Inzinerine Ekonomika-Engineering Economics, 2023, 34(5), 593–611

Measuring Economic Resilience through Industrial Portfolio: the Cases of New EU Member States Since 2004

Andrius Montrimas, Jurgita Bruneckiene, Vilda Giziene

Kaunas University of Technology
K. Donelaicio st. 73, LT-44029, Kaunas, Lithuania
E-mail: andrius.montrimas@ktu.edu; jurgita.bruneckiene@ktu.lt; vilda.giziene@ktu.lt

https://doi.org/10.5755/j01.ee.34.5.35515

The relevance of economic resilience topic is increasingly growing, still mixed results prevail in academic research. Resilience research typically concentrates on the Western European region. The research gap appears in focus towards the East since the concept of economic resilience is context dependent. By adapting the calculation mechanism of Martin and Gardiner (2019) to national level, we empirically analysed the economic resilience of 10 Southern and Eastern European countries between 2004 and 2020. We found common competition-related structural changes suggesting where to look for possible consistencies when analysing resilience: countries rarely change industrial portfolios when resist to shocks, unless specific or longer lasting production chain disruptions occur; individual properties dominate when countries recover from shocks, although common industrial portfolio shifts evident in manufacturing, and real estate industries. Results provide an original methodology and initial basis for the development of nation-specific policies to increase economic resilience and structural reforms effectiveness.

Keywords: *Economic Resilience; Industrial Portfolio; Structural Changes; Reorientation; Resistance; Recoverability.*

Introduction

Various turbulences in economic and political activity, economic and political shocks, as well as military conflicts, are growing worldwide affecting the national awareness and future economic and political strategies of countries. Many nations in such "new normal" times set strategic goals focused on increasing the resilience of their economies to various shocks. Economic resilience is the capability of an economy to avoid economic shocks and rapid recovery to main functionality (Briguglio *et al.*, 2008).

After the 2008 financial crisis, scientific research in the field of economic resilience has been growing rapidly with intensive searches for ways, factors, and conditions that may keep the economy as resilient as possible to both internal (regional and national) as well as external (global) economic shocks. European countries, however, are still characterized by unequal economic resilience (Cuadrado-Roura *et al.*, 2016). As the concept of economic resilience is characterized by geographic heterogeneity and context dependent, this research field is still lacking methodological and empirical insights under the context of economic shocks.

The scientific literature distinguishes various factors that determine economic resilience, such as economic structure, labour market conditions, export orientation, innovation, entrepreneurship, and institutional structures, even distance from economic centre (Martin & Gardiner, 2019; Martin & Sunley, 2016). Among many factors, the economic structure is treated as particularly important for the resilience of a country, as the development of each country's economy depends on the resilience of individual industries (Delgado-Bello *et al.*, 2023), which may react differently to an economic shock (Fingleton *et al.*, 2012). For example, in 2008 the global financial crisis negatively affected the productivity of the Lithuanian construction sector (in the first quarter of 2009 compared to the first quarter of 2008 it decreased by -16.7 percent), while the economic shock caused by the COVID-19 pandemic had a positive impact (increased by 20.7 percent in the second quarter of 2020 compared to the second quarter of 2019). That is why the analysis of industry characteristics in the context of economic shocks may provide needed information for targeted and more effective economic support measures - both during a crisis, and to foster long-term resilience (OECD, 2021). Most of the literature has been based on the Western Europe and other developed economies (Hundt & Grun, 2020; Martini, 2020; Delgado-Bello *et al.*, 2023). The results of resilience research from other countries Italy (Di Caro, 2015), Germany (Hundt & Grun, 2022), Britain (Martin *et al.*, 2016, Martin & Gardiner, 2019) can be transferred to the Eastern Europe countries only to a limited extent. The differences are in the institutional setting, prevailing industry structure, and the degree of export orientation and the economic development performance. Oprea et al. (2020) are amongst the few that analyse resilience of the Eastern European regions, located in Central Europe and the Balkan peninsula (Bulgaria, Hungary, Croatia, Czech Republic, Romania, Slovakia, and Slovenia) at NUTS (Nomenclature of territorial units for statistics, a hierarchical system for dividing up the economic territory of the EU and the UK. Eurostat) 2 regional level.

Despite the high relevance of the topic, so far only a few studies have empirically examined the resilience of small open economies from Eastern Europe (Poland and the Baltic States). Our study addresses this research gap.

The aim of this article is to conduct an in-depth analysis of how the industrial portfolio of a country influences the resilience of its economy. Conroy (1975) and Martin (2012) denote the region's industrial portfolio being its mix of

economic activities, the relationships, and interdependencies between them that can influence the reaction of the region's economy to recessionary disturbances and fluctuations.

Industrial portfolio denotes economy's industries or its products (Martin *et al.,* 2016). This is to provide a comprehensive case study-based assessment that offers valuable methodological insights into the intricate relationship between industrial portfolio and national resilience. We employ the theory of regional diversification (Boschma *et al.,* 2017) to investigate the economic resilience concept through industrial portfolio approach at national level. The research methods include a systematic, comparative, and logical analysis of scientific literature, OLS covariate regression, fixed and random effects modelling. The analysis covers a period of 17 years of 10 Southern and Eastern European countries that joined the European Union (hereon – EU) since 2004 (the 2004–2020 period). These countries are benchmarked against the aggregate performance of 25 EU member states. Data sources are OECD and World bank data bases.

This article makes several important contributions. First, it complements and extends the literature on regional diversification with the focus on the Eastern European countries. It provides a new look at the regional diversification from a perspective of the components of National Accounts (NAs) – balance sheets of the EU counties (Eurostat, 2011). The article examines the association of diversification/specialization with the resistance and recoverability of countries. We state that the interrelatedness of industries affects national resilience to economic shocks in the economies that freely operate within the EU. Second, the article presents the adaptation of the methodology of Martin and Gardiner (2019) to the national level. Third, it provides original empirical evidence based on the cases of ten open economies that joined the EU in 2004 with revealed common trends within industrial performances during the EU-wide recessions and the consequent recovery periods. Finally, an industry-focused analysis is essential for policymaking, as it allows tailoring policies and support measures.

The paper is organized as follows. Theoretical analysis provides the grounds for the resilience calculation by adapting the methodology of Martin and Gardiner (2019). Data and methodology section provides the data and research methodology. The results, their interpretation in the discussion and the conclusions are presented in the latter chapters. The source data is retrieved and processed by using R script.

Literature Review

Understanding the Concept of Resilience

There is no commonly accepted definition of 'resilience' in literature (Oprea *et al.,* 2020). The concept, proposed by Martin and Sunley (2014), describes it as a multifaceted process. Briguglio et al. (2009) treat economic resilience as a set of actions implemented by socio-economic systems to help the territory recover from and/or to adapt to a negative recessionary shock or to help benefit to the greatest extent from a positive shock. Economists usually see the regional resilience as a highly complex concept that consists of many variables. Resistance, recovery, re-orientation, and renewal – the four 'dimensions' of regional resilience, identified by Martin (2012) that are most frequently taken as the basis for an economic interpretation by many economists (Martin & Sunley, 2014; Martin *et al.,* 2016; Oprea *et al.,* 2020). Later research works introduced and elaborated on additional dimensions that describe region's sensitivity, robustness, responsiveness, and adaptiveness to different types of recessionary shocks at various levels of detail (Martin & Sunley, 2014; Martin *et al.,* 2016).

