybių apimtimi.

H2: Žmogiškųjų išteklių pasiskirstymo pokyčiai ES šalyse ekonominių šokų ir atsigavimo metu reikšmingai veikia jų ekonominę raidą šokų ir atsigavimo metu – patvirtinta grupei valstybių su nuolat diversifikuota pramonės struktūra ir grupei valstybių, kurios geriau priešinasi ir atsigauna po ekonominių šokų su labiau diversifikuota pramonės struktūra. Galimos reikšmingos įtakos tendencija buvo atskleista šalims, kurios geriau priešinasi ir atsigauna po ekonominių šokų su labiau specializuota pramonės struktūra. Tačiau tai reikalauja tolesnių tyrimų su didesne panašių valstybių apimtimi.

H3: Žmogiškųjų išteklių prieinamumo pokyčiai ES šalyse ekonominių šokų ir atsigavimo metu reikšmingai veikia jų ekonominę raidą šokų ir atsigavimo metu – patvirtinta atsigavimo laikotarpių metu valstybėse, kurios keitė savo pramonės struktūrą, ją labiau specializuodamos arba diversifikuodamos. Šis rezultatas skatina tolesnius nuodugnius tyrimus, įtraukiant daugiau veiksnių, lemiančių žmogiškųjų išteklių migraciją ES šalyse.

Tyrimo išvados.

1. Literatūros analizė atskleidė atsparumo ekonominiams šokams ir pramonės struktūros pokyčių sąsajas ir tai leido nuodugniau išanalizuoti ekonominių šokų poveikį ekonominei valstybių raidai. Mokslinėje literatūroje atskleidžiamas cikliškas priežastinis ryšys tarp ekonominių šokų ir vidinių bei išorinių ekonominės raidos įvykių, kur išoriniai veiksniai yra svarbūs valstybių atsparumą ekonominiams šokams lemiantys elementai. Valstybių veiksmai, siekiant sumažinti neigiamas ekonominių šokų pasekmes, mokslinėje literatūroje aprašomi analizuojant pramonės struktūros pertvarkymus (perorientuojant). Tačiau šie veiksmai gali tapti vėlesnių ekonominių šokų priežastimi. Sparčios globalizacijos laikais ekonominės sistemos yra atviros, todėl jos yra veikiamos išorinių veiksnių, kylančių iš būtinybės dalyvauti prekyboje su kitomis ekonominėmis sistemomis. Šie išoriniai veiksniai iškraipo nagrinėjamų sistemų ekonominės raidos cikliškumą. Todėl atliekant ankstesnius ekonominio atsparumo tyrimus gaunami skirtingi rezultatai. Tačiau išorinių veiksnių poveikis gali būti įtrauktas į uždaros (pasaulinės) ekonominės sistemos atsparumo ekonominiams šokams vertinimą.

2. Tyrime atliktas atsparumo ekonominiams šokams metodų ir jų modelių vertinimas leido išsamiai išnagrinėti naudojamų modelių sandarą. Modelių ir juose naudotų rodiklių analizė atskleidžia šiuos pagrindinius aspektus, į kuriuos reikia atsižvelgti vertinant atsparumą nacionaliniu lygmeniu:
   a) Stipri tarpusavio priklausomybė tarp aplinkos ir ekonomikos mokslo krypčių skatina ieškoti bendrų atsparumo ekonominiams šokams vertinimo sprendimų.
   b) Dauguma modelių yra pagrįsti sudėtingu atsparumo ekonominiams šokams vertinimu, o Martin ir kt. (2016), Martin ir Gardiner (2019) pateiktu universalesniu ir paprastesniais skaičiavimais atliekamo santykinio atsparumo ekonominiams šokams vertinimo modeliu gaunami rezultatai, panašūs į sudėtingų modelių gaunamus rezultatus.
   c) Tarpinis vartojimas yra jautresnis ekonominiams šokams nei ankstesniuose atsparumo ekonominiams šokams tyrimuose naudoti pagrindiniai rodikliai (produkcija ar BVP). Todėl tarpinis vartojimas kaip rodiklis yra patrauklesnis atsparumui ekonominiams šokams vertinti. Tarpinio vartojimo rodiklis taip pat galėtų pakeisti užimtumo kintamuosius atsparumo ekonominiams šokams matavimo modeliuose Adamo Smitho užimtumu pagrįstos vertės teorijos kontekste.

3. Atsižvelgiant į šiuo metu visuotinai keliamą tikslą užtikrinti tvarų pasaulinės visuomenės vystymąsi, įskaitant ekonominius, socialinius ir aplinkosaugos aspektus, didžiulis išorinių veiksnių vaidmuo atvirus ekonominius santykius palaikančių valstybių raidoje tampa iššūkiu vertinant jų atsparumą ekonominiams šokams. Holistinė perspektyva leidžia daryti prielaidą, kad pasaulio ekonomikoje visi kiti regionai su savo verslo ciklais yra vidiniai, o

sudėtinga ir daugialypė žmonių elgsena atitinka Adamo Smitho ir daugelio kitų ekonomistų teorijas. Be to, šiandienis statistinių duomenų detalumo lygis tarptautinėse sąnaudų ir produkcijos lentelėse leidžia atlikti pasaulio pramonės struktūros vertinimą naudojant mikroekonominio tikslumo statistinius duomenis, kurie yra sustandartizuoti ir periodiškai atnaujinami iš nacionalinių sąskaitų.

4. Tyrimo metu sukurta metodika, kuri leidžia įvertinti valstybes pagal jų atsparumą ekonominiams šokams, nagrinėjant tų valstybių pramonės struktūrą. Siekiant kuo labiau sumažinti išorinių veiksnių poveikį ekonomikos vystymosi cikliškumui, metodika taiko holistinę teoriją, laikančią pasaulio ekonomiką uždara ekonomika. Metodika paremta EBPO tarptautinių sąnaudų ir produkcijos lentelių statistika ir sukurta siekiant išmatuoti tarpinio vartojimo pokyčius nacionalinėse pramonės struktūrose. Šie pokyčiai apibrėžia valstybių galimybes konkuruoti tarptautinėje prekyboje. Taigi konkurencingumas yra pagrindinis santykinio atsparumo matavimo modelio rodiklis, kurį galima išskirti iš pasaulinės ekonomikos raidos rezultatų. Tyrimo rezultatai, gauti lyginant valstybes pagal jų konkurencingumą, atspindi rezultatus, gaunamus lyginant šias šalis pagal jų santykinį atsparumą ekonominiams šokams. Metodikos pasaulinių tarpinio vartojimo verčių dinamikos rezultatai leidžia statistiškai nustatyti ekonominių šokų ir atsigavimo laikotarpius. Taip pat tampa įmanoma statistiškai nustatyti pramonės šakas ir regionus / šalis, kuriose gamtos anomalijos, ekonominiai ar tarptautiniai politiniai įvykiai sukėlė pasaulinius arba regioninius ekonominius šokus.

5. Nors mokslinėje literatūroje pateikiami argumentai už pramonės specializaciją arba prieš ją kaip tokią, šiame tyrime pabrėžiama, kad labai svarbų vaidmenį atlieka sprendimų dėl fiskalinės ir monetarinės politikos priėmimo savalaikiškumas, pertvarkant valstybių pramonės struktūras į labiau diversifikuotas arba labiau specializuotas. Dauguma ES šalių geriau priešinasi ekonominiams šokams ir atsigauna, jei prieš ekonominius šokus jų pramonės struktūra labiau diversifikuota, o ekonominių šokų ir atsigavimo po jų laikotarpiu valstybės pertvarko savo pramonės struktūrą specializacijos link. Tyrimo metu atskleista tendencija, kad kai kurios mažos ir vidutinės ES ekonomikos, atvirkščiai, yra linkusios efektyviau priešintis ir atsigauti, kai prieš ekonominius šokus jų pramonės struktūra yra labiau specializuota. Be to, šioms valstybėms padeda efektyviau atsigauti po ekonominių šokų augantis gyventojų skaičius. Rezultatai atskleidžia galimybę valstybėms nustatyti, numatyti ir nukreipti savo nacionalinę politiką į efektyvų pramonės struktūros formavimą prieš prasidedant ekonominiams šokams. Tai sukurtų galimybes efektyviau pasipriešinti neigiamiems būsimų ekonominių šokų padariniams.
   Tyrimo rezultatai perteikia tikrą situaciją, kuri rodo, kad ekonomikoje optimali yra lanksti pramonės struktūra, galinti greitai prisitaikyti prie nuolat kintančios ekonominės aplinkos.

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2001 – 2005 Bachelor's degree: International relations, economics field of study at Birmingham – Southern College (Alabama, United States of America)

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2020 – now Director at MB Amenteris (*High-level economic modelling and prioritisation of investments for public entities in transport and energy sectors; Consultancy to suppliers and public entities in public procurements of transport and energy sectors; Preparation of EU funding applications and feasibility studies; Participation in Research and Innovation (R&I) projects*)

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LIST OF SCIENTIFIC PAPERS AND SCIENTIFIC CONFERENCES

Scientific papers related to the topic of dissertation:

1. Montrimas, A., Bruneckienė, J., Navickas, V., & Martinkienė, J. (2024). Measuring national economic resilience through industrial portfolios. *Journal of International Studies, 17(1)*, 124-154. doi:10.14254/2071-8330.2024/17-1/8
2. Montrimas, A., Bruneckiene, J., & Giziene, V. (2023). Measuring economic resilience through industrial portfolio: the cases of new EU member states since 2004. *Engineering economics, 34*(5), 593-611. doi:10.5755/j01.ee.34.5.35515
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1. Montrimas, A. (2023). Methodological approach for measuring resilience through industrial composition. In *18th prof. Vladas Gronskas International Scientific Conference Abstract Book* (p. 25). Vilniaus universiteto leidykla. https://www.journals.vu.lt/proceedings/article/view/34082/32562
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ANNEX

Table 1. Industrial resilience from the national industrial portfolio point of view (adapted from Montrimas et al., 2024, with updates to structure and results by the author)