Sectoral structure (denoted as industrial portfolio in this article) is one of the main determinants when studying resilience at both the theoretical and empirical levels (Delgado-Bello *et al.,* 2023). The research (Martini, 2020; Oprea *et al.,* 2020; Hundt & Grun, 2022; Delgado-Bello *et al.,* 2023) focuses on identifying the most or least resilient industries, but even here there are mixed results. Kluge (2017) argues that in Western Europe, the manufacturing sector is more resilient to economic shocks than the service sector. Mai et al (2019) stated that in China, construction, real estate, and financial services have the greatest potential to "disrupt" the country's economy, while the industrial sector has the greatest potential to "stabilize" it. However, Ray et al., (2016) highlighted the service sector as one of the best performers during crises. Papaioannou (2023), Kim et al, (2022) clarified that information and communication technology intensive countries were able to counteract part of the economic losses, as they were more resilient to the lockdowns triggered by the pandemic. Sectors closely related to the cycle, such as construction, are more sensitive to financial crises (Delgado-Bello *et al.,* 2023), however public services and administration tend to be more stable over time (Martin *et al.,* 2016). No consensus found in results suggests that to fill the research gap in finding strategies to increase the economic resilience of countries' economies, it is necessary to expand the research field from individual industry to industrial portfolio.

The Role of Industrial portfolio in Economic Resilience

A region's industrial mix or industrial portfolio acts as one input to resilience (Conroy, 1975, Martin, 2012). Scientists studying the industrial portfolio, again, do not reach a unified opinion regarding different geographical areas. The mixed results can be found in research, which prove the context-dependency of economic resilience. Even Conroy in 1975 recognized industrial diversity as a means of economic stability or as having a neutral influence. Brown et al (2016) found that more concentrated counties had lower unemployment rates when times were good, however counties with more diverse industry structures fared better during times of national or local employment shocks. Doran, Fingleton (2018) argued that a diversified structure helps the local economy to mitigate sector-specific shocks and thus contribute to overall economic stability. However, Cuadrado-Roura, Maroto (2016) stated that specialization in dynamic sectors improved regional economic resilience. Hundt and Grun (2022) stressed not only the effects of specialization, along with Marshall–Arrow–Romer (MAR) and Jacobs externalities as such, but also the temporal occurrence of these effects and timely impact on resilience. An example is provided by the cluster

life cycle concept, where the beneficial effects of increasing (knowledge) specialization primarily in the growth and sustainment phase of clusters. In the potentially final stage of the life cycle, however, a high degree of specialization can have a negative impact as it carries the risk of lock-in, but even then, specialized clusters and regions can avert the resulting decline as long as they maintain or keep renewing their competitiveness.

Krugman index is commonly applied for identification of regional structural specialization (Martin *et al.,* 2016; Martin & Gardiner, 2019; Martini, 2020). It compares the employment share for each industry in a region with the corresponding national share (Martini, 2020). Sectoral employment may be subject to data availability constraint. The results as Oprea et al (2020) note, might represent longer response periods.

Resilience Evaluation Methods

Martin and Gardiner (2019) distinguish several different approaches for analysing regional resilience in general literature. Although no consensus on generally agreed methodology or in results, they note the necessity of presence of a reference specified counterfactual or expected position as a reference point against which resistance and recoverability are measured.

Resilience within the patterns of regional growth is usually evaluated through Gross domestic product (GDP) per capita (Martin & Sunley, 2015). Regional output fluctuations and employment changes are nevertheless considered as the ones better reflecting market reactions to turbulences (Martin & Sunley, 2015, Martin *et al.,* 2016). Many attempts to quantify resilience are contrarily made through evaluation of GDP per capita changes within specific regions (Oprea *et al.,* 2020; Hundt & Grun, 2022), while others follow Martin et al (2016) by using employment statistics for quantification of resilience (Martini, 2020). Oprea et al (2020) note the unemployment statistics being dependent on GDP and having longer response periods to shocks than GDP. Martin and Gardiner (2019) meanwhile indicate a partial employment data availability constraint by making assumptions for the occupational skill mix.

Resilience in literature is usually measured through two main properties, as suggested by Martin et al (2016) - resistance and recovery (Martin & Gardiner, 2019; Martini, 2020; Oprea *et al.,* 2020; Hundt & Grun, 2022). Resilience is usually interpreted as the ability to recover from shock or to reach the pre-shock level. Martin and Gardiner (2019) note the concept of 'hysteresis' in the general literature as the counterpart of resilience. More specifically, those models of shocks and perturbations that allow for the possibility that a recession or similar disturbance can have permanent (especially) negative effects on an economy's growth path. The output does not revert to its pre-shock trend, and instead the trend itself is shifted, typically downwards in these cases. Martin and Gardiner (2019) refer to the Hamilton's (1989) concepts of hysteretic recession when identifying the recovery paths (from shocks) of output development within an economy.

Martin and Gardiner (2019) use annual output data, measured in constant prices to evaluate relative resilience of cities (regions) by benchmarking them to the national economy. They propose a methodology for comparing cities and regions to one another by benchmarking them to the national resistance and recovery. Considering a recession being an economy-wide event, they apply an expectation that each city (or region) within the economy should react in the same way as the macro-aggregate. The national reaction is thus the benchmark against which all cities can be compared, while the alterations from the benchmark indicate each city's (or region's) relative resilience. Martin and Gardiner (2019) use resistance and recoverability (recovery) variables for measuring relative resilience of 85 cities of the Great Britain between 1971 and 2015. The zero values of resistance and recoverability variables indicate the same result of economic state as of the national economy.

Mascaretti et al (2022) provide an extensive list of researchers, who underline OECD's input-output tables – IOTs (OECD, 2022) – being a powerful instrument, used to represent and analyse the production structure of an economy, perform impact analysis, or estimate the effects of various shocks, affecting economic activity at different geographic levels. Pamucar et al (2023) use IOTs to model interdependencies of industries through the inputs of intermediate consumption. They reveal how COVID-19 pandemic-induced perturbations in Agriculture, Mining and Minerals, and Energy industries spread to others within an economy. Term 'intermediate consumption' (or 'intermediate use') means the goods and services consumed as inputs by a process of production, excluding fixed assets (Eurostat, 2013). In other words, it consists of country's goods and services that are either transformed or used up by the production process.

IOTs use the data and accounting structure of National Accounts (NAs) which detail the statistics of national and sectoral output, including industrial portfolio contents and employment results in terms monetary value (European Commission, 2008). GDP is denoted as the sum of Gross value added (GVA) and net taxes on products (Eurostat, 2013). An important property of GDP within the NAs is that it does not include intermediate consumption at purchaser prices. Van Leeuwen et al (2005) note that input-output models are based on the idea that any output requires a corresponding input, meaning that consumption is equal to production in each industry. Mascaretti et al (2022) denote 'intermediate' meaning the interindustrial relationships in IOTs that emerge from the so-called inter-industry input matrix, where row entries represent outputs from a given sector, and column entries represent inputs to an industry.

OECD has accumulated the national results of IOTs into the Inter-country-input-output tables - ICIO tables (OECD, 2023), thence a cross-national standardised information on economic performance, including employment results and industrial portfolio properties. ICIO tables additionally have the values of imported intermediate products, which are included into the value of country's intermediate consumption. The following analyses, among many others, use ICIO tables by identifying them as the World Input-Output Database (WIOD):

- Lewis et al (2021) consider a multi-country, two-sector Eaton–Kortum trade model to analyse the world economy with non-homothetic preferences. They portray the global expenditure shift from goods to services over time in the world market through the structure of the IOTs. Their

analyses, however, have been completed in a notion of growth with the inflation factor included.

- Picek and Schroder (2018) use the same databases to analyse the Germany's final demand spillover effects on the national GDP of Southern European countries through the consumption perspective.

These approaches and altogether set the grounds for measuring the relative resilience, as a construct of resistance and recovery, of regional economic structures from industrial portfolio perspective. The use of economic performance information of NAs, structured in the ICIO tables, implies to be suitable method, practically proven in working on similar research questions.

Data and Research Methodology

Grounds for Choosing the Data of Intermediate Consumption

We denote 'intermediate consumption' being the aggregate input value of domestic and foreign products, reflected in *product x product* ICIO tables (OECD, 2023), which represents the industrial portfolio of a country as defined by Martin (2012).

For the methodological justification of choice of using the values of intermediate consumption instead of output in the further research, we compare aggregate statistics of intermediate consumption against output results of the countries. We use the R script to transform the source files of ICIO tables from the OECD website into the balanced panel data sets. The two panels include annual intermediate consumption and output values of each of the 45 industries under the CPA classification, assigned to each of the 77 countries, enlisted in the ICIO tables during the period between 1995 and 2020.

The Source files contain national intermediate consumption and output values in current prices (USD million), meaning that they include inflation over the years. Elevated inflation usually follows shocks or recessions with various effects, complicating the efforts to understand the dynamics of economic developments. We target to compare the annual economic performances throughout the period from 2004 to 2020 and some aggregate comparisons in this article are made for the whole period from 1995. We therefore benchmark the national economic performance results to 1994 basic prices. Knowing the property of the values of intermediate consumption within the IOTs being at purchaser prices, we eliminate the national inflation values, obtained from the World Bank's database, measured by the annual consumer price index. The following actions performed to eliminate the inflation factor from annual intermediate consumption and output results. First, we take the inflation values by annual consumer price index from the World Bank database for each of the countries on the list of the ICIO tables during the period of 1995 to 2020. The changes of the value of intermediate consumption over time are reflected through the unified consumer price level over the period. Next, we calculate the cumulative inflation rates for every country in the ICIO tables separately by assigning the price level of 1994 to be 100% and progressing by respective annual inflation in every next year until 2020. Finally, we eliminate the inflation part of the intermediate consumption and output values by applying the following formula:

$$IC_{CI}^{t} = \frac{IC\_inf_{CI}^{t}}{cum\_inflation_{C}^{t}} * 100\%, \quad (1)$$

where:

IC_{CI}^{t} - denotes annual value of intermediate consumption (excluding inflation) of industry *I* in country *C* in year *t* (between 1995 and 2020),

$IC\_inf_{CI}^{t}$ - denotes annual value of intermediate consumption (including inflation) of industry *I* in country *C* in year *t*, obtained from ICIO tables,

$cum\_inflation_{C}^{t}$ – denotes cumulative inflation rate (%, when 100 % = 1994) of country *C* in year *t*, calculated as described above from the World Bank data set.

Same calculation applied to obtain the annual output values excluding inflation.

Comparison results of Figures 1 and 2 shows the general trend of annual intermediate consumption results being more volatile than output results in the EU-25, as well as in the world. The EU-25 intermediate consumption results have been more volatile than output results between 2004 and 2020 (Figure 1), while the world aggregate intermediate consumption fluctuations outrun those of output throughout the whole period of OECD's consolidated statistics between 1995 and 2020 (Figure 2).

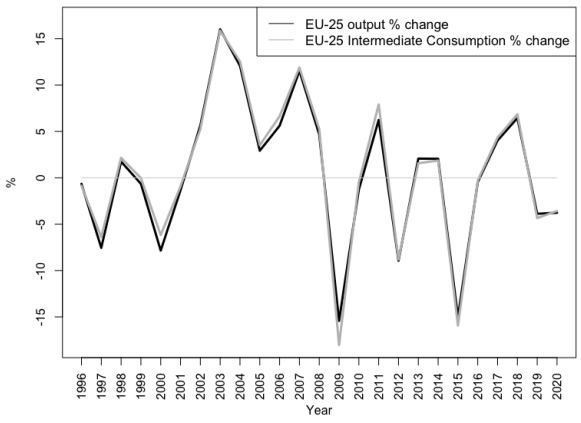


Figure 1. Annual Aggregate Output and Intermediate Consumption Percent Changes of the EU-25, 1994 Price Level.
Source – developed by authors based on ICIO data.

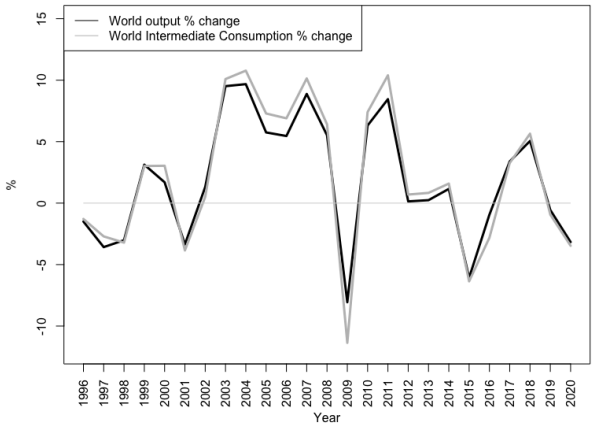


Figure 2. World Annual Aggregate Output and Intermediate Consumption Percent Changes, 1994 Price Level.
Source – developed by authors based on ICIO data.

After comparing the aggregated annual world and EU-25 intermediate consumption results excluding inflation with the respective output results (see Figures 1 and 2 below) we use the values of intermediate consumption at basic prices in the further research due to their higher volatility to the economic turbulences of the world.

Data and Benchmarking Logic

The empirical research analyses the resilience of 10 countries from Southern and Eastern Europe that joined the EU in 2004 (hereon – Countries): Malta, Cyprus, Slovenia, Slovakia, Czech Republic, Hungary, Poland, Lithuania, Latvia, and Estonia. All ten Countries are independent economies promoting free trade within the EU.

Statistical evidence of the Eurostat suggests that the Southern and Eastern part of the EU has a common property of low population density The density of population in these regions vary between 29,8 and 136,1 persons per square kilometre in 2022. This is 10 to 2 times less density than in Great Britain.

Majority of the ten Countries that joined the EU in 2004 are of similar sizes as the British cities. Malta's population density is exceptionally large, but the population count is like Liverpool, Manchester, or Glasgow. Cyprus and Estonia are at the level of Birmingham. Latvia, Lithuania, and Slovakia stand between Birmingham and London. Czech Republic and Hungary have slightly larger population than London. Poland is the only one of the analysed Countries, considered a large EU nation. Empirical evidence in Figure 3a reveals similar reactions of Poland's economy to EU-wide recessional shocks to the reactions of nine other Countries throughout the analysed period.

The analysis covers a period of 17 years (2004–2020 years).

We use the data from the ICIO tables of OECD, the organization that has systemized the data and accounting structure of the NAs.

The ICIO tables provide structured annual economic performance information between 1995 and 2020 in current prices. The national level data is regularly supplied to the IOTs within the EU in full alignment of relation between products and industries, classified according to CPA - statistical classification of products (goods as well as services) by activity under the EU regulation No. 1209/2014 and NACE - common statistical classification of economic activities in the European Community under the EU regulation No. 1893/2006 (European Commission, 2008). OECD is therefore able to harmonize national IOTs for presentation of inter-industrial flows of goods and services produced domestically and abroad. The ICIO tables contain diagonal blocks, representing domestic transaction flows of intermediate goods and services across industries, while the off-diagonal blocks represent the inter-country flows of intermediates via exports and imports (see the link to IOTs in References).

The selected Countries are benchmarked against the aggregate performance of 25 EU member states. We follow the logic of Martin and Gardiner (2019) for benchmarking the regional economies against the national economic structure to obtain the results of relative resilience in the presence of country-wide recessionary shocks. Therefore, we benchmark the performance of the Countries against the aggregate performance of the 25 EU member states that formed the EU economic block between the 1st of May 2004 and the 1st of February 2020.

The panel data for calculation of the benchmark EU-25 aggregate performance involves 45 industries in 25 EU member states during the 17 years, including the aggregate values of EU-25 for 45 industries during 17-year period. This panel data includes the ten Countries from the Southern and Eastern Europe, which are in focus for the analysis.