Region	Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	ARG	39	-3	10	-216	-321	-169	-10541	71	73	531	355	29	258	0	163	90	473	279	-1390	414	-1619	163	-254	-533	-207
	BRA	4504	-136	11631	-530	1348	-517	-2832	-44	12	1009	303	41	-28	-63	686	10	-702	-705	-773	-1058	-773	190	-94	-181	-708
	CHL	0	41	-435	-91	-37	-280	-930	60	74	632	305	-3	73	-73	173	17	186	-514	-1790	-24	-497	195	69	1378	-41
	COL	-254	-225	-1537	-430	5431	-284	-641	-88	33	450	271	58	52	-55	230	-2	555	1447	-644	-762	-1501	163	-33	-206	-405
Americas	PER	-202	-44	-552	-159	149	60	1099	-20	19	1448	1313	14	143	77	119	9	741	-103	-637	-379	-453	66	13	-93	-30
	CRI	-484	-70	-161	-73	-210	128	-563	-15	-47	-414	-261	-21	-27	83	172	17	588	4663	14	-333	930	-23	226	-98	100
	MEX	-592	-5	-484	-122	405	35	-737	-64	-41	-59	-185	-39	-158	-102	7	-31	29	1294	25	-103	-934	-30	-33	3	-381
	CAN	174	129	-39	47	717	47	303	18	3	451	261	-12	17	-48	128	-7	125	409	-608	-199	-334	59	-18	24	30
	USA	127	161	307	-52	75	-31	-466	-39	-29	-193	-76	-39	-50	-27	-25	-23	161	-232	1	197	130	-32	-25	-4	-34
	IRL	70	227	913	7714	-680	584	-151	72	-4	-295	182	41	-106	43	-135	-126	1832	-1081	404	-576	1314	44	163	135	1141
	ISL	313	524	-70	82	-20	-463	1179	84	25	846	-241	85	-446	-290	-13	44	-470	-405	843	78	1835	250	-22	385	-342
	GBR	181	197	246	-69	-513	13	907	4	25	14	-36	-8	-139	-86	-99	-9	82	-244	481	-215	-414	-79	20	-177	-144
	NOR	220	19	16	-32	-826	209	2220	0	-2	287	402	48	39	-56	38	5	69	1804	-537	-778	-295	5	-4	-272	-311
	SWE	410	-12	344	-95	-137	-315	728	48	20	23	235	14	152	-58	0	14	-265	-842	-396	-272	292	-7	-34	-332	124
	FIN	-19	-91	354	-61	-460	-17	2434	46	23	26	83	17	104	-20	-51	2	-460	-459	-176	-449	168	250	20	-272	206
	DNK	-20	-174	458	-25	-617	129	1444	22	6	-262	149	13	168	-34	-120	1	-447	-1347	-15	-482	590	47	12	-73	-95
	DEU	-79	-123	229	-63	-619	148	-10	44	7	20	88	16	43	-18	-131	29	-748	254	119	575	327	75	-4	-165	84
	AUT	-43	-129	234	-36	-578	122	1368	41	10	-296	476	13	213	-13	-104	54	-474	277	-181	-427	244	19	94	-103	-71
	BEL	-125	-110	187	-28	-505	103	1132	38	8	-458	-49	14	102	-26	-51	7	-622	-32	145	-618	581	-31	46	-58	-34
	FRA	-52	-133	256	-29	-584	103	717	22	1	155	58	8	54	-29	-99	-4	-572	65	234	-399	186	170	15	-242	19
	LUX	-33	89	1494	-37	226	43	1896	37	61	704	544	47	113	-92	107	-8	-341	757	-874	-179	1523	35	29	-122	105
	NLD	55	-132	359	-63	-629	65	173	34	8	75	71	16	112	-21	-80	9	-638	376	118	-146	192	105	30	-281	-40
	CHE	17	-166	281	-115	-803	67	1496	14	16	-109	101	11	161	40	7	48	-315	1684	117	-110	-117	-120	21	250	121
	PRT	-15	-87	427	-112	-400	-41	962	36	10	-132	20	14	106	-33	-106	-25	-1215	905	425	-336	424	177	34	43	148
	ESP	87	-144	509	56	-506	34	1833	54	14	360	109	26	206	-39	-231	-42	-912	-390	194	-271	475	70	34	12	-30
Europe	ITA	272	-74	118	-59	-661	25	942	28	7	-71	60	13	-69	-71	-91	-1	-897	307	54	-409	-150	131	1	-206	-52
	CYP	361	-54	1352	-42	-942	-12	41	42	12	288	312	51	46	82	-250	-45	-760	2541	768	-376	889	79	332	-208	319
	MLT	-169	-93	433	5	252	184	-163	38	0	390	971	33	289	-13	-130	7	-208	-795	829	-337	1150	156	47	708	512
	SVN	-172	-242	358	-155	-1039	-266	1298	23	19	-85	84	37	148	-43	-126	-4	-1037	-743	-21	-367	217	230	105	-239	-8
	HRV	137	85	-64	-240	-589	211	4993	64	47	-40	263	45	121	-72	-123	-5	-1006	-2065	101	-252	1475	112	46	40	93
	CZE	46	-291	-839	-206	-434	-354	3611	70	38	-309	623	37	195	-95	-68	30	-967	-33	104	-339	529	288	63	-96	-182
	EST	1570	146	-203	-162	201	121	4867	78	89	326	225	43	144	-143	-58	70	-110	768	678	-326	409	160	38	-66	-22
	LVA	-6	194	-318	121	716	261	1215	58	46	1050	1125	2859	32	-177	-79	61	-90	14272	-1042	-498	147	59	61	-16	262
	LTU	-92	178	214	-157	925	170	96334	97	90	-758	-88	127	168	-120	-112	-14	91	2238	1697	-346	899	118	27	359	369
	SVK	-437	216	-401	-376	-380	-341	1054	54	28	-405	422	116	344	-171	-129	33	-83	1240	1112	-357	377	61	68	-372	-184
	POL	90	-57	922	-285	-291	442	-104	10	14	1013	351	58	332	-154	-12	-25	-614	225	498	-259	201	143	67	10	-27
	HUN	-269	-326	11	-206	-899	281	3483	29	9	356	103	3	-129	-112	-239	-8	-1153	-194	9	-298	986	139	63	-73	-242
	GRC	-84	-242	-46	-45	-1018	-60	2337	72	26	50	428	4	142	113	-316	-39	-1101	393	-132	-405	-59	535	24	-160	-287
	BGR	-1825	-1873	3717	-53	-289	562	1340	75	60	1611	765	175	110	116	-67	67	-277	821	4103	-163	-142	213	77	-138	3
	ROU	-1011	-1307	-1810	-850	-1981	246	922	15	8	1851	809	95	1916	40	-2	49	-174	862	3755	-194	-168	316	88	16	5
	UKR	-1568	49	-543	-749	-992	516	3652	62	72	298	1679	26	193	-371	-45	15	824	-392	-3734	-1779	1087	-73	-65	656	154
	BLR	-1287	-728	-1796	-1745	-4493	-1117	-4629	-94	-10	1081	618	20	223	-169	253	-185	-2509	-2184	-1604	-1241	-1602	249	-41	36	-389
	RUS	-658	-376	-2726	-1178	1379	-67	-932	12	50	683	450	60	152	-240	140	53	212	-899	-1260	-1185	-1117	415	-28	349	-217
	TUR	-1175	-854	-2037	-929	-1965	-1671	703	-20	30	364	-337	-9	-114	-244	375	-22	298	1601	-555	-298	-572	-200	-271	-391	-434
	KAZ	-1424	-127	-1058	27	861	417	-582	11	115	1829	1842	3030	50	570	5200	91	129	1115	-98	-978	-2693	2724	-116	-540	-403
	CHN	233	309	859	117	735	638	1060	18	68	409	2241	91	85	70	76	131	1446	2023	862	327	-1112	-119	41	125	23
	HKG	7	39	235	-45	376	-615	-400	-58	-36	-27	-71	-43	-14	-67	105	-41	-219	-1885	716	114	267	-109	-26	363	-155
	TWN	76	52	-115	204	628	-438	325	-25	-12	-419	982	-33	-63	-123	206	35	-284	-680	67	-226	-197	112	-9	203	350
	KOR	4852	-96	-1589	444	799	-187	2607	-9	-9	740	-142	5	-184	-7	996	10	22	331	876	-11	-18	119	-8	-79	-110
	JPN	-280	-183	-510	191	501	-184	-767	-10	-13	-206	-678	-39	163	64	90	-38	137	-3028	-895	-268	1224	-38	-3	20	68
	LAO	-493	251	-2859	-1160	-1151	-448	-865	6	-28	519	3188	18	225	59	272	321	874	-1582	4900	-528	1144	97	29	331	-18
	MMR	-98	-291	-3580	-288	1202	-75	-3079	-187	-102	-332	-23	8	565	583	325	115	206	71	-919	-422	-307	30	75	-305	50
	BGD	38	67	-568	-135	-64	8	580	-33	-30	401	287	-19	-48	141	-33	-81	80	1954	936	511	600	168	52	322	-33
	BRN	293	39	-1551	2269	4475	-374	1414	97	38	884	975	-15	940	-402	183	553	126	-2131	-722	-366	-1484	80	137	-83	-330
	MYS	435	-41	-1191	141	416	-317	1097	2	-1	678	59	10	199	-160	234	140	-163	-520	-1059	492	119	6	73	64	-165
Asia/Oceania	IDN	2829	-115	-3509	401	371	-352	1520	15	-25	554	-297	-17	36	39	352	33	-323	-1289	-801	-299	-73	89	-68	307	-82
	PHL	16	-240	-1601	257	-387	-182	1308	-21	-10	815	756	52	294	-18	177	-9	-62	1911	240	-133	309	-91	-106	251	-43
	AUS	347	31	-442	153	-584	-224	2054	58	29	81	-59	20	-6	48	212	32	114	-2113	-304	-655	280	37	-11	-115	73
	NZL	197	8	-657	-52	-423	-212	1947	50	41	392	-233	15	3	-50	73	29	434	-228	511	-404	56	141	15	39	-23
	SGP	357	55	-579	-86	534	-86	760	0	29	884	1443	18	-186	106	220	31	170	1001	420	-124	353	-86	-12	-62	-199
	THA	36	-395	-1823	62	1002	-53	2144	32	21	751	2746	32	133	-77	263	27	351	391	-499	-275	-241	130	63	115	-189
	VNM	371	154	24	38	1096	442	767	18	112	427	161	-19	65	71	-185	-14	1481	2066	1739	520	1693	52	19	202	62
	KHM	-139	-125	-1117	-127	864	561	3119	-48	4392	127	-643	-10	-96	134	-74	5	651	825	536	94	863	136	84	538	-123
	PAK	-258	-195	-116	-142	-274	-257	1659	-1	-17	-6	165	6	-315	-18	24	-24	-521	-3046	-459	59	574	-66	-93	-874	-218
	IND	104	70	-656	-35	31	78	484	4	3	733	-25	34	6	8	107	-137	-1016	-3372	871	-269	82	129	8	49	-260
	SAU	515	128	-2067	713	2578	-91	963	57	53	772	90	-44	483	-359	309	208	39	-879	-517	-302	1106	264	193	299	-310
	JOR	-272	42	-546	-22	215	256	1808	-17	41	551	281	-2	101	159	16	13	215	2823	-24	-328	776	614	-37	363	-71
	ISR	-2	-125	-5	-127	1140	-145	-2110	-14	8	276	334	76	253	-165	128	5	34	1926	1620	-82	332	206	32	201	201
	EGY	352	1	261	178	-230	-376	-740	-115	-42	244	379	93	-50	63	-30	77	18	-3394	-190	-228	-2868	-581	-25	356	180
	MAR	237	-185	-282	-38	-116	107	1269	17	-9	-348	94	-1	151	14	-83	-4	-151	1691	4255	-342	63	26	33	69	-275
	SEN	-48	-224	4869	-262	-226	-78	1356	81	39	-152	365	12	72	121	-12	9	-198	-175	932	286	980	168	73	73	96
	CMR	-101	-205	611	46	-763	232	1104	65	17	1255	-139	46	144	29	-189	48	-226	-952	101	-399	2039	28	-60	66	481
Africa	CIV	3067	-4	602	3	-1459	122	2038	-15	-13	215	1680	-14	546	28	-19	-70	497	-582	1237	124	515	126	83	570	32
	NGA	-720	45	-632	-120	2290	-479	-1850	26	-2	-97	1732	345	-223	940	431	55	719	39405	1929	-623	-1989	-530	60	316	-958
	TUN	612	-185	-25	-4	-680	113	827	12	16	-487	19124	28	171	-35	-12	-51	5	-1189	-680	-584	-773	-258	-80	-628	-76
	ZAF	-365	-55	-515	-30	99	-465	-1542	130	57	396	-123	-28	-200	-38	302	-28	-426	-1416	-622	-313	-1291	79	-126	-349	-430
	ROW	-9	-1	-389	30	47	393	-1728	-21	-10	633	345	16	112	-42	183	91	220	-970	-551	-260	199	58	9	158	-54
	Countries total	**8764**	**-7546**	**-9203**	**750**	**1314**	**-3366**	**142527**	**1313**	**5680**	**24997**	**50178**	**7869**	**8815**	**-1096**	**9349**	**1680**	**-8524**	**53925**	**14868**	**-22177**	**7357**	**8634**	**1303**	**1589**	**-4028**
	ROW* - Rest of the world																									

Table 2. Industrial resilience from the global industry point of view (adapted from Montrimas et al., 2024, with updates to structure and results by the author)