The analysed period covers four EU-wide recessionary shocks (Kok *et al.*, 2022), best visible in Figure 3, although different in origin:

- Global financial crisis – September 2008 to May 2010,
- Euro area sovereign debt crisis, May 2010 to the second half of 2013,
- European migrant crisis of 2015-2016, and
- Slowdown of the world economy due to the US – China trade tensions, followed by COVID-19 pandemic, from 2019 onwards.

Financial crisis of 2008 was a global recession, caused by collapse of a major banking entity, which quickly exposed the vulnerability of financial institutions around the world. Euro area sovereign debt crisis was rather a regional recession initiated by the Greek public debt sustainability issue and later spread to other vulnerable EU member states. Figure 2 shows relatively stable world economic performance between 2010 and 2013, while there is a significant economic performance drop of EU-25 during that period in Figure 1. European migrant crisis and the US-China trade tensions, followed by the COVID-19 pandemic were unique economic shocks. The first was caused by the idea to fill the employment shortages in the Western Europe, while the latter was a mixture of raised trade barriers and disrupted production chains that stalled the global economic performance.

Onsets of these shocks are considered 2008, 2011, 2014 and 2018). Troughs of shocks are considered 2009, 2012, 2015 and 2020 (estimated, relating to the end of analysed period).

Research Methodological Framework

Our analysis builds on the methodology of Martin and Gardiner (2019) for evaluating relative resilience of regions by benchmarking them against the economic performance of a common wider economic construct. We lift the comparison of resistance and recoverability (recovery) from urban to national level within the definition of "ecological resilience" (Walker et al (2004); Angulo et al (2018); Martin and Gardiner (2019).

For calculation of national resistance and recoverability we apply the calculation mechanism of Martin and Gardiner (2019) by lifting them to the national level with reference to the integral EU-25 market:

$$RES_C^{t,t-k} = \frac{\Delta\, IC_C^{Contraction} - \Delta\mathbb{E}\,(IC_C^{Contraction})}{|\Delta\mathbb{E}\left(IC_C^{Contraction}\right)|}, \quad (2)$$

$$REC_C^{t,t-k} = \frac{\Delta\, IC_C^{Expansion} - \Delta\mathbb{E}\,(IC_C^{Expansion})}{|\Delta\mathbb{E}\left(IC_C^{Expansion}\right)|}, \quad (3)$$

in both equations:

$$\Delta\mathbb{E}\left(IC_C^{t,t-k}\right) = \left(\frac{IC_{EU}^{t} - IC_{EU}^{t-k}}{IC_{EU}^{t-k}}\right) * IC_C^{t-k}, \quad (4)$$

Where:

- $RES_C^{t,t-k}$ is the resistance of Country *C* during contraction period between *t-k* (onset of a shock) and *t* (trough of a shock).
- $REC_C^{t,t-k}$ is the recoverability of Country *C* during expansion period between *t-k* (trough of a shock) and *t* (onset of the next shock).
- $\Delta\, IC_{CI}^{Contraction}$ and $\Delta\, IC_{CI}^{Expansion}$ denote the respective annual changes of the value of intermediate consumption of County *C* during the contraction and expansion periods as denoted above.
- $\Delta\mathbb{E}\,(IC_{CI}^{t,t-k})$ is the 'expected' change (as per Martin and Gardiner, 2019) of changes of the value of intermediate consumption in Country *C* during either contraction or expansion period.
- IC_{EU}^{t} and IC_{EU}^{t-k} are the annual aggregate values of intermediate consumption of the EU-25 (during the trough and onset of a shock respectively) for contraction period in resistance calculation and inverse for expansion period in recoverability calculation.

For evaluation of national industrial specialization, we use the same data panel and adapt the Krugman specialization index (KSI) from the approach of Martin and Gardiner (2019), as follows:

$$KSI_C^t = \sum_{I=1}^{45} |s_{CI}^t - s_{EUI}^t| \quad (5)$$

Where:

- s_{CI}^t - share of industry *I* of total value of intermediate consumption in one of the Countries *C*.
- s_{EUI}^t – share of industry *I* of total value of intermediate consumption in EU-25.
- *t* – year of presence of the Countries in the EU, between 2004 and 2020.
- *I* – one of 45 industries under CPA classification, based on the IOT methodology.

The standardized annual results of intermediate consumption of the ICIO tables enable the comparison of the economic performance trends of the Countries in reference to the EU-25 aggregate results for a 45-industry level of sectoral disaggregation. To emphasize the structural properties of each Country, we drop the industries that have not contributed by more than 5 % to the annual value of intermediate consumption of any of the Countries during the analysis period. Thence for the calculation at industry level, we narrow down the research to 22 industries.

We apply the same resistance and recoverability calculation mechanism from Martin and Gardiner (2019) for measuring the industrial capabilities of each defining industry in the Countries against the aggregate value of intermediate consumption of this industry at the EU-25 level. We herein evaluate industrial performances during the shocks and recovery periods in terms to what extent the industries lost or gained their comparative advantages within the EU-25 market:

$$RES_{CI}^{t,t-k} = \frac{\Delta\, IC_{CI}^{Contraction} - \Delta\mathbb{E}\,(IC_{CI}^{Contraction})}{|\Delta\mathbb{E}\left(IC_{CI}^{Contraction}\right)|}, \quad (6)$$

$$REC_{CI}^{t,t-k} = \frac{\Delta\, IC_{CI}^{Expansion} - \Delta\mathbb{E}\,(IC_{CI}^{Expansion})}{|\Delta\mathbb{E}\left(IC_{CI}^{Expansion}\right)|}, \quad (7)$$

in both equations:

$$\Delta\mathbb{E}\left(IC_{CI}^{t,t-k}\right) = \left(\frac{IC_{EUI}^{t} - IC_{EUI}^{t-k}}{IC_{EUI}^{t-k}}\right) * IC_{CI}^{t-k}, \quad (8)$$

Where:

- $RES_{CI}^{t,t-k}$ is the resistance of industry *I* in country *C* during contraction period.
- $REC_{CI}^{t,t-k}$ is the recoverability of industry *I* in country *C* during expansion period.
- $\Delta\, IC_{CI}^{Contraction}$ and $\Delta\, IC_{CI}^{Expansion}$ denote the respective annual changes of the value of intermediate consumption of industry *I* in country's *C* during the contraction and expansion periods.
- $\Delta\mathbb{E}\,(IC_{CI}^{t,t-k})$ is the 'expected' change of the value of intermediate consumption of industry *I* in country *C* during either contraction or expansion period.
- IC_{EUI}^{t} and IC_{EUI}^{t-k} are the annual aggregate value of intermediate consumption of industry *I* of the EU-25 (during the trough and onset of a shock respectively).

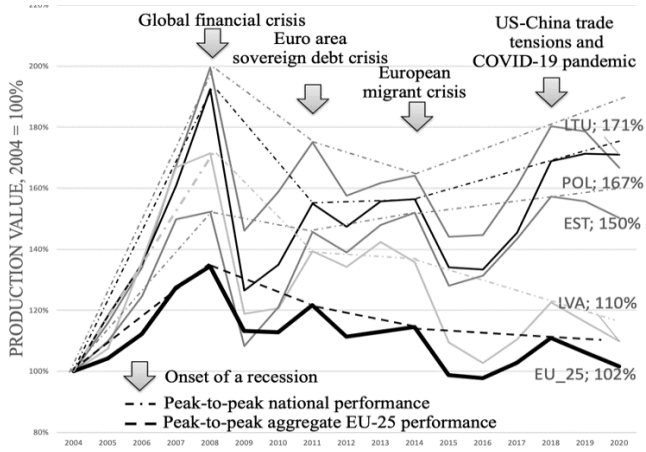
Stronger producers in the region (with technological advantages, high-skilled workforce, and other properties MAR externalities) are less likely to lose their production capacities during a regional recession than the weaker ones. Thence the fluctuations of the value of intermediate consumption of distinct industries include regional and local properties, which result in respective fluctuation of the country's overall value of intermediate consumption during the contraction or/and expansion periods.

OLS regression, together with fixed and random effects modelling was applied to evaluate the national resistance and recoverability correlation with industrial specialization (KSI) from the data of Annex 2-1 and Annex 2-2. The control variables for fixed effects – Country and Population (size). The Hausman test and the Breusch-Pagan Lagrange multiplier test were used for statistical reliability and to select the best-fitting model for the data panel.

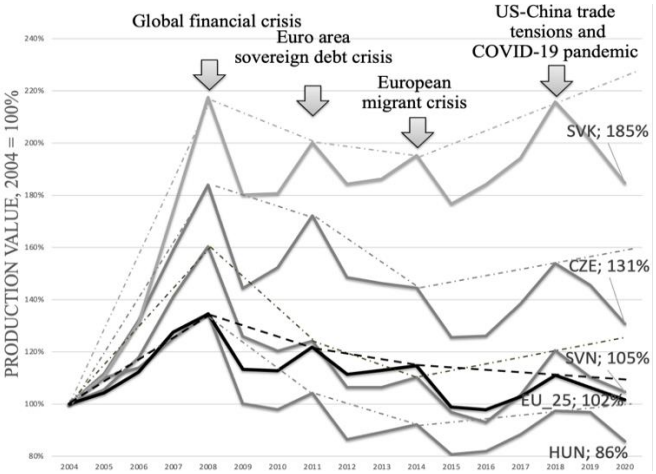
Results

The progress of the growth of value of intermediate consumption of the Countries in relation to the EU-25 aggregate is graphically presented in Figure 3. The values of intermediate consumption in all Countries have onsets in the same year as the EU-25 aggregate. The steep EU-wide drops of the value of intermediate consumption are reflected in the respective fluctuations of each Country as well. Figure 3 also shows the EU-25 and all Countries except Malta, going through negative Hysteretic recessions with lowered growth rate (visually explained by Martin, 2012; Angulo *et al.*, 2018; Martin & Gardiner, 2019) since 2008. Malta, contrarily, has managed to resume its pre-shock growth level from 2014 onwards, tending towards the Hamilton negative hysteretic recession result. Yet the trends of the intermediate consumption peak-to-peak performances of all ten Countries are altered by major EU-wide recessionary shocks, thus confirming the applicability for the logic detailed by Martin and Gardiner (2019) at the

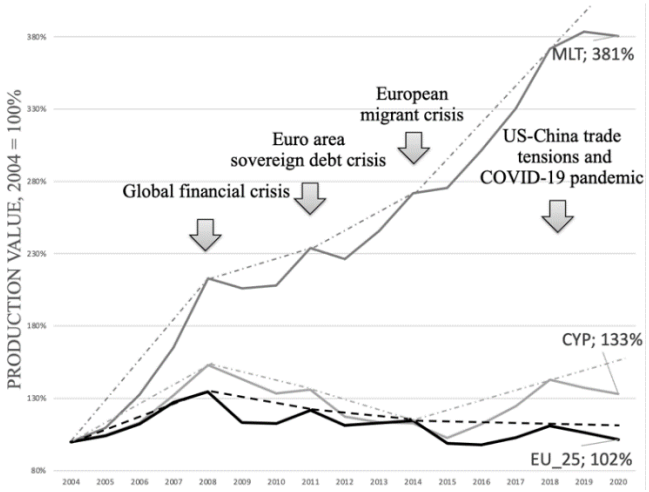
national level. All Countries, contributing to the single economy, reacting in similar way, but at different magnitudes as the macro-aggregate of the EU. Thence the EU reactions to the recessionary shocks can be considered as references.



a) Lithuania, Poland, Estonia, and Latvia



b) Slovakia, Czech Republic, Slovenia, and Hungary



c) Malta and Cyprus

Figure 3. National Growth of Value of Intermediate Consumption in Comparison to the EU-25 between 2004 and 2020
Source – Developed by the Authors based on ICIO data

The correlation results in the fixed effects within model of national Resistance and KSI, controlled for Population differences show strong significance of coefficients (Table 1).

Table 1

Results of Fixed Effects within Model (y=Resistance, x1=KSI, x2=Population). (Created by the Authors)

	Estimate	t-value	Pr(>|t|)
KSI	0.058372	2.9101	0.0070079**
Population	-3.449054	-3.9698	4.557e-4***

Figure 4 shows the relationship of the estimated outcome of Resistance and KSI, when adjusted to population differences. The Hausman test shows (p-value= 7.418e-05) preference of fixed effects model over the random effects. The results note that there is a strong significance between national resistance and national specialisation values when the population and country differences are applied.

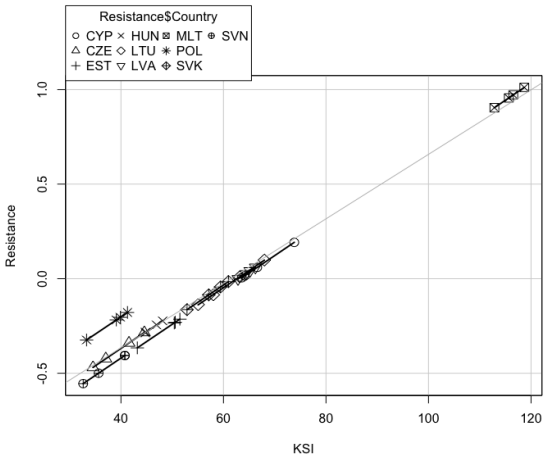


Figure 4. Estimated Resistance, when KSI Controlled for Population Differences. Created by the authors.

Recoverability and KSI correlation results are weak and insignificant in all modelling cases, meaning that the individual effects prevail in this correlation.

Industrial Resistance Results

National resistance and recoverability results are the two main measures of Country's resilience (Martin & Sunley, 2015; Martin, 2018; Martin & Gardiner, 2019). Annexes 2–1 and 2–2 herein provide the national, along with the structural change tendencies in terms of reorientation across all 22 industrial sectors. In other words, structural change tendencies are reflected by more significant national losses of the value of intermediate consumption and gains within the main industries, sparked by a recessionary shock.

The following information highlights the resistance results for the industries with the most significant structural shifts across the Countries during the recessionary shocks.

During the recessionary period of 2008–2009, there were no significant structural shifts evident in industries across the Countries within the EU-25 economic environment. Table 2 shows some more significant individual decreases of Latvian and Slovenian value of intermediate consumption in R - Arts, entertainment, and recreation industry, while Malta has recorded some more significant gains in intermediate consumption in H49 - Land transport and transport via pipelines industry during the recession.

Table 2

Resistance of National Industries with the Most Significant Changes during 2008–2009 Recession (from Annex 2–1). (Created by the authors)

Country	National resistance	KSI	Population	H49	R
LTU	-1,17	55	3,2	-0,9	-2,6
LVA	-0,94	63	2,2	-0,7	**-5,6**
EST	-0,83	43	1,3	-1,0	-2,8
POL	-0,70	33	38,1	-0,3	-1,4
HUN	-0,63	45	10,0	-0,7	-1,2
CZE	-0,37	35	10,3	0,0	-0,8
SVN	-0,36	41	2,0	-0,4	0,0
SVK	-0,09	53	5,4	0,4	**-7,5**
CYP	0,59	64	0,8	1,2	0,0
MLT	0,80	113	0,4	**5,1**	1,0

During the 2011 recession national structures experienced essential reshuffles in Coke and refined petroleum products (C19) and IT and other information services (J62) industries (Table 3). Hungary, Slovenia, Cyprus, Czech Republic, Poland, and Slovakia have given up significant shares of their market positions in one or both industries. Estonia, Latvia, and Malta meanwhile were significant gainers of market positions in one or both industries thus recording strong resistance to the EU-wide recessionary shock. Table 3 shows some correlation of National resistance with the resistance results of the two industries, implying that the structural shifts were sparked by the shock of 2011 and were significant (if not essential) contributors in determining the National resistance result.