	Industry	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
01T02	Agriculture, hunting, forestry	-476	-43	-36	-183	-10	-135	100	-8	3	-25	182	-10	-4	-92	29	-17	-165	-34	-142	-191	36	88	-30	-152	-1060
03	Fishing and aquaculture	-78	-63	0	-181	-358	62	252	19	-13	-34	294	-13	38	-431	54	10	-183	61	0	-298	109	2056	-27	-5	-104
05T06	Mining and quarrying, energy producing products	-112	-48	6	-123	-52	-19	81	-16	-23	-20	-11	6	-10	21	-23	14	-161	78	-47	6	15	3	-21	60	36
07T08	Mining and quarrying, non-energy producing products	-116	-4	0	-1169	-109	-113	162	-2	-24	-33	-26	-5	100	-53	-37	-14	-530	-17	-2	-7	102	27	-3	141	3
09	Mining support service activities	-346	-52	7	176	-57	-119	111	17	-5	-32	-20	129	93	4	-19	10	-111	688	1997	10	85	81	67	1795	23
10T12	Food products, beverages and tobacco	-96	-35	-52	-75	59	-160	554	-10	25	27	51	-14	-19	-48	104	-10	-112	-12	-94	-168	44	604	222	630	-61
13T15	Textiles, textile products, leather and footwear	-63	-87	-23	-125	-2008	38	30	-18	-8	-47	-19	-45	-83	-707	4	-5	-107	-86	-72	-893	31	48	-57	358	-717
16	Wood and products of wood and cork	16	-116	-68	-172	25	8	12	51	12	69	19	50	67	-14	2	-28	-261	-82	2	-200	56	0	-18	41	-248
17T18	Paper products and printing	2	-25	-86	-709	-96	20	112	183	54	115	25	41	57	-29	30	3	-66	1314	-79	-53	-46	27	88	-101	8
19	Coke and refined petroleum products	-87	-740	-10	-18	-23	9	54	-1	-1	22	-9	2788	1	9	-9	1	-164	226	8	2	-19	81	225	-42	32
20	Chemical and chemical products	-24	-118	-63	-1011	-78	29	177	24	21	-19	-7	2	57	-32	0	-11	-173	-195	-584	-32	43	2	36	41	-13
21	Pharmaceuticals, medicinal chemical and botanical products	306	-42	-896	108	102	-151	-39	15	39	61	81	-27	29	-618	209	150	-232	138	3237	-301	-247	149	6	568	-65
22	Rubber and plastics products	-25	-47	-82	-206	-83	55	41	60	25	44	-4	29	75	-26	2	-9	-287	180	4	-138	41	69	-37	-89	-15
23	Other non-metallic mineral products	-74	-42	-11	-244	-203	3	131	-16	22	6	145	10	-43	-84	6	11	-291	-70	-73	-479	63	42	-28	51	-104
24	Basic metals	5	-172	1	-1	-91	13	-191	5	6	-37	10	-6	-35	-19	29	-25	-672	59	-138	-74	9	38	33	-84	-10
25	Fabricated metal products	-70	-55	-94	-1365	-74	35	257	37	45	8	46	12	78	-7	17	-7	-212	-123	-103	-82	-85	250	-21	19	2
26	Computer, electronic and optical equipment	269	-111	3286	35	281	89	2521	73	3122	1	21	42	135	126	48	291	-150	-22	-97	-308	457	21	8	155	645
27	Electrical equipment	105	-72	-194	-14	405	43	1819	-10	1274	243	51	293	-76	72	87	-27	-159	-112	-126	-517	81	50	-41	122	84
28	Machinery and equipment, nec	-16	-161	-37	69	-61	87	250	32	33	-34	71	80	-15	87	36	9	252	12354	-51	-954	75	19	70	10	143
29	Motor vehicles, trailers and semi-trailers	292	-174	539	-18	-171	58	214	33	51	-42	2595	31	18	92	22	44	-49	12	-47	-5417	44	1000	350	157	96
30	Other transport equipment	216	-118	-39	61	87	98	251	87	138	-12	232	-7	11	7	105	20	58	96	-68	-346	185	172	295	49	82
31T33	Manufacturing nec; repair and installation of machinery/equipment	11	-14	-75	-166	-60	29	352	33	43	158	6	50	-15	-19	24	117	-14	167	-2029	-28	-65	164	18	75	-89
35	Electricity, gas, steam and air conditioning supply	-36	-41	-321	-100	-62	-170	108	2	18	-15	32	-11	-16	1	27	39	-107	158	-266	-37	43	11	-16	-672	-62
36T39	Water supply; sewerage, waste management and remediation	-9	-25	-4471	-42	2224	-260	-15	6	25	45	186	5	480	-17	35	-4	49	163	-109	-30	-80	15	-31	-145	-458
41T43	Construction	-111	-93	-156	22	162	32	-1	14	27	40	119	73	176	34	617	210	74	251	316	-6	30	252	34	-37	590
45T47	Wholesale and retail trade; repair of motor vehicles	-52	-87	-96	-138	-80	10	58	21	10	44	125	47	15	-9	12	-23	-242	347	337	-43	22	43	0	46	-71
49	Land transport and transport via pipelines	33	-42	-132	-300	37	-706	35	17	12	17	69	28	-12	-16	16	-32	-1119	11	-93	-74	29	58	-26	19	-63
50	Water transport	22	-200	-131	-228	-61	-1714	-55	-10	-18	-10	26	1	1	19	-12	-43	-70	63	24	-25	9	8	-39	-224	-21
51	Air transport	-239	-1193	-111	-374	-72	32	95	11	25	12	33	24	30	-4	4	-19	-73	78	134	-55	80	277	28	47	23
52	Warehousing and support activities for transportation	-55	-76	-1113	-112	290	-544	-38	5	9	35	17	27	21	-6	42	10	-304	496	-30	-27	-9	75	4	5	-67
53	Postal and courier activities	-16	-167	-329	-95	-1827	-63	30	38	59	319	49	74	514	-36	1170	21	2	-27	-213	-99	76	208	2	52	-105
55T56	Accommodation and food service activities	-40	18	-107	-155	121	-225	497	104	74	259	252	107	75	-81	758	65	154	53	5	-10260	-71	140	12	204	40
58T60	Publishing, audiovisual and broadcasting activities	-92	-105	-284	-106	-91	-77	925	97	52	284	112	111	93	-58	162	499	-758	55	-6	-61	-68	94	-27	90	-206
61	Telecommunications	-91	-165	-185	-58	-47	-101	406	72	112	382	412	89	170	-71	1146	-55	-92	65	-64	-121	-189	195	-45	-80	-638
62T63	IT and other information services	24	-110	-43	-43	67	173	6	64	50	136	99	69	-4	-53	151	10	17	67	-29	-112	-35	33	-15	98	-142
64T66	Financial and insurance activities	-3118	-2685	-630	-128	-360	27	-14	17	31	162	3	86	1182	-383	1698	-14	-150	24	-84	-80	-8	-2	11	-367	-363
68	Real estate activities	34	-78	-149	-88	-86	-30	5	14	30	13	165	224	560	-8	120	51	-2071	53	-117	-385	-31	420	5	-90	18
69T75	Professional, scientific and technical activities	-148	-417	-268	-106	-89	-262	20	20	28	71	34	22	80	-13	110	-4	-289	31	-36	-170	3450	76	12	-81	-905
77T82	Administrative and support services	-130	-433	-191	-107	-68	42	38377	23	28	44	60	57	35	-5	58	-1	329	147	-22	-52	-43	81	-7	-79	-44
84	Public administration and defence; compulsory social security	8331	142	337	268	772	-101	93344	92	134	109	2687	3125	843	880	107	164	153	14982	3672	51	733	890	43	-963	10
85	Education	265	431	11618	7937	37	1086	102	27	15	189	13842	62	3717	97	724	122	-192	16631	476	10	2505	297	3	-15	-58
86T88	Human health and social work activities	17	58	-258	323	530	-290	503	34	36	40	8492	30	113	446	775	85	-34	5261	8744	-19	323	160	140	-35	-143
90T93	Arts, entertainment and recreation	-118	36	-13997	-88	2150	-251	106	14	52	434	296	69	158	-43	751	37	-17	182	14	-67	-8	83	33	54	10
94T96	Other service activities	4654	23	-260	-203	343	50	782	43	32	21967	19334	110	128	-7	160	36	7	212	718	-46	-413	228	48	-38	-42
97T98	Activities of households as employers*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Industries total	**8764**	**-7546**	**-9203**	**750**	**1314**	**-3366**	**142527**	**1313**	**5680**	**24997**	**50178**	**7869**	**8815**	**-1096**	**9349**	**1680**	**-8524**	**53925**	**14868**	**-22177**	**7357**	**8634**	**1303**	**1589**	**-4028**
	*Undifferentiated goods- and services-producing activities of households for own use																									

Table 3. Industrial competitiveness from the national industrial portfolio point of view (adapted from Montrimas et al., 2024, with updates to structure and results by the author)