Table 3

Resistance of National Industries with the Most Significant Changes during 2011–2012 Recession (from Annex 2–1). (Created by the authors)

Country	National resistance	KSI	Population	Ind. C19	Ind. J62
HUN	-0,99	47	10,0	**-45,0**	**-28,2**
SVN	-0,67	33	2,1	**-100,0**	**-9,8**
CYP	-0,61	64	0,8	**-21,0**	**-6,1**
CZE	-0,61	37	10,5	-2,6	**-29,4**
POL	-0,17	39	38,1	**-5,8**	1,7
SVK	0,07	59	5,4	**-41,5**	**11,1**
LTU	0,42	68	3,1	1,0	-2,4
EST	0,46	51	1,3	**28,9**	**17,8**
LVA	0,56	65	2,1	**221,0**	-1,7
MLT	0,62	116	0,4	-4,3	**19,6**

The changes in other industries were less significant (for more details please see Annex 2-1).

Table 4 reveals no significant structural changes within the analysed countries have been recorded during the 2014 recessionary shock. Although some worth mentioning market gains were recorded by Lithuania and Cyprus in Computer, electronic and optical equipment (C26) industry.

Table 4

Resistance of National Industry with the Most Significant Changes during 2014–2015 Recession (from Annex 2–1). (Created by the Authors)

Country	National resistance	KSI	Population	Ind.C26
LVA	-0,40	66	2,0	2,5
EST	-0,14	51	1,3	-3,1
LTU	-0,04	63	2,9	**5,0**
CZE	0,04	42	10,5	0,0
HUN	0,10	48	9,9	-1,0
POL	0,11	41	38,0	-1,3
SVN	0,12	36	2,1	-2,7
SVK	0,31	61	5,4	-1,9
CYP	0,34	67	0,9	**15,8**
MLT	1,10	117	0,4	-0,7

The 2018–2020 recessionary period was different from the previous ones in terms of industrial resistance (Table 5). The largest market position losses were in Professional,

scientific, and technical activities (M) industry by Czech Republic, Slovakia, and Poland, thus affecting their national resistance results. Poland, together with Hungary, have suffered market losses in Financial and insurance activities (K) industry as well. National resistance constructed on the gains in Professional, scientific, and technical activities (M) industry by Estonia, Latvia, Lithuania, and Malta, although the latter three recorded additional individual gains (for detailed information please see Annex 2–1).

Table 5

Resistance of National Industries with the Most Significant Changes during 2018–2020 Recession (from Annex 2-1). (Created by the Authors)

Country	National resistance	KSI	Population	Ind. K	Ind. L	Ind. M
CZE	-0,79	45	10,6	-3,1	2,4	**-36,0**
SVK	-0,71	57	5,4	-2,2	-4,1	**-28,5**
SVN	-0,56	41	2,1	3,8	1,5	2,5
HUN	-0,41	45	9,8	**-9,1**	-2,5	0,0
LVA	-0,23	64	1,9	1,1	2,1	**30,9**
POL	0,11	40	38,0	**-8,5**	-3,1	**-9,6**
CYP	0,17	74	0,9	-4,0	**-5,9**	1,1
EST	0,47	50	1,3	-1,1	1,4	**28,2**
LTU	1,15	58	2,8	2,6	2,5	**20,2**
MLT	1,29	119	0,5	**5,8**	**5,9**	**13,4**

Table 5, similarly to Table 3, shows correlation of National resistance with the resistance combined results of the three industries, implying that the structural shifts were sparked by the shock of 2018–2019 and were significant (if not essential) contributors in determining the National resistance result.

The economic shock of 2011–2012 sparked in Greece and rolled through the Southern Europe. Coincidently the results of Table 3 indicate significant structural losses in two material supply and manufacturing industries of the Countries that are located nearby Greece. The Countries, located further away from Greece, simultaneously recorded gains in the value of intermediate consumption in the same industries.

The economic shock of 2018–2020, meanwhile, has lasted longer than the other shocks (Table 5). These results suggest (see the values of KSI, Population and industrial resistance) that smaller and more flexible to adapt Countries were able to exploit their comparative advantages and gain additional share of intermediate consumption in the industries where the large and less specialized countries were losing the value of intermediate consumption in the EU-25 market.

Industrial Recoverability Results

The statistics of industrial recoverability in Table 6 reveal individual properties of national economic development during the recovery period of 2009–2011. Significant structural shifts, reshaping the economies during this period, are best visible in C26 - Computer, electronic and optical equipment industry, along with service industries (namely I - Accommodation and food service activities, K - Financial and insurance activities, L - Real estate activities, and R - Arts, entertainment, and recreation industry).

Table 6

National Recovery of National Industries with the Most Significant Changes during 2009–2011 Recession (from Annex 2-2) Created by the Authors

Country	National recovery	KSI	Population density	Ind. C26	Ind. I	Ind. K	Ind. L	Ind. R
CYP	-1,68	61	90,0	**-22,5**	**-7,2**	**24,8**	-2,4	**73,0**
SVN	-1,20	39	101,7	**37,4**	-1,1	**14,4**	-2,9	**-8,9**
HUN	-0,47	42	107,5	**15,8**	-2,2	**-23,3**	-3,3	**-12,9**
SVK	0,50	56	109,9	**-9,1**	**-13,3**	2,9	**10,3**	0,2
MLT	0,80	113	1311,7	**25,2**	**20,2**	**7,6**	1,8	**78,3**
LVA	1,30	61	33,7	**91,6**	**6,6**	-0,9	2,4	**-5,8**
CZE	1,58	35	135,6	**12,8**	-4,7	**18,4**	**5,4**	1,8
POL	1,65	36	124,2	**27,7**	**16,3**	**-8,8**	**7,8**	**-7,1**
LTU	2,03	60	49,4	**12,5**	1,7	**-20,3**	-3,2	**-30,4**
EST	3,62	41	30,7	**589,5**	**14,5**	**6,9**	**7,8**	**17,6**

The recovery period of 2012–2014 from the Euro area sovereign debt crisis, as Table 7 indicates, was as well dominated by individual properties of each Country. This recovery, contrarily from the previous one, significantly restructured a range of material supply and manufacturing industries in the EU market. The most captivating difference of structural changes across industries can be noted between Cyprus and Malta – the closest neighbours of Greece, the economy where the crisis began. National recovery index of Cyprus is the lowest of the Countries, while the index of

Malta is the highest. Table 6 reveals Cyprus losing significant market shares in four material supply and manufacturing industries (namely C13 - Textiles, textile products, leather, and footwear, C16 - Wood and products of wood and cork, C25 - Fabricated metal products, C26 - Computer, electronic, and optical equipment), D - Electricity, gas, steam, and air conditioning supply industry, F – Construction, and L - Real estate activities industries during 2012-2014 recovery period. Malta has lost market shares in the same material supply, manufacturing, and energy supply industries, but recorded significant gains in C29 - Motor vehicles, trailers, and semi-trailers production, F – Construction, and L - Real estate activities industries. Other Countries, apart from their individual structural shifts, mainly expanded their market shares in C25 - Fabricated metal products and L - Real estate activities industries.