Region	Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	ARG	5	0	4	-4	0	-3	-21	11	12	7	6	7	6	-3	9	8	2	1	-6	4	-7	5	-8	-7	-6
	BRA	50	-2	154	6	8	-8	-5	0	6	11	6	8	12	-6	30	5	-5	-3	-3	-14	-5	5	-2	-2	-11
	CHL	13	-1	-3	-1	1	-4	-2	11	13	6	5	4	6	-5	12	5	1	1	-5	-5	-3	4	5	37	-3
	COL	18	-5	-11	-7	50	-3	-3	-4	8	6	4	10	3	-4	9	5	4	0	-1	-10	-6	3	1	-2	-8
Americas	PER	0	0	-5	-2	1	1	4	2	7	7	9	6	6	3	5	6	3	1	-1	-6	-2	2	2	-1	-4
	CRI	-6	-2	4	4	0	1	-2	4	0	-1	-1	3	0	10	3	4	3	0	0	-1	-1	2	9	2	2
	MEX	-7	-1	-4	-1	4	0	-1	-2	1	4	1	1	-2	-9	4	2	-1	12	-1	-5	-4	1	1	0	-8
	CAN	3	2	-1	3	6	-1	-1	6	6	4	4	3	0	-6	7	3	0	2	-2	-5	-2	3	1	0	-3
	USA	2	2	1	0	2	-1	-1	1	3	3	1	1	0	-6	3	3	0	1	1	-1	-1	1	2	-1	-4
	IRL	3	5	5	845	-1	6	3	11	5	2	5	9	3	-5	-4	-3	8	0	1	-2	3	5	11	-4	8
	ISL	3	66	2	4	0	-5	1	13	7	11	-3	13	-11	-17	3	6	-3	9	2	-4	7	15	1	9	-5
	GBR	1	4	1	0	-1	-1	2	5	8	1	2	4	-2	-8	-1	3	0	0	3	-3	-4	-2	3	-2	-4
	NOR	3	0	-1	1	-3	1	6	5	5	6	5	9	4	-7	3	4	0	1	-1	-10	-4	1	3	-3	-6
	SWE	3	-3	1	-1	-1	-4	2	9	7	3	4	6	4	-8	5	6	-2	1	-2	-7	0	2	1	-3	-1
	FIN	0	-2	2	0	-2	0	3	9	8	2	5	7	11	-7	2	5	-3	1	0	-7	3	5	3	-1	-1
	DNK	1	-4	0	2	-2	1	2	7	6	4	3	6	5	-6	-2	5	-3	0	0	-7	3	2	3	0	-3
	DEU	3	-6	1	0	-1	-1	2	9	6	2	2	6	5	-6	1	6	-4	1	1	-6	0	2	3	-2	-1
	AUT	-1	-4	1	1	-3	2	4	9	6	3	4	6	17	-5	-1	13	-3	1	0	-7	1	3	8	-2	-4
	BEL	-2	-3	2	0	-2	0	0	9	6	0	3	6	5	-6	2	4	-4	1	1	-7	-1	1	5	0	-4
	FRA	0	-3	1	0	-2	0	2	7	5	2	3	5	4	-6	1	4	-4	1	2	-8	0	3	3	-3	-3
	LUX	0	-1	4	0	-1	1	15	8	11	3	17	9	4	-2	4	4	-2	3	2	-4	3	3	4	-2	1
	NLD	0	-4	1	0	-2	-1	1	8	6	2	2	6	5	-6	0	5	-4	0	1	-6	0	2	4	-3	0
	CHE	-2	-6	2	-1	-5	0	5	6	7	1	2	6	7	-1	3	8	0	2	0	-3	2	1	3	2	1
	PRT	2	-3	1	-1	-3	-1	1	8	6	0	2	6	4	-5	1	3	-6	1	1	-6	1	4	4	0	0
	ESP	2	-3	2	2	-1	1	4	10	6	2	3	7	3	-7	-1	1	-6	0	1	-7	1	3	5	1	-4
Europe	ITA	3	-2	0	0	-3	-1	2	7	5	1	2	6	1	-8	4	4	-4	1	0	-8	2	5	2	-2	-4
	CYP	0	0	8	2	-5	9	1	9	6	1	6	10	5	-1	-8	2	-8	7	-4	-1	9	7	36	-2	6
	MLT	-1	-3	3	1	2	-5	6	8	5	1	9	7	7	-3	1	3	-3	4	4	-5	6	9	4	10	8
	SVN	-3	-5	0	-2	-5	-3	2	7	7	2	4	8	6	-7	-1	3	-5	0	2	-6	0	5	13	-2	-1
	HRV	2	3	-4	-4	-3	2	7	11	10	7	5	8	4	-7	-2	3	-5	0	1	-6	7	3	6	1	0
	CZE	1	-5	-2	-2	-2	2	7	12	9	5	8	8	6	-8	0	7	-6	-2	0	-6	1	4	4	-1	-5
	EST	194	1	2	1	2	3	7	13	13	6	6	10	5	-10	5	9	-3	2	3	-7	3	4	4	-1	-1
	LVA	-2	3	-1	4	10	0	5	11	11	17	10	379	4	-9	3	14	-1	13	-4	-6	0	3	5	0	6
	LTU	-1	3	2	-1	7	5	2308	14	14	7	6	16	5	-9	4	5	-1	5	7	-5	0	6	5	5	3
	SVK	0	-1	-2	0	-3	-1	8	10	8	7	7	16	9	-9	-3	9	-2	2	8	-5	3	3	6	-4	-5
	POL	-2	-5	1	-4	-1	4	1	6	7	8	6	10	9	-10	5	3	-3	3	1	-5	0	5	5	0	-3
	HUN	-4	-6	-3	-3	-4	2	9	7	6	4	2	5	3	-9	-2	4	-7	2	1	-6	2	5	6	0	-6
	GRC	-2	-6	-1	1	-4	1	2	12	8	-1	5	4	5	4	-6	2	-6	3	1	-7	0	10	3	-2	-5
	BGR	-27	-40	6	-1	-3	4	6	12	12	7	8	29	4	-2	3	7	-1	0	12	-5	-1	5	5	-1	-1
	ROU	-9	-28	-15	-15	-13	-3	1	6	6	14	8	14	58	-4	6	10	-6	6	18	-4	0	7	5	0	-1
	UKR	-22	1	-10	-14	-6	6	8	11	13	3	8	6	1	-19	4	4	9	2	-16	-24	4	2	2	7	1
	BLR	-18	-16	-16	-34	-29	-14	-13	-5	4	7	6	7	7	-12	9	-9	-15	-2	-8	-17	-6	6	2	0	-6
	RUS	-9	-9	-23	-22	8	-1	-5	6	10	7	7	10	6	-14	8	10	0	0	-7	-16	-4	9	1	2	-5
	TUR	-17	-19	-18	-17	-11	-21	-2	3	8	7	0	4	0	-11	6	2	0	1	-3	-7	-3	-3	-8	-4	-8
	KAZ	-19	-3	-8	5	4	5	-2	5	17	18	23	290	11	0	173	9	2	10	-1	-11	-16	23	-2	-5	-7
	CHN	4	26	6	3	5	6	0	8	12	12	60	13	7	2	3	15	7	9	5	3	-4	-1	4	1	0
	HKG	0	-1	-2	0	5	-6	-2	-2	0	2	1	-1	3	-4	5	1	-3	-4	24	0	3	0	0	5	-2
	TWN	1	4	-4	5	5	-5	2	2	3	3	13	1	-1	-8	8	6	-2	-1	-1	-4	-2	4	2	1	4
	KOR	1077	-3	-13	10	5	-4	5	4	5	5	6	5	-4	-4	93	4	0	2	3	-2	-1	3	2	-1	-2
	JPN	-5	-4	-5	5	4	-4	-2	4	4	1	-3	1	6	-1	5	5	0	-7	-3	-6	3	0	2	0	0
	LAO	-7	-1	-26	-23	-3	-5	-5	5	1	10	22	6	9	1	18	24	7	3	21	1	7	3	3	2	1
	MMR	-1	-7	-27	-6	10	-2	-5	-14	-6	-2	1	5	14	20	10	13	1	-3	-1	-8	-1	2	4	-3	1
	BGD	1	1	-3	-1	0	0	2	1	2	3	3	3	0	3	1	-3	0	6	4	5	3	4	4	3	-1
	BRN	3	0	-12	64	44	-4	9	14	9	13	15	4	13	-15	3	69	-1	6	37	5	-7	3	10	0	-5
	MYS	14	-1	-10	3	7	-4	2	5	5	7	2	6	6	-7	7	15	-1	-1	-5	3	1	1	5	1	-3
Asia/Oceania	IDN	615	-1	-30	9	3	-4	3	6	2	3	3	3	3	0	11	12	-3	-4	-4	-4	0	3	-1	3	-2
	PHL	1	-5	-12	6	-2	-4	4	2	3	5	13	10	5	-2	6	3	3	1	1	0	0	-1	-2	2	-1
	AUS	5	-1	-5	4	-2	-3	5	10	8	4	1	7	1	-1	7	7	0	-4	-2	-8	0	3	2	-1	0
	NZL	3	0	-6	-1	-2	-3	3	10	9	4	-2	7	0	-6	4	5	3	2	3	-5	-1	2	2	0	-1
	SGP	5	0	-3	-1	3	0	2	4	7	8	9	6	-3	2	7	7	1	0	1	-1	-1	1	2	0	-2
	THA	1	-9	-13	2	7	-2	4	8	7	5	14	8	4	-3	9	6	2	0	-3	-4	-2	3	4	1	-3
	VNM	5	3	-1	2	6	4	4	7	16	6	5	3	4	0	-3	1	10	8	8	7	8	2	3	2	0
	KHM	-3	-2	-8	-1	53	4	258	0	466	0	7	4	-1	3	5	3	4	3	3	5	5	3	5	4	0
	PAK	-4	-4	-2	-2	-2	-4	4	4	3	1	2	5	-7	-4	3	1	-3	-5	-2	0	4	1	-2	-8	-4
	IND	1	1	-5	0	0	1	1	5	5	7	4	8	1	-2	4	-8	-7	-2	10	-3	-1	3	2	0	-5
	SAU	7	1	-12	16	18	-4	4	10	10	7	2	0	20	-17	16	19	3	-2	-5	-7	9	6	12	2	-8
	JOR	-4	2	-3	1	0	4	5	3	8	7	5	4	5	4	2	3	0	6	0	-5	2	10	0	3	-1
	ISR	0	-3	-1	-2	9	-2	-5	3	5	3	4	14	8	-7	6	4	1	4	0	-2	2	4	3	2	2
	EGY	4	0	2	4	1	-5	-4	-8	0	3	6	14	0	4	-1	12	-2	0	-5	-5	-10	-8	1	3	1
	MAR	6	-5	-1	-1	-2	-1	2	6	4	3	4	4	6	-2	1	6	0	1	27	-6	-2	2	3	0	-4
	SEN	-2	-6	44	-6	-1	-2	4	13	9	3	3	6	4	2	2	5	-1	0	2	-3	3	6	6	5	1
	CMR	0	-3	5	10	-5	4	3	10	8	-1	0	9	5	-1	-2	6	-1	3	0	-6	30	3	0	1	9
Africa	CIV	29	-3	5	3	-10	0	24	2	4	5	15	3	7	5	-2	-1	-1	10	8	1	6	3	5	7	2
	NGA	-11	0	-5	0	15	-2	-4	7	5	-1	18	49	0	26	20	12	6	329	7	-9	-11	-7	5	3	-17
	TUN	13	-6	1	1	-4	-1	2	6	6	0	124	8	7	-4	-2	-1	0	-2	-3	-9	-3	-4	-2	-5	0
	ZAF	-5	-2	-5	0	1	-6	-4	18	11	4	0	2	-5	-3	10	2	-3	-6	-4	-5	-6	3	-2	-3	-7
	ROW*	0	-1	-3	2	2	3	-2	2	4	7	5	6	4	-4	8	13	1	-2	-2	-4	1	2	2	1	-2
	Countries total	**1910**	**-137**	**-71**	**849**	**153**	**-79**	**2697**	**483**	**975**	**356**	**595**	**1223**	**378**	**-296**	**571**	**483**	**-74**	**447**	**131**	**-366**	**28**	**254**	**262**	**40**	**-153**

ROW* - Rest of the world

Table 4. Industrial competitiveness from the global industry point of view (adapted from Montrimas et al., 2024, with updates to structure and results by the author)

	Industry	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
01T02	Agriculture, hunting, forestry	-4	-9	-10	-6	-2	-4	1	7	10	3	4	12	6	-9	10	10	-3	2	-1	-10	-2	4	2	-1	-2
03	Fishing and aquaculture	-7	-9	-6	-5	-2	0	6	9	8	5	7	7	11	-5	16	12	-3	11	6	-5	1	6	2	0	-4
05T06	Mining and quarrying, energy producing products	-3	-2	-11	-3	5	-4	0	10	10	14	7	8	13	-12	9	17	-2	0	-4	-16	-6	8	8	0	-6
07T08	Mining and quarrying, non-energy producing products	-5	-3	-9	-5	-1	-3	2	10	11	9	12	10	8	-11	8	9	-4	1	-2	-10	3	8	5	2	-2
09	Mining support service activities	-5	-3	-9	7	2	-2	1	10	12	10	11	31	28	-9	8	16	-2	4	26	-12	2	8	11	43	-6
10T12	Food products, beverages and tobacco	-5	-8	-9	-5	0	-3	2	8	11	6	4	10	7	-7	11	11	-2	3	-1	-9	-2	4	2	1	-4
13T15	Textiles, textile products, leather and footwear	-6	-8	-8	-8	-2	-5	-1	6	5	2	3	5	0	-14	8	8	-2	-1	0	-9	-3	4	2	9	-4
16	Wood and products of wood and cork	-3	-7	-8	-3	-2	-4	2	11	12	5	5	8	0	-13	5	6	-4	0	3	-8	-1	3	3	-2	-2
17T18	Paper products and printing	-6	-7	-7	-4	0	-4	1	9	9	7	5	8	3	-10	6	5	-4	2	-1	-9	-2	1	7	-3	-4
19	Coke and refined petroleum products	-1	-6	-13	3	13	-6	-1	12	17	26	8	378	13	-16	12	18	-1	10	-4	-18	-9	18	45	-6	-8
20	Chemical and chemical products	-5	-5	-9	-6	0	-5	1	10	13	5	9	11	11	-13	11	10	-2	-1	-1	-7	-3	4	6	-2	-3
21	Pharmaceuticals, medicinal chemical and botanical products	1	-7	-9	8	4	-2	3	10	10	12	10	6	9	-5	12	27	-2	16	37	-8	-1	1	7	7	0
22	Rubber and plastics products	-4	-7	-6	-4	0	-2	2	11	11	7	7	10	3	-11	9	9	-3	1	2	-7	-2	4	2	-2	-3
23	Other non-metallic mineral products	-4	-7	-8	-3	-2	-3	2	11	12	7	7	11	3	-12	5	9	-5	0	0	-8	-1	4	5	-1	-3
24	Basic metals	-6	-6	-6	-3	-1	-4	0	11	20	5	14	12	5	-19	21	9	-7	-1	-1	-10	-5	8	8	-3	-5
25	Fabricated metal products	-3	-6	-7	-4	0	-2	1	10	14	6	11	12	6	-14	6	8	-3	0	-1	-9	0	5	4	-1	-4
26	Computer, electronic and optical equipment	0	-1	26	7	39	2	160	13	296	8	10	14	4	4	12	4	-3	2	-1	-4	3	3	4	1	4
27	Electrical equipment	1	-9	-6	2	21	-4	100	9	180	4	13	47	0	-1	12	11	-3	0	-2	-9	0	6	3	0	0
28	Machinery and equipment, nec	-2	-8	-4	2	1	0	6	13	16	3	9	26	7	2	8	16	2	1	1	-9	0	5	6	-2	4
29	Motor vehicles, trailers and semi-trailers	7	-5	7	6	-2	-1	16	12	14	2	14	12	3	3	18	14	0	2	1	-8	-1	4	11	5	2
30	Other transport equipment	4	-5	2	-1	1	7	8	13	19	2	28	11	7	-7	3	13	3	8	1	-3	9	11	17	6	1
31T33	Manufacturing nec; repair and installation of machinery/equipment	-3	-5	-8	-2	1	-2	3	9	11	8	6	10	4	-7	9	7	-1	5	0	-6	1	5	5	0	-2
35	Electricity, gas, steam and air conditioning supply	-4	-8	-9	-1	1	-3	4	12	10	9	10	10	10	-7	8	8	-1	1	-2	-11	-3	3	5	-2	-6
36T39	Water supply; sewerage, waste management and remediation	-4	-7	-8	2	3	-3	3	11	14	8	9	11	15	-8	12	9	0	1	-1	-10	0	4	4	-1	-2
41T43	Construction	-1	-6	-5	2	2	3	7	15	16	9	17	16	10	-4	13	15	0	4	5	-6	0	6	6	-2	3
45T47	Wholesale and retail trade; repair of motor vehicles	-2	-6	-7	-2	0	-2	2	10	11	8	8	11	7	-10	8	7	-2	1	0	-8	0	4	4	0	-3
49	Land transport and transport via pipelines	-1	-8	-7	-4	3	-2	2	12	11	8	6	12	6	-9	9	5	-1	2	0	-9	-1	4	4	-1	-5
50	Water transport	-2	-7	-6	-2	1	-2	0	10	10	7	10	15	9	-11	10	3	0	0	0	-10	-5	5	4	-1	-5
51	Air transport	-3	-5	-6	-2	0	-4	1	11	13	10	7	10	7	-11	9	8	0	3	2	-10	0	11	6	-2	-15
52	Warehousing and support activities for transportation	-2	-5	-6	-1	1	-2	2	12	11	8	8	12	8	-9	9	10	-1	2	1	-8	0	5	5	-1	-7
53	Postal and courier activities	-4	-1	-5	-1	-1	-3	2	10	10	8	6	11	4	-9	5	4	-2	2	-1	-9	0	5	5	0	-1
55T56	Accommodation and food service activities	-4	-4	-7	-3	7	-4	2	13	9	6	16	15	7	-4	93	11	1	4	3	-8	0	3	5	2	-6
58T60	Publishing, audiovisual and broadcasting activities	-2	-3	-5	-2	0	-3	3	10	10	8	5	10	6	-9	6	4	-2	3	0	-10	0	3	3	0	-5
61	Telecommunications	-1	-3	-3	2	2	-2	2	10	9	5	6	9	4	-7	4	2	-4	0	-1	-10	0	1	1	-2	-3
62T63	IT and other information services	8	-3	4	4	9	4	3	13	11	13	10	14	6	-3	10	12	2	6	2	-5	2	7	7	3	-2
64T66	Financial and insurance activities	-3	-6	-5	-3	-2	-3	3	11	11	8	8	14	5	-4	6	5	-2	3	0	-6	-1	2	2	-1	-3
68	Real estate activities	-2	-3	-6	0	0	1	4	11	13	8	9	14	7	-3	8	8	-1	3	-1	-9	1	9	5	-1	-1
69T75	Professional, scientific and technical activities	-1	-3	-5	-1	0	-2	3	10	11	8	10	12	7	-6	4	7	-1	3	1	-7	1	4	4	0	-3
77T82	Administrative and support services	-2	-4	-6	-2	0	-1	3	12	11	8	10	13	7	-7	5	8	0	4	2	-9	1	6	5	0	-7
84	Public administration and defence; compulsory social security	1929	31	1	7	12	-1	2306	17	19	13	94	301	57	14	23	38	0	130	14	-2	32	15	8	-3	-2
85	Education	7	55	154	882	15	8	9	14	10	15	51	20	12	2	43	29	-2	90	8	-4	12	8	5	-1	-6
86T88	Human health and social work activities	11	-1	-4	5	9	-3	11	16	12	13	64	10	17	7	28	23	-2	116	30	-7	7	12	3	1	-3
90T93	Arts, entertainment and recreation	-2	-1	-5	-1	20	-4	7	12	12	13	14	16	10	-8	29	11	-2	2	2	-10	3	8	7	2	-15
94T96	Other service activities	53	-5	-5	-3	1	-1	3	10	9	6	10	10	9	-4	11	7	-3	3	5	-8	-2	3	2	0	-5
97T98	Activities of households as employers*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Industries total	**1910**	**-137**	**-71**	**849**	**153**	**-79**	**2697**	**483**	**975**	**356**	**595**	**1223**	**378**	**-296**	**571**	**483**	**-74**	**447**	**131**	**-366**	**28**	**254**	**262**	**40**	**-153**

*Undifferentiated goods- and services-producing activities of households for own use

Table 5. Integral OLS regression results of EU countries: competitiveness vs. national properties

OLS regression results

	Competitiveness			
	(1)	(2)	(3)	(4)
KSI	0.074*			
	(0.041)			
pdelta_KSI		-21.196		
		(16.111)		
pdelta_pop			121.520**	
			(54.777)	
pdelta_dens				140.705***
				(51.430)
Constant	-5.978***	-1.974***	-2.491***	-2.544***
	(2.275)	(0.754)	(0.767)	(0.761)
N	336	336	336	336
R2	0.010	0.005	0.015	0.022
Adjusted R2	0.007	0.002	0.012	0.019
Residual Std. Error (df = 334)	13.699	13.730	13.665	13.614
F Statistic (df = 1; 334)	3.269*	1.731	4.922**	7.485***

*p < .1; **p < .05; ***p < .01

Table 6. Integral OLS regression results of EU countries: competitiveness vs. national properties, controlled for the shock-year dummy variable

OLS regression results, controlled for shock-year dummy

	Competitiveness			
	(1)	(2)	(3)	(4)
KSI	0.076**			
	(0.034)			
pdelta_KSI		-9.192		
		(13.548)		
pdelta_pop			101.316**	
			(45.884)	
pdelta_dens				98.790**
				(43.337)
shock_year	-15.297***	-15.220***	-15.182***	-15.049***
	(1.266)	(1.278)	(1.267)	(1.269)
Constant	2.850	6.838***	6.431***	6.369***
	(2.035)	(0.973)	(0.983)	(0.987)
N	336	336	336	336
R2	0.312	0.302	0.312	0.312
Adjusted R2	0.307	0.298	0.307	0.308
Residual Std. Error (df = 333)	11.438	11.514	11.439	11.434
F Statistic (df = 2; 333)	75.377***	72.183***	75.344***	75.573***

*p < .1; **p < .05; ***p < .01

Table 7. Integral OLS regression results of EU countries: competitiveness vs. national properties, controlled for time specifics

OLS regression results, controlled for time specifics

	Competitiveness			
	(1)	(2)	(3)	(4)
KSI	0.061**			
	(0.030)			
pdelta_KSI		-9.868		
		(12.334)		
pdelta_pop			68.133*	
			(40.658)	
pdelta_dens				79.968**
				(38.298)
year1999	7.319***	7.177***	7.230***	7.183***
	(2.679)	(2.702)	(2.685)	(2.679)
year2000	5.783**	5.898**	5.701**	5.643**
	(2.679)	(2.697)	(2.685)	(2.679)
year2002	17.237***	17.005***	17.311***	17.145***
	(2.679)	(2.719)	(2.684)	(2.679)
year2009	-4.993*	-5.082*	-5.185*	-5.243*
	(2.679)	(2.696)	(2.687)	(2.681)
year2011	19.132***	19.282***	18.971***	18.913***
	(2.679)	(2.699)	(2.686)	(2.680)
year2012	3.045	3.177	3.083	3.223
	(2.679)	(2.694)	(2.685)	(2.678)
year2014	15.836***	15.958***	15.828***	15.757***
	(2.680)	(2.693)	(2.686)	(2.680)
year2015	-1.620	-1.395	-1.508	-1.596
	(2.680)	(2.694)	(2.685)	(2.679)
year2018	29.525***	29.616***	29.256***	29.132***
	(2.681)	(2.699)	(2.701)	(2.695)
year2019	7.930***	8.087***	7.977***	7.939***
	(2.681)	(2.694)	(2.686)	(2.680)
year2020	7.460***	7.457***	7.454***	7.760***
	(2.681)	(2.709)	(2.688)	(2.678)
Constant	-14.180***	-10.969***	-11.159***	-11.170***
	(2.434)	(1.910)	(1.899)	(1.894)
N	336	336	336	336
R2	0.487	0.482	0.485	0.488
Adjusted R2	0.468	0.462	0.466	0.469
Residual Std. Error (df = 323)	10.024	10.077	10.044	10.020
F Statistic (df = 12; 323)	25.577***	25.020***	25.367***	25.616***

*p < .1; **p < .05; ***p < .01

Table 8. Integral OLS regression results of EU countries: competitiveness vs. national properties, controlled for country and time specifics

OLS regression results, controlled for country and time specifics

	Competitiveness			
	(1)	(2)	(3)	(4)
KSI	-0.505***			
	(0.085)			
pdelta_KSI		-14.007		
		(12.072)		
pdelta_pop			-116.363*	
			(59.450)	
pdelta_dens				-54.772
				(50.958)
year1999	7.631***	7.103***	7.561***	7.468***
	(2.412)	(2.554)	(2.537)	(2.548)
year2000	5.803**	5.946**	5.929**	5.882**
	(2.411)	(2.549)	(2.536)	(2.548)
year2002	17.845***	16.880***	17.287***	17.410***
	(2.413)	(2.571)	(2.535)	(2.548)
year2009	-4.895**	-5.124**	-4.636*	-4.805*
	(2.411)	(2.548)	(2.541)	(2.552)
year2011	19.224***	19.341***	19.433***	19.298***
	(2.411)	(2.551)	(2.539)	(2.550)
year2012	3.976	3.191	3.251	3.091
	(2.415)	(2.546)	(2.535)	(2.547)
year2014	17.144***	15.950***	16.230***	16.127***
	(2.419)	(2.545)	(2.538)	(2.550)
year2015	0.025	-1.374	-1.333	-1.339
	(2.424)	(2.546)	(2.535)	(2.548)
year2018	31.669***	29.557***	30.609***	30.183***
	(2.432)	(2.551)	(2.572)	(2.577)
year2019	9.971***	8.061***	8.442***	8.293***
	(2.430)	(2.546)	(2.539)	(2.550)
year2020	9.625***	7.358***	8.098***	7.646***
	(2.433)	(2.561)	(2.543)	(2.546)
CountryBEL	2.027	-0.648	-0.696	-0.782
	(3.714)	(3.890)	(3.872)	(3.889)
CountryBGR	1.679	-7.045*	-9.231**	-8.023**
	(3.965)	(3.888)	(4.027)	(3.991)
CountryCYP	23.871***	1.818	2.920	2.180
	(5.241)	(3.890)	(3.922)	(3.916)
CountryCZE	1.692	0.332	-0.638	-0.331
	(3.695)	(3.901)	(3.884)	(3.899)
CountryDEU	0.103	0.123	-0.649	-0.257
	(3.683)	(3.890)	(3.885)	(3.895)
CountryDNK	4.992	-0.015	-0.328	-0.221
	(3.790)	(3.898)	(3.872)	(3.891)
CountryESP	-1.073	-0.241	-0.569	-0.486
	(3.685)	(3.891)	(3.873)	(3.890)
CountryEST	15.824***	4.795	3.711	4.348
	(4.118)	(3.889)	(3.917)	(3.919)
CountryFIN	2.969	-0.040	-0.171	-0.044
	(3.715)	(3.890)	(3.874)	(3.891)

CountryFRA	-0.365	0.193	-0.016	-0.003
	(3.683)	(3.892)	(3.872)	(3.889)
CountryGBR	6.801*	1.268	1.095	0.965
	(3.815)	(3.902)	(3.873)	(3.890)
CountryGRC	5.440	-3.998	-5.002	-4.531
	(4.021)	(3.891)	(3.896)	(3.904)
CountryHRV	3.404	-2.341	-4.202	-2.940
	(3.802)	(3.889)	(4.002)	(3.947)
CountryHUN	-1.149	-2.432	-3.565	-2.764
	(3.689)	(3.889)	(3.921)	(3.908)
CountryIRL	25.989***	7.678**	8.458**	7.898**
	(4.822)	(3.892)	(3.904)	(3.908)
CountryITA	-3.697	-1.606	-2.343	-2.046
	(3.698)	(3.889)	(3.885)	(3.901)
CountryLTU	21.385***	4.722	2.440	3.840
	(4.598)	(3.896)	(4.090)	(4.041)
CountryLUX	41.523***	8.254**	10.496**	9.094**
	(6.732)	(3.894)	(4.075)	(4.018)
CountryLVA	22.515***	2.675	-0.040	1.393
	(4.967)	(3.888)	(4.116)	(4.073)
CountryMLT	31.585***	6.240	8.135**	7.161*
	(5.634)	(3.888)	(3.993)	(3.985)
CountryNLD	1.595	0.071	0.050	-0.097
	(3.694)	(3.891)	(3.873)	(3.889)
CountryPOL	5.460	0.550	-0.405	0.189
	(3.775)	(3.888)	(3.902)	(3.903)
CountryPRT	0.620	-1.088	-1.818	-1.397
	(3.694)	(3.888)	(3.889)	(3.899)
CountryROU	-4.030	-13.685***	-15.351***	-14.643***
	(4.016)	(3.890)	(3.979)	(4.018)
CountrySVK	6.989*	-0.809	-1.620	-1.246
	(3.919)	(3.891)	(3.886)	(3.897)
CountrySVN	2.963	-2.034	-2.587	-2.384
	(3.784)	(3.891)	(3.877)	(3.893)
CountrySWE	2.413	0.590	0.710	0.509
	(3.700)	(3.897)	(3.878)	(3.895)
Constant	6.785	-11.040***	-10.549***	-10.856***
	(4.301)	(3.245)	(3.244)	(3.254)
N	336	336	336	336
R2	0.619	0.576	0.579	0.576
Adjusted R2	0.569	0.520	0.524	0.520
Residual Std. Error (df = 296)	9.021	9.524	9.484	9.527
F Statistic (df = 39; 296)	12.350***	10.303***	10.452***	10.291***