Table 7

National recovery of national industries with the most significant changes during 2012-2014 recession (from Annex 2-2). (Created by the authors)

Country	National recovery	KSI	Population density	Ind. C13	Ind. C16	Ind. C19	Ind. C24	Ind. C25	Ind. C26	Ind. C29	Ind. D	Ind. F	Ind. H49	Ind. H50	Ind. L
CYP	-2,29	65	93,8	**-11,9**	**-7,4**	-1,5	-4,3	**-37,1**	**-8,6**	-0,6	**-11,6**	**-22,5**	0,5	-0,1	**-20,2**
CZE	-1,95	39	136,1	0,1	-1,5	0,5	-0,3	-0,3	-1,2	2,3	**-8,0**	**-8,8**	-4,3	1,7	**-8,7**
LVA	-0,59	64	32,7	**-6,8**	4,9	**153,8**	**-7,9**	**7,7**	**21,1**	2,2	**-5,2**	**12,4**	-2,7	3,0	**20,9**
SVN	0,25	36	102,2	**-6,5**	-1,0	**8,8**	1,6	**5,5**	1,1	-0,8	-3,0	-4,4	-0,3	-4,8	-2,9
POL	0,45	40	124,3	**8,5**	4,0	-0,3	0,5	4,4	1,6	0,4	-3,6	-0,4	**6,2**	**16,6**	**14,5**
SVK	1,09	64	110,3	-2,4	**9,2**	0,5	1,0	**42,5**	0,9	0,2	**-8,1**	**12,1**	**6,5**	-0,4	**6,0**
LTU	1,16	70	47,7	2,4	**6,0**	-0,6	-0,9	**13,9**	-0,2	**8,0**	2,2	**26,5**	**9,4**	4,5	**28,8**
HUN	1,28	48	106,6	3,4	1,5	0,1	1,8	**13,4**	**-6,5**	**7,1**	**-7,7**	**23,8**	-0,3	1,4	-2,7
EST	2,31	51	30,5	0,9	**6,5**	1,7	**9,5**	**12,4**	2,2	0,2	0,7	1,9	0,0	0,3	**7,8**
MLT	6,06	113	1329,2	**-20,1**	-0,1	0,9	-0,7	**-11,3**	**-7,7**	**13,0**	-4,0	**18,4**	**-8,0**	**8,5**	**12,3**

The last recovery period of the analysis between 2015 and 2018 has not had significant structural shifts within industries across the Countries. Table 8 shows that Cyprus has gained significant market shares in three material supply and manufacturing industries (namely C19 - Coke and refined petroleum products, C24 - Basic metals, and C26 - Computer, electronic, and optical equipment). Other structural shifts within the Countries were less visible.

Table 8

National Recovery of National Industries with the Most Significant Changes during 2015-2018 Recession (from Annex 2-2). (Created by the authors)

Country	National recovery	KSI	Pop. density	Ind. C19	Ind. C24	Ind. C26
LVA	-0,03	64	31,0	-4,4	-3,3	3,2
HUN	0,66	49	107,6	1,0	1,1	1,6
SVK	0,79	61	111,5	0,8	1,0	-3,6
CZE	0,83	45	136,8	**-5,4**	0,5	2,6
EST	0,84	53	30,3	-0,5	-0,7	-3,9
SVN	0,97	40	102,5	-1,0	0,9	3,4
POL	1,03	40	123,6	1,0	1,4	0,2
LTU	1,09	60	45,8	0,6	-0,1	4,9
MLT	1,81	120	1450,2	3,5	**6,4**	-4,7
CYP	2,17	73	92,4	**149,7**	**14,5**	**13,2**

Despite the domination of individual properties, common trends of structural changes across countries could be noted in material supply and manufacturing industries during recovery periods. More significant sectoral reshufflings as well occurred in service Real estate activities (L) industry during two out of three recovery periods.

Comparative advantages in each of the three recovery periods, where different from each other in terms of structural shifts across countries. These statistics, well explain the lack of correlation significance between the national recoverability and other independent factors, such as KSI.

Discussion

We have chosen the annual aggregate sectoral intermediate consumption for modelling instead of output data. We build on the empirical evidence of the annual economic performances of the EU-25 member states showing that the aggregate values of intermediate consumption have been more sensitive than output results between 2004 and 2020 (Figure 1). The proportional fluctuations of the world aggregates of intermediate consumption coincidently outrun those of output throughout the whole period of OECD's consolidated statistics between 1995 and 2020 (Figure 2).

Differently from Martin and Gardiner (2019), we do not consider distances between the analysed countries and the EU economic centres because of two reasons. 1) Low density and spread-out population of most of Countries (except for Malta) in comparison to the Great Britain. 2) Studies of Pindyck & Rubinfeld (2013), Loungani et al (2017), Santos and Khan (2018) discuss the recent reshaping world trade environment by applying the information technology developments. historically buyers and sellers needed to be face-to-face. Now technologies allow businesses to trade instantly from different locations of the world, thence travelling between economic centres often becomes unnecessary.

The Krugman index of specialization in Martin and Gardiner (2019) uses the employment shares in industrial sectors of a city (region) and compares them to the national level respectively throughout time. We take Leontief's (1936) approach to intermediate consumption of products in an industry, which are inputs, or resources that enable the added value generation in an economy (see Annex 1-1). Each product is a resource, and if the product is not a service, then it essentially consists of resources - product inputs in the form of labour and materials. Materials in this case are products as well, produced by combining labour and raw materials, that are retrieved by human work force. This deconstruction of the value of a product, within intermediate consumption along the production chain to its very sources, underlines the two main elements that create a nation's wealth – natural resources and productive population – highlighted by Adam Smith (Manis, 2005). The performance of productive population in the form of employment in all stages of the production chain constructs the value of a product. Following this logic, the value of intermediate consumption within an industry can be considered as the value of employment. In the IOTs it reflects the result of product availability and attractiveness to consumers with the local environment properties, such as MAR (Hundt & Grun, 2022) or Jacobs (Beaudry & Schiffauerova, 2009) externalities included. Martin & Gardiner (2019) solved partial employment data availability constraint by making assumptions for the occupational skill mix. We use the shares of the value of intermediate consumption that resulted from full occupational skill mix within each industry, thus eliminating possible employment data availability constraint issue.

We construct our own mechanism for identification of structural changes. The concept of reorientation, proposed by Martin (2012), refers to changes in region's economic structure as consequences of shocks, while some degree of structural changes occur continuously. Martin and Gardiner (2019) link the reorientation capabilities of an economy to the speed of recovery to the pre-recession economic growth trend rate, or even greater one. EU-wide economic shocks in our analysis are considered as the reference turbulences, while Figure 3 (a, b and c) underline the speed of recovery of each analysed economy as relatively equal. The difference, meanwhile, is the slope – the growth rate of the Hysteretic recession – in each economy. Poland is one of the largest European nations. Its properties economic performance results do not jeopardise the analysis results, implying the adaptability of the selected analysis approach to large countries as well as the small ones.

When the fluctuations of the aggregate EU-25 value of intermediate consumption are considered as reference, the results of industrial resistance and recoverability help identify the industries across the Countries that have either been more exposed or accumulated greater gains than the EU-25 market during the recessionary shocks and recovery periods. Following the definition of reorientation (Martin, 2012), when measuring an industry's resistance, we are looking at more significant changes in its value of intermediate consumption, sparked by a recessionary shock. Significant positive changes imply strong competitive position in the market, resulting in relative gains in sales of products during the general EU-wide trend of contraction. Significant negative changes reveal weaker position in the market that results in greater losses in sales of products than the general trend of contraction in the EU-25. All these changes within industries, sparked by a major shock, can be considered as structural changes following the logic of Hundt and Grun (2022).

The results of Figure 4 indicate a possibility of a trend of countries with higher industrial specialization tending to be more resistant from recessionary shocks. Yet this correlation should be tested at larger extent. Size of countries in this respect is also important – the smaller the country, the more specialized in certain industries. Large economies (Poland, Czech Republic, Hungary) are visibly larger contributors to the EU-25 overall intermediate consumption and, naturally, their industrial portfolio tends to remain more balanced. Resistance results are better when the shares of intermediate consumption of their main industries increase in the EU-25 market or, at least, maintain the pre-crisis market position.