*p < .1; **p < .05; ***p < .01

Table 9. OLS regression results of EU countries: competitiveness vs. national properties for economic shocks and recoveries separately, controlled for the time and country specifics

OLS regression results during shocks and recoveries separately, controlled for time and country specifics

	Competitiveness					
	During shocks (1)	During shocks (2)	During shocks (3)	During recoveries (4)	During recoveries (5)	During recoveries (6)
KSI	-0.439***			-0.661***		
	(0.107)			(0.144)		
pdelta_KSI		-55.732***			19.873	
		(17.329)			(19.086)	
pdelta_pop			-225.486*			-52.576
			(133.714)			(91.409)
CountryBEL	1.927	-1.826	-0.618	2.304	-1.756	-0.706
	(4.540)	(4.583)	(4.678)	(6.420)	(7.021)	(6.979)
CountryBGR	-3.839	-11.479**	-13.184***	10.899	-2.078	-3.322
	(4.808)	(4.577)	(4.872)	(6.950)	(6.962)	(7.512)
CountryCYP	21.998***	0.632	4.272	28.896***	-0.202	1.652
	(6.604)	(4.598)	(4.837)	(8.806)	(7.049)	(7.069)
CountryCZE	-1.265	-1.969	-3.178	6.018	2.993	3.312
	(4.506)	(4.580)	(4.681)	(6.404)	(7.001)	(7.038)
CountryDEU	0.021	-1.315	-0.766	0.139	-0.814	-0.247
	(4.490)	(4.585)	(4.687)	(6.386)	(7.028)	(7.031)
CountryDNK	5.139	0.195	0.230	5.218	-2.128	-1.061
	(4.650)	(4.573)	(4.676)	(6.530)	(7.030)	(6.978)
CountryESP	-1.194	-0.667	-0.320	-0.959	-0.779	-0.431
	(4.492)	(4.573)	(4.679)	(6.388)	(6.978)	(6.993)
CountryEST	10.861**	-0.463	0.696	24.268***	8.843	8.582
	(5.038)	(4.614)	(4.701)	(7.140)	(6.989)	(7.188)
CountryFIN	2.628	-0.580	0.136	4.007	-0.414	-0.546
	(4.523)	(4.583)	(4.679)	(6.456)	(6.954)	(6.986)
CountryFRA	0.311	0.203	0.255	-1.604	-1.109	-0.401
	(4.490)	(4.573)	(4.676)	(6.391)	(6.987)	(6.978)
CountryGBR	10.052**	3.804	4.686	2.579	-5.500	-3.823
	(4.703)	(4.576)	(4.681)	(6.541)	(7.115)	(6.981)
CountryGRC	5.527	-4.104	-4.057	6.363	-6.816	-6.305
	(4.955)	(4.584)	(4.714)	(6.906)	(7.032)	(7.051)
CountryHRV	4.375	-2.215	-2.601	2.791	-5.145	-6.136
	(4.642)	(4.605)	(4.846)	(6.590)	(6.968)	(7.420)
CountryHUN	-3.180	-5.542	-5.611	1.869	-0.164	-0.626
	(4.496)	(4.592)	(4.751)	(6.396)	(6.964)	(7.135)
CountryIRL	27.448***	9.810**	12.336**	25.883***	1.645	3.376
	(6.056)	(4.583)	(4.762)	(8.120)	(7.044)	(7.046)
CountryITA	-3.275	-1.115	-2.582	-4.444	-2.382	-2.429
	(4.512)	(4.574)	(4.725)	(6.406)	(6.958)	(6.997)
CountryLTU	17.671***	0.898	1.014	28.773***	6.604	5.016
	(5.650)	(4.651)	(4.928)	(7.954)	(6.962)	(7.752)
CountryLUX	36.820***	7.723*	11.141**	52.306***	7.661	10.040
	(8.420)	(4.573)	(5.107)	(11.471)	(6.997)	(7.490)

CountryLUX	36.820***	7.723*	11.141**	52.306***	7.661	10.040
	(8.420)	(4.573)	(5.107)	(11.471)	(6.997)	(7.490)
CountryLVA	20.434***	1.260	0.127	27.917***	1.076	0.020
	(6.155)	(4.612)	(5.020)	(8.519)	(7.008)	(7.766)
CountryMLT	31.345***	8.307*	12.386**	34.946***	1.800	3.223
	(7.055)	(4.579)	(5.071)	(9.558)	(6.966)	(7.188)
CountryNLD	1.857	-0.363	0.392	1.242	-1.183	-0.312
	(4.510)	(4.575)	(4.679)	(6.396)	(6.997)	(6.979)
CountryPOL	3.628	-1.523	-2.048	8.544	1.973	1.781
	(4.618)	(4.578)	(4.735)	(6.525)	(6.965)	(7.058)
CountryPRT	1.382	-1.301	-0.915	-0.213	-3.194	-3.029
	(4.504)	(4.588)	(4.701)	(6.406)	(6.983)	(7.033)
CountryROU	-4.615	-12.938***	-14.167***	-1.479	-15.494**	-16.820**
	(4.852)	(4.579)	(4.828)	(7.079)	(6.954)	(7.327)
CountrySVK	6.948	0.024	-0.582	8.051	-2.972	-2.886
	(4.798)	(4.573)	(4.690)	(6.777)	(6.976)	(7.031)
CountrySVN	2.544	-2.412	-2.103	4.032	-2.927	-2.677
	(4.636)	(4.573)	(4.676)	(6.530)	(6.985)	(7.020)
CountrySWE	3.070	0.821	1.534	1.554	-1.699	-0.354
	(4.520)	(4.573)	(4.690)	(6.403)	(7.031)	(6.993)
year2000	5.800**	6.425***	6.064**			
	(2.245)	(2.295)	(2.344)			
year2009	-4.906**	-5.546**	-4.312*			
	(2.245)	(2.293)	(2.372)			
year2012	3.867*	3.329	3.350			
	(2.252)	(2.287)	(2.341)			
year2015	-0.167	-1.168	-1.230			
	(2.266)	(2.288)	(2.342)			
year2019	9.732***	7.798***	8.716***			
	(2.278)	(2.289)	(2.362)			
year2020	9.371***	6.365***	8.478***			
	(2.282)	(2.323)	(2.384)			
year2002				10.296***	10.197***	9.849***
				(2.700)	(2.948)	(2.954)
year2011				11.532***	11.153***	11.827***
				(2.699)	(3.001)	(2.950)
year2014				9.789***	8.309***	8.644***
				(2.710)	(2.954)	(2.949)
year2018				24.545***	22.332***	22.695***
				(2.738)	(2.939)	(2.992)
Constant	4.221	-9.867***	-10.700***	20.398***	-2.742	-3.036
	(5.151)	(3.589)	(3.658)	(7.101)	(5.314)	(5.352)
N	196	196	196	140	140	140
R2	0.459	0.439	0.413	0.530	0.443	0.439
Adjusted R2	0.345	0.320	0.289	0.390	0.276	0.271
Residual Std. Error	8.399 (df = 161)	8.555 (df = 161)	8.748 (df = 161)	10.097 (df = 107)	10.995 (df = 107)	11.033 (df = 107)
F Statistic	4.018*** (df = 34; 161)	3.703*** (df = 34; 161)	3.334*** (df = 34; 161)	3.772*** (df = 32; 107)	2.657*** (df = 32; 107)	2.615*** (df = 32; 107)

*p < .1; **p < .05; ***p < .01

Table 10. OLS regression results of EU countries with diversified portfolios: competitiveness during economic shocks vs. industrial specialisation, controlled for time and country specifics

During economic shocks

	Competitiveness		
	All countries (1)	AUT,DEU,ESP,FRA,ITA,SWE (2)	BEL,CZE,NLD,PRT (3)
KSI	-0.058	0.046	-0.410
	(0.134)	(0.152)	(0.311)
CountryBEL	-0.475		
	(1.603)		
CountryCZE	-2.610*		-3.111*
	(1.443)		(1.719)
CountryDEU	-0.196	-0.255	
	(1.366)	(1.351)	
CountryESP	-0.655	-0.509	
	(1.377)	(1.365)	
CountryFRA	0.277	0.268	
	(1.364)	(1.348)	
CountryITA	-1.675	-1.242	
	(1.475)	(1.492)	
CountryNLD	0.334		-0.003
	(1.465)		(1.652)
CountryPRT	0.100		-0.459
	(1.436)		(1.746)
CountrySWE	1.215	0.712	
	(1.511)	(1.538)	
year2000	2.598**	2.597*	3.116
	(1.143)	(1.457)	(2.016)
year2009	-6.468***	-7.478***	-4.109*
	(1.259)	(1.572)	(2.347)
year2012	-0.935	-0.917	-0.028
	(1.293)	(1.608)	(2.438)
year2015	-6.360***	-7.670***	-3.021
	(1.448)	(1.766)	(2.888)
year2019	4.734***	3.536*	8.463**
	(1.518)	(1.788)	(3.294)
year2020	4.712***	4.103**	7.596**
	(1.536)	(1.806)	(3.343)
Constant	-6.253	-9.487*	6.551
	(4.522)	(5.179)	(12.061)
N	70	42	28
R2	0.803	0.830	0.799
Adjusted R2	0.743	0.760	0.680
Residual Std. Error	2.552 (df = 53)	2.523 (df = 29)	2.784 (df = 17)
F Statistic	13.470*** (df = 16; 53)	11.795*** (df = 12; 29)	6.744*** (df = 10; 17)

*p < .1; **p < .05; ***p < .01

Table 11. OLS regression results of EU countries with diversified portfolios: competitiveness during recoveries vs. industrial specialisation

During recoveries

	Competitiveness		
	All countries	AUT,DEU,ESP,FRA,ITA,SWE	BEL,CZE,NLD,PRT
	(1)	(2)	(3)
KSI	0.418*	0.211	1.415**
	(0.249)	(0.290)	(0.627)
Constant	-9.288	-1.265	-50.578*
	(9.598)	(10.715)	(25.612)
N	50	30	20
R2	0.055	0.019	0.220
Adjusted R2	0.036	-0.016	0.177
Residual Std. Error	7.764 (df = 48)	7.098 (df = 28)	8.382 (df = 18)
F Statistic	2.815* (df = 1; 48)	0.531 (df = 1; 28)	5.089** (df = 1; 18)

*p < .1; **p < .05; ***p < .01

Table 12. OLS regression results of EU countries with a diversification effect: competitiveness during economic shocks vs. industrial specialisation, controlled for time and country specifics

During economic shocks

	Competitiveness		
	All countries	without BGR'97,ROU'97	without BGR'97,ROU'97,GBR
	(1)	(2)	(3)
KSI	-0.691***	-0.321***	-0.420***
	(0.215)	(0.110)	(0.145)
CountryEST	16.033**	1.776	2.428
	(6.720)	(3.343)	(3.392)
CountryFIN	3.698	-4.549	-5.499
	(7.030)	(3.447)	(3.608)
CountryGBR	13.136*	1.939	
	(6.655)	(3.276)	
CountryHRV	6.944	-3.499	-3.864
	(6.711)	(3.299)	(3.343)
CountryLTU	25.542***	7.330*	9.037**
	(7.460)	(3.769)	(4.071)
CountryLUX	53.393***	22.432***	27.540***
	(12.701)	(6.548)	(8.105)
CountryLVA	30.144***	9.237**	11.663**
	(8.297)	(4.226)	(4.774)
CountryPOL	5.960	-4.135	-4.593
	(6.747)	(3.314)	(3.372)
CountryROU	-0.492	-6.217*	-6.360*
	(6.628)	(3.380)	(3.394)
year2000	12.824**	-0.651	1.035
	(5.542)	(2.822)	(3.014)
year2009	-8.917	-20.078***	-20.383***
	(5.707)	(2.820)	(3.104)
year2012	5.176	-6.024**	-6.647**
	(5.702)	(2.819)	(3.121)
year2015	-0.338	-11.744***	-12.600***
	(5.675)	(2.812)	(3.113)
year2019	10.975*	-0.240	-0.297
	(5.700)	(2.818)	(3.142)
year2020	9.803*	-1.479	-1.238
	(5.691)	(2.816)	(3.134)
Constant	12.953	15.580**	20.675**
	(13.694)	(6.750)	(8.877)
N	70	68	61
R2	0.485	0.703	0.716
Adjusted R2	0.330	0.610	0.621
Residual Std. Error	12.392 (df = 53)	5.849 (df = 51)	5.866 (df = 45)
F Statistic	3.125*** (df = 16; 53)	7.553*** (df = 16; 51)	7.552*** (df = 15; 45)

*p < .1; **p < .05; ***p < .01

Table 13. OLS regression results of EU countries with a diversification effect: competitiveness during recoveries vs. industrial specialisation, controlled for time and country specifics

During recoveries

	Competitiveness		
	All countries	without ROU'99	without ROU'99,GBR
	(1)	(2)	(3)
KSI	-1.057***	-0.854***	-1.061***
	(0.183)	(0.188)	(0.246)
CountryEST	14.608**	13.974**	14.622**
	(5.971)	(5.562)	(5.485)
CountryFIN	-11.828*	-9.303	-11.884*
	(6.366)	(6.008)	(6.239)
CountryGBR	-11.970*	-10.102*	
	(6.178)	(5.796)	
CountryHRV	-11.183*	-9.609	-11.217*
	(6.111)	(5.721)	(5.758)
CountryLTU	23.369***	20.558***	23.431***
	(6.463)	(6.116)	(6.417)
CountryLUX	60.057***	50.514***	60.268***
	(10.467)	(10.444)	(12.809)
CountryLVA	24.975***	20.904***	25.065***
	(6.988)	(6.699)	(7.348)
CountryPOL	-6.219	-4.242	-6.263
	(6.206)	(5.828)	(5.939)
CountryROU	-11.521*	-6.191	-6.696
	(5.957)	(5.929)	(5.833)
year2002	14.718***	11.915***	13.311***
	(4.203)	(4.065)	(4.228)
year2011	14.175***	13.046***	11.108**
	(4.491)	(4.203)	(4.736)
year2014	8.657*	7.202*	4.043
	(4.396)	(4.131)	(4.601)
year2018	18.830***	17.399***	16.149***
	(4.403)	(4.136)	(4.669)
Constant	53.514***	43.487***	56.120***
	(12.196)	(12.020)	(15.694)
N	50	49	44
R2	0.758	0.672	0.712
Adjusted R2	0.661	0.537	0.587
Residual Std. Error	9.398 (df = 35)	8.745 (df = 34)	8.587 (df = 30)
F Statistic	7.814*** (df = 14; 35)	4.984*** (df = 14; 34)	5.698*** (df = 13; 30)

*p < .1; **p < .05; ***p < .01

Table 14. OLS regression results of EU countries with a specialisation effect: competitiveness during economic shocks vs. industrial specialisation

During economic shocks

	Competitiveness		
	All countries	DNK,GRC,HUN,SVK,SVN	CYP,IRL,MLT
	(1)	(2)	(3)
KSI	0.251***	0.123	0.136
	(0.048)	(0.198)	(0.118)
Constant	-22.371***	-11.299	-17.105***
	(3.042)	(16.217)	(5.836)
N	56	21	35
R2	0.338	0.020	0.039
Adjusted R2	0.326	-0.032	0.009
Residual Std. Error	6.330 (df = 54)	7.997 (df = 19)	5.173 (df = 33)
F Statistic	27.595*** (df = 1; 54)	0.387 (df = 1; 19)	1.322 (df = 1; 33)

*p < .1; **p < .05; ***p < .01

Table 15. OLS regression results of EU countries with a specialisation effect: competitiveness during recoveries vs. industrial specialisation

During recoveries

	Competitiveness		
	All countries	DNK,GRC,HUN,SVK,SVN	CYP,IRL,MLT
	(1)	(2)	(3)
KSI	0.212*	0.535	0.425
	(0.125)	(0.440)	(0.347)
Constant	-6.352	-33.445	-15.767
	(7.793)	(35.206)	(16.965)
N	40	15	25
R2	0.070	0.102	0.061
Adjusted R2	0.046	0.033	0.020
Residual Std. Error	13.435 (df = 38)	16.029 (df = 13)	11.935 (df = 23)
F Statistic	2.873* (df = 1; 38)	1.475 (df = 1; 13)	1.494 (df = 1; 23)

*p < .1; **p < .05; ***p < .01

Table 16. OLS regression results of EU countries with diversified portfolios: competitiveness vs. changes in industrial specialisation during economic shocks, controlled for country and time specifics

During economic shocks

		Competitiveness	
	All countries	DEU,ESP,NLD,SWE	BEL,CZE,FRA,PRT,AUT,ITA
	(1)	(2)	(3)
pdelta_KSI	20.539*	48.183**	5.761
	(10.449)	(17.840)	(13.700)
CountryBEL	-0.474		-0.736
	(1.332)		(1.286)
CountryCZE	-3.124**		-2.900**
	(1.329)		(1.280)
CountryDEU	0.171		
	(1.335)		
CountryESP	-0.540	-1.204	
	(1.319)	(1.382)	
CountryFRA	0.297		0.279
	(1.319)		(1.263)
CountryITA	-1.551		-1.467
	(1.321)		(1.266)
CountryNLD	0.276	-0.202	
	(1.322)	(1.359)	
CountryPRT	0.351		0.031
	(1.339)		(1.298)
CountrySWE	0.976	0.322	
	(1.319)	(1.380)	
year2000	1.952*	1.257	1.895
	(1.148)	(1.949)	(1.393)
year2009	-6.874***	-6.430***	-6.797***
	(1.107)	(1.782)	(1.387)
year2012	-1.462	-1.088	-2.182
	(1.112)	(1.848)	(1.365)
year2015	-6.982***	-6.640***	-7.090***
	(1.110)	(1.782)	(1.381)
year2019	4.393***	2.661	5.012***
	(1.105)	(1.799)	(1.385)
year2020	4.564***	6.334***	3.386**
	(1.114)	(1.793)	(1.381)
Constant	-8.448***	-8.414***	-7.930***
	(1.191)	(1.511)	(1.288)
N	70	28	42
R2	0.815	0.852	0.839
Adjusted R2	0.760	0.765	0.773
Residual Std. Error	2.468 (df = 53)	2.516 (df = 17)	2.363 (df = 29)
F Statistic	14.631*** (df = 16; 53)	9.795*** (df = 10; 17)	12.628*** (df = 12; 29)

*p < .1; **p < .05; ***p < .01

Table 17. OLS regression results of EU countries with diversified portfolios: competitiveness vs. changes in industrial specialisation during recoveries, controlled for country and time specifics

During recoveries

	All countries	Competitiveness DEU,ESP,NLD,SWE	BEL,CZE,FRA,PRT,AUT,ITA
	(1)	(2)	(3)
pdelta_KSI	76.687***	103.565***	-14.396
	(21.231)	(20.096)	(48.085)
CountryBEL	-4.645		-0.014
	(3.761)		(4.391)
CountryCZE	0.571		4.454
	(3.715)		(4.183)
CountryDEU	-3.851		
	(3.777)		
CountryESP	-2.515	1.952	
	(3.661)	(3.042)	
CountryFRA	-3.149		0.121
	(3.683)		(4.035)
CountryITA	-3.090		-1.954
	(3.613)		(3.696)
CountryNLD	-3.485	0.715	
	(3.704)	(3.018)	
CountryPRT	-5.106		-2.041
	(3.673)		(3.990)
CountrySWE	-4.796	-0.972	
	(3.784)	(3.007)	
year2002	6.033**	2.384	7.289**
	(2.574)	(3.381)	(3.422)
year2011	9.361***	8.478**	9.699***
	(2.548)	(3.362)	(3.333)
year2014	-1.533	-4.556	1.773
	(2.615)	(3.443)	(3.485)
year2018	14.225***	9.647**	15.560***
	(2.550)	(3.370)	(3.422)
Constant	3.925	1.955	-0.345
	(3.098)	(3.021)	(3.632)
N	50	20	30
R2	0.629	0.810	0.640
Adjusted R2	0.481	0.672	0.450
Residual Std. Error	5.697 (df = 35)	4.754 (df = 11)	5.766 (df = 19)
F Statistic	4.243*** (df = 14; 35)	5.876*** (df = 8; 11)	3.371** (df = 10; 19)

*p < .1; **p < .05; ***p < .01

Table 18. OLS regression results of EU countries with an industrial diversification effect: competitiveness vs. changes in industrial specialisation during economic shocks, controlled for country and time specifics

During economic shocks

	Competitiveness		
	All countries	without BGR'97, ROU'97	without BGR'97, ROU'97, BGR'09
	(1)	(2)	(3)
pdelta_KSI	-134.467***	40.487*	77.493***
	(36.696)	(24.050)	(26.715)
CountryEST	9.082	-0.623	2.514
	(6.530)	(3.444)	(3.467)
CountryFIN	10.370	-2.457	0.020
	(6.472)	(3.497)	(3.439)
CountryGBR	15.399**	1.139	3.313
	(6.468)	(3.539)	(3.447)
CountryHRV	7.634	-2.747	0.247
	(6.512)	(3.451)	(3.456)
CountryLTU	9.366	2.054	5.697
	(6.618)	(3.438)	(3.533)
CountryLUX	20.121***	4.076	5.873*
	(6.482)	(3.605)	(3.478)
CountryLVA	10.846	1.049	4.167
	(6.527)	(3.444)	(3.465)
CountryPOL	9.775	-3.825	-1.511
	(6.468)	(3.518)	(3.442)
CountryROU	-1.726	-6.603*	-3.910
	(6.469)	(3.585)	(3.542)
year2000	12.202**	-2.679	-3.252
	(5.414)	(3.003)	(2.849)
year2009	-9.683*	-18.755***	-20.183***
	(5.591)	(2.950)	(2.842)
year2012	7.759	-5.766*	-6.052**
	(5.432)	(2.972)	(2.813)
year2015	0.648	-11.298***	-11.250***
	(5.470)	(2.949)	(2.790)
year2019	13.619**	-0.021	-0.331
	(5.430)	(2.974)	(2.816)
year2020	9.125	-0.355	0.215
	(5.570)	(2.947)	(2.796)
Constant	-22.831***	-0.393	-2.746
	(5.882)	(3.513)	(3.441)
N	70	68	67
R2	0.509	0.672	0.710
Adjusted R2	0.361	0.569	0.617
Residual Std. Error	12.100 (df = 53)	6.148 (df = 51)	5.816 (df = 50)
F Statistic	3.439*** (df = 16; 53)	6.533*** (df = 16; 51)	7.642*** (df = 16; 50)

*p < .1; **p < .05; ***p < .01

Table 19. OLS regression results of EU countries with an industrial diversification effect: competitiveness vs. changes in industrial specialisation during recoveries, controlled for country and time specifics

During recoveries

	Competitiveness		
	All countries	without ROU'99	without ROU'11
	(1)	(2)	(3)
pdelta_KSI	65.247*	55.658*	134.030***
	(33.566)	(28.364)	(33.601)
CountryEST	10.067	10.248	8.772
	(7.924)	(6.671)	(6.722)
CountryFIN	2.339	2.197	3.363
	(7.915)	(6.663)	(6.711)
CountryGBR	-6.185	-5.601	-10.373
	(8.159)	(6.871)	(6.998)
CountryHRV	-3.303	-3.253	-3.662
	(7.901)	(6.652)	(6.694)
CountryLTU	8.686	8.685	8.692
	(7.899)	(6.650)	(6.692)
CountryLUX	8.697	8.918	7.118
	(7.937)	(6.682)	(6.736)
CountryLVA	1.902	2.167	0.005
	(7.953)	(6.696)	(6.756)
CountryPOL	3.914	3.943	3.706
	(7.900)	(6.650)	(6.693)
CountryROU	-12.508	-2.943	-22.456***
	(7.928)	(7.106)	(7.198)
year2002	15.114**	10.240**	15.083***
	(5.585)	(4.864)	(4.732)
year2011	20.667***	16.182***	12.184**
	(5.753)	(4.976)	(5.350)
year2014	15.204**	10.461**	14.233***
	(5.606)	(4.872)	(4.756)
year2018	25.134***	20.445***	23.772***
	(5.625)	(4.884)	(4.778)
Constant	-8.953	-5.341	-5.734
	(6.687)	(5.704)	(5.726)
N	50	49	49
R2	0.572	0.526	0.699
Adjusted R2	0.401	0.331	0.576
Residual Std. Error	12.489 (df = 35)	10.514 (df = 34)	10.581 (df = 34)
F Statistic	3.339*** (df = 14; 35)	2.699*** (df = 14; 34)	5.649*** (df = 14; 34)

*p < .1; **p < .05; ***p < .01

Table 20. OLS regression results of EU countries with an industrial specialisation effect: competitiveness vs. changes in industrial specialisation during economic shocks

During economic shocks

	All countries (1)	Competitiveness DNK,MLT,SVK,SVN (2)	CYP,GRC,HUN,IRL (3)
pdelta_KSI	-25.546	-31.297	-25.689
	(26.855)	(36.007)	(42.275)
Constant	-6.803***	-6.307***	-7.198***
	(1.056)	(1.390)	(1.693)
N	56	28	28
R2	0.016	0.028	0.014
Adjusted R2	-0.002	-0.009	-0.024
Residual Std. Error	7.717 (df = 54)	6.565 (df = 26)	8.956 (df = 26)
F Statistic	0.905 (df = 1; 54)	0.755 (df = 1; 26)	0.369 (df = 1; 26)

*p < .1; **p < .05; ***p < .01

Table 21. OLS regression results of EU countries with am industrial specialisation effect: competitiveness vs. changes in industrial specialisation during recoveries

During recoveries

	All countries (1)	Competitiveness DNK,MLT,SVK,SVN (2)	CYP,GRC,HUN,IRL (3)
pdelta_KSI	-67.948*	59.013	-129.807***
	(35.393)	(65.550)	(35.631)
Constant	6.939***	6.029*	8.567***
	(2.125)	(3.102)	(2.512)
N	40	20	20
R2	0.088	0.043	0.424
Adjusted R2	0.064	-0.010	0.392
Residual Std. Error	13.303 (df = 38)	13.861 (df = 18)	10.967 (df = 18)
F Statistic	3.686* (df = 1; 38)	0.811 (df = 1; 18)	13.272*** (df = 1; 18)

*p < .1; **p < .05; ***p < .01

Table 22. OLS regression results of EU countries with diversified portfolios: competitiveness vs. proportional changes in population, controlled for country and time specifics

	Competitiveness	
	During shocks	During recoveries
	(1)	(2)
pdelta_pop	-155.006	-63.770
	(103.188)	(113.033)
year2000	2.674**	
	(1.122)	
year2009	-6.212***	
	(1.165)	
year2012	-1.073	
	(1.123)	
year2015	-6.558***	
	(1.127)	
year2019	4.382***	
	(1.121)	
year2020	4.576***	
	(1.138)	
year2002		4.907
		(2.991)
year2011		9.253***
		(2.981)
year2014		0.754
		(2.985)
year2018		14.331***
		(3.101)
CountryBEL	-0.687	-0.697
	(1.342)	(4.203)
CountryCZE	-3.064**	3.199
	(1.349)	(4.353)
CountryDEU	-0.598	-0.353
	(1.361)	(4.335)
CountryESP	-0.400	-0.486
	(1.343)	(4.239)
CountryFRA	0.260	-0.402
	(1.338)	(4.202)
CountryITA	-2.223	-2.492
	(1.438)	(4.250)
CountryNLD	0.302	-0.298
	(1.345)	(4.205)
CountryPRT	-0.658	-3.136
	(1.390)	(4.339)
CountrySWE	1.347	-0.299
	(1.366)	(4.240)
Constant	-7.668***	1.839
	(1.236)	(3.623)
N	70	50
R2	0.810	0.496
Adjusted R2	0.753	0.294
Residual Std. Error	2.504 (df = 53)	6.644 (df = 35)
F Statistic	14.124*** (df = 16; 53)	2.457** (df = 14; 35)

*p < .1; **p < .05; ***p < .01

Table 23. OLS regression results of EU countries with an industrial diversification effect: competitiveness vs. proportional changes in population during economic shocks, controlled for country and time specifics

During economic shocks

	Competitiveness		
	All countries	without BGR'97, ROU'97	without BGR'97, ROU'97, BGR'09
	(1)	(2)	(3)
pdelta_pop	-610.170	-51.926	-52.668
	(432.744)	(209.939)	(208.936)
CountryEST	16.430**	0.126	1.607
	(7.666)	(3.851)	(4.020)
CountryFIN	16.809**	-0.858	0.625
	(8.121)	(4.083)	(4.242)
CountryGBR	22.420**	3.212	4.698
	(8.760)	(4.403)	(4.548)
CountryHRV	10.863	-2.148	-0.671
	(7.116)	(3.542)	(3.727)
CountryLTU	13.666*	1.833	3.309
	(7.134)	(3.531)	(3.717)
CountryLUX	34.172**	7.278	8.773
	(13.163)	(6.556)	(6.638)
CountryLVA	12.000	1.298	2.773
	(7.260)	(3.574)	(3.756)
CountryPOL	12.929*	-2.277	-0.796
	(7.389)	(3.705)	(3.881)
CountryROU	-0.495	-5.690	-4.212
	(7.130)	(3.653)	(3.831)
year2000	14.707**	-1.461	-1.311
	(6.086)	(3.140)	(3.127)
year2009	-3.122	-18.916***	-19.652***
	(6.031)	(3.105)	(3.148)
year2012	10.763*	-4.908	-4.758
	(6.016)	(3.094)	(3.082)
year2015	5.754	-10.730***	-10.579***
	(6.142)	(3.174)	(3.161)
year2019	16.991***	0.902	1.053
	(6.073)	(3.132)	(3.119)
year2020	16.303**	-0.343	-0.192
	(6.175)	(3.193)	(3.180)
Constant	-31.983***	-2.150	-3.634
	(7.366)	(4.132)	(4.288)
N	70	68	67
R2	0.407	0.654	0.661
Adjusted R2	0.228	0.546	0.553
Residual Std. Error	13.299 (df = 53)	6.312 (df = 51)	6.282 (df = 50)
F Statistic	2.276** (df = 16; 53)	6.033*** (df = 16; 51)	6.103*** (df = 16; 50)

*p < .1; **p < .05; ***p < .01

Table 24. OLS regression results of EU countries with an industrial diversification effect: competitiveness vs. proportional changes in population during recoveries, controlled for country and time specifics

During recoveries

	Competitiveness		
	All countries	without ROU'99	without ROU'11
	(1)	(2)	(3)
pdelta_pop	-469.908**	-381.194**	-485.201**
	(189.226)	(162.313)	(182.203)
CountryEST	16.729**	15.704**	16.906**
	(7.973)	(6.774)	(7.670)
CountryFIN	13.945	11.571	14.354
	(9.188)	(7.825)	(8.841)
CountryGBR	13.076	10.190	13.574
	(9.832)	(8.381)	(9.462)
CountryHRV	-1.635	-1.885	-1.591
	(7.685)	(6.524)	(7.393)
CountryLTU	5.621	6.199	5.522
	(7.765)	(6.594)	(7.470)
CountryLUX	38.487***	33.146***	39.408***
	(13.732)	(11.741)	(13.218)
CountryLVA	0.479	1.088	0.374
	(7.776)	(6.603)	(7.480)
CountryPOL	12.964	11.293	13.252
	(8.455)	(7.191)	(8.135)
CountryROU	-11.001	-2.179	-16.287**
	(7.750)	(6.973)	(7.930)
year2002	10.688*	6.853	10.543*
	(5.710)	(4.951)	(5.494)
year2011	22.299***	17.820***	19.577***
	(5.437)	(4.763)	(5.413)
year2014	17.478***	12.546**	17.522***
	(5.448)	(4.802)	(5.241)
year2018	26.612***	21.901***	26.618***
	(5.422)	(4.765)	(5.216)
Constant	-19.343**	-14.014**	-19.079***
	(7.253)	(6.314)	(6.979)
N	50	49	49
R2	0.597	0.546	0.635
Adjusted R2	0.435	0.360	0.484
Residual Std. Error	12.122 (df = 35)	10.291 (df = 34)	11.661 (df = 34)
F Statistic	3.699*** (df = 14; 35)	2.925*** (df = 14; 34)	4.221*** (df = 14; 34)

*p < .1; **p < .05; ***p < .01

Table 25. OLS regression results of EU country-groups with an industrial diversification effect: competitiveness vs. proportional changes in population during recoveries, controlled for country and time specifics

During recoveries

	Competitiveness		
	All countries	BGR,GBR,HRV,LTU,LVA,POL,ROU w/oROU'11	EST,FIN,LUX
	(1)	(2)	(3)
pdelta_pop	-469.908**	-464.980*	-161.975
	(189.226)	(245.564)	(462.492)
CountryEST	16.729**		
	(7.973)		
CountryFIN	13.945		-7.465
	(9.188)		(10.303)
CountryGBR	13.076	12.916	
	(9.832)	(10.955)	
CountryHRV	-1.635	-1.649	
	(7.685)	(7.529)	
CountryLTU	5.621	5.653	
	(7.765)	(7.665)	
CountryLUX	38.487***		6.779
	(13.732)		(23.724)
CountryLVA	0.479	0.513	
	(7.776)	(7.684)	
CountryPOL	12.964	12.871	
	(8.455)	(8.809)	
CountryROU	-11.001	-16.531*	
	(7.750)	(8.124)	
year2002	10.688*	16.875**	-4.049
	(5.710)	(7.231)	(9.750)
year2011	22.299***	22.266***	10.184
	(5.437)	(6.948)	(10.791)
year2014	17.478***	21.806***	3.496
	(5.448)	(6.344)	(11.353)
year2018	26.612***	29.412***	13.136
	(5.422)	(6.730)	(14.377)
Constant	-19.343**	-21.902***	10.718
	(7.253)	(7.385)	(11.461)
N	50	34	15
R2	0.597	0.698	0.421
Adjusted R2	0.435	0.546	-0.157
Residual Std. Error	12.122 (df = 35)	11.853 (df = 22)	11.911 (df = 7)
F Statistic	3.699*** (df = 14; 35)	4.614*** (df = 11; 22)	0.729 (df = 7; 7)

*p < .1; **p < .05; ***p < .01

Table 26. OLS regression results of EU countries with an industrial specialisation effect: competitiveness vs. proportional changes in population during economic shocks

During economic shocks

	All countries	Competitiveness DNK,GRC,HUN,SVK,SVN	CYP,IRL,MLT
	(1)	(2)	(3)
pdelta_pop	266.873***	-86.380	352.976
	(98.682)	(149.635)	(238.053)
Constant	-8.722***	-0.026	-11.027***
	(1.161)	(2.772)	(0.942)
N	56	21	35
R2	0.119	0.017	0.062
Adjusted R2	0.103	-0.034	0.034
Residual Std. Error	7.303 (df = 54)	8.008 (df = 19)	5.108 (df = 33)
F Statistic	7.314*** (df = 1; 54)	0.333 (df = 1; 19)	2.199 (df = 1; 33)

*p < .1; **p < .05; ***p < .01

Table 27. OLS regression results of EU countries with an industrial specialisation effect: competitiveness vs. proportional changes in population during recoveries, controlled for time and country specifics

During recoveries

		Competitiveness	
	All countries	DNK,GRC,HUN,SVK,SVN	CYP,IRL,MLT
	(1)	(2)	(3)
pdelta_pop	267.923**	299.528**	39.018
	(128.577)	(104.707)	(306.446)
CountryDNK	1.312		
	(6.385)		
CountryGRC	-0.457		-4.251
	(6.871)		(6.330)
CountryHUN	6.894		1.906
	(7.190)		(7.298)
CountryIRL	2.263	2.317	
	(6.181)	(4.170)	
CountryMLT	-0.507	-0.712	
	(6.233)	(4.221)	
CountrySVK	2.446		-0.980
	(6.783)		(6.086)
CountrySVN	2.325		-0.865
	(6.729)		(5.946)
year2002	9.645*	-4.518	18.099***
	(4.887)	(5.391)	(5.388)
year2011	-0.021	-20.804***	12.602**
	(4.895)	(5.406)	(5.399)
year2014	10.741**	1.821	15.389**
	(4.933)	(5.447)	(5.510)
year2018	25.661***	17.616**	29.858***
	(5.021)	(5.996)	(5.392)
Constant	-7.424	2.225	-9.659
	(6.033)	(4.882)	(6.173)
N	40	15	25
R2	0.651	0.918	0.688
Adjusted R2	0.496	0.837	0.501
Residual Std. Error	9.767 (df = 27)	6.588 (df = 7)	8.520 (df = 15)
F Statistic	4.194*** (df = 12; 27)	11.242*** (df = 7; 7)	3.674** (df = 9; 15)

*p < .1; **p < .05; ***p < .01

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