Structural shifts during the recovery periods, contrarily, are very much country specific. Thence their industrial specialization does not play a significant role in recovery from recessionary shocks. Reorientation in different countries happens differently despite the same time frames, dictated by the common EU-25 market trend. In this context, the changes of the value of intermediate consumption within individual industries, shown in Annex 2–2 reflects each country's vulnerability, or capability to gain market positions by adapting to the new economic environment.

2011 was the recessionary shock with strong regional effects, especially in the Southern Europe, triggered by the default of the Greek economy. The analysis results, therefore, show the exposed Coke and refined petroleum products industry along with the IT and other information services industry during the shock, which suffered significant market shifts away from the southern part towards the northern part of the EU (Annex 2–1). The analysis furthermore shows the consequential industrial reshufflings that rolled over to the other material supply and manufacturing industries during the recovery period. Many of the Countries managed to recover by strengthening their market positions mainly in Fabricated metal products, Construction, or Real estate activities industries, or by reshuffling between sectors within the country. Cyprus and Czech Republic, meanwhile, imply to have lost the market positions there, resulting in negative recoverability results. While individual properties prevail, the common trend is still visible in economic behaviour of the Countries during recovery periods (Annex 2-2), underlining the adaptive capability trends of each country within the material supply, manufacturing, and transportation industries.

Conclusions, Limitations, and Further Research

The results confirm individual properties of different economic shocks, while noting that economic performances of countries during resistance periods substantially differ from recoveries due to reorientation processes. The literature review notes resilience being the composite result of resistance and recoverability. The results of this analysis suggest that resistance and recoverability should be evaluated separately. The results reveal an implication to

measure resistance through the industrial specialisation and population variables. The individual effects of reorientation of countries, however, prevail during recovery periods, in the form of industrial comparative advantage shifts. The recoverability of individual industries with the most significant impact on economic performance should be thence analysed separately by considering a larger data panel (more shocks, more countries).

Every recessionary shock had distinct effect on industrial performance of analysed Countries, although some common properties with direct impact on the national resistance are evidential:

- Countries in general during the periods of recessionary shocks do not overcome significant structural shifts, unless the shocks are longer-lasting (one economic pathology follows another), or the disruptions have some specific properties (for example, region-specific).
- Some individual comparative advantages in the market of certain industries have contributed significantly to boost the national resistance levels.

Despite the individual properties of national economic environments, the obtained results show tendencies within industrial portfolio changes during recessionary periods. It becomes possible to identify the industries, which may be mostly affected during a recessionary shock of certain nature.

Industrial recoverability contains individual properties in national economies during in each of the recovery periods. Yet some common trends of structural shifts across countries are evident in material supply and manufacturing industries. More significant sectoral reshufflings as well occurred in Real estate activities industry during two out of three recovery periods.

The analysis results overall show the adaptability of this resilience analysis method at national level despite the size of countries selected to the panel. The main property has to be maintained – all selected countries have to be the contributors to one larger economic construct (such as the EU), against which the benchmarking is performed during joint resistance and recovery periods.

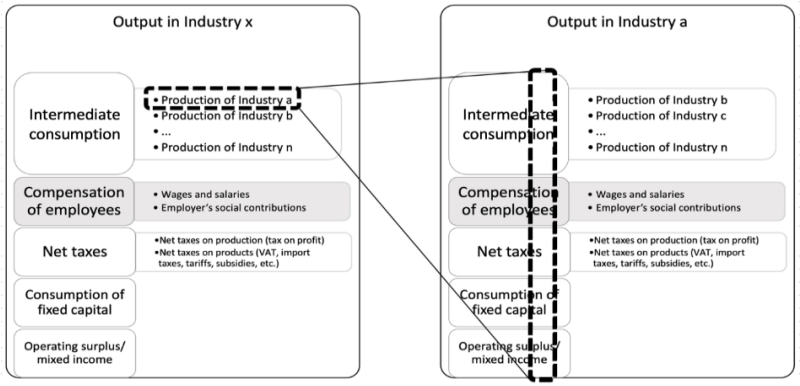
The limitations of this research include the results being specific to the sample of selected Countries, observed during the defined period and processed through quantitative analysis. The sample includes ten EU member states that joined the block in 2004. The defined period is limited to 17 years, including four EU-wide recessionary shocks and three recovery periods. Post-COVID-19 recovery is not included in the study due to missing economic performance information for 2021 onwards. Having in mind the difficulty to obtain standardized economic performance data for periods prior to 1995 that contains industrial disaggregation, a wider range of countries could be taken for analysis in future research to obtain more robustness in the results. This study shows similar effects of structural shifts between large and small economies that compete within the EU market. Within this notion, it would be rational to consider the remaining EU member states for the future research. This implication should provide insights on how all EU member states behave and adapt within separate industries when compete in the environment of increased scarcity during a recessionary EU-wide shock, when some production chains are disrupted, or how they adapt to the new economic environment afterwards.

The potential effects on political crises in individual countries or estimates of their economic and environmental performance are as well ignored in our empirical research. This research evaluates only the results of political or economic initiatives of countries, expressed in the changes of the value of intermediate consumption. Application of political intensions, fiscal or monetary instruments consequently ignored within the study.

We identified opportunities for future research. Theoretical and empirical research on the concept of economic resilience needs to be extended. It should help reevaluate the EU strategic policy on economic resilience, including structural reforms. The use various mathematical and econometrical methods at wider extent would help identify more appropriate strategies of economic resilience. Additional analyses required to understand how wider range of economic performance components impact national resilience in response to economic shocks, including the definition of suggested changes in national strategies. Incorpoblocksn of additional economies into future analyses, following the methodology, proposed in this research, would enable the comparison and even benchmarking of economic resilience strategies among the EU member states as well as the other nations, in close economic relations with the EU block.

Annexes

Annex 1



Annex 1-1. Visual example of the composition of the value of intermediate consumption in subsequent industries. Created by the authors.

Annex 2

Annex 2-1. Country resistance index, Krugman index of specialization, population statistics (million) and resistance results of national industries (see industry index under Annex 2-2) during the four recessional shocks in the EU-25. Created by the authors.

Resistance of National Industries during 2008–2009 Recession

Country	National resistance	KSI	Population	A01	C10	C13	C16	C19	C20	C24	C25	C26	C29	D	F	G	H49	H50	H52	I	J62	K	L	M	R
LTU	-1,17	55	3,2	-1,0	-0,8	-0,5	-0,6	-0,1	-0,7	0,3	-0,6	0,3	-1,7	1,0	-2,4	-1,3	-0,9	0,0	-0,6	-1,7	-1,6	-2,0	-3,6	-2,1	-2,6
LVA	-0,94	63	2,2	-0,8	-0,5	-0,7	-0,3		0,9	0,0	-0,6	0,7	-1,0	-0,1	-1,9	-1,4	-0,7	0,3	0,2	-2,7	-4,5	-0,5	-3,2	-1,3	**-5,6**
EST	-0,83	43	1,3	-1,2	-0,6	-0,2	-0,5	0,5	-0,6	-0,5	-0,7	0,3	-0,4	-0,6	-1,2	-0,4	-1,0	0,3	-0,8	-2,5	-3,2	-1,0	-1,8	-0,8	-2,8
POL	-0,70	33	38,1	-1,3	-0,9	-0,3	-0,6	-0,1	-0,1	-0,3	-0,2	0,4	0,0	-0,7	-0,5	-1,0	-0,3	-1,4	-1,1	-1,5	-1,2	-1,8	-2,9	-1,1	-1,4
HUN	-0,63	45	10,0	-0,9	-0,7	-0,4	-0,6	0,0	-0,3	-0,3	-0,3	0,0	-0,4	-0,9	-0,2	-0,8	-0,7	1,1	0,0	-1,5	-0,8	-1,1	-2,6	-1,0	-1,2
CZE	-0,37	35	10,3	-0,7	-0,4	-0,1	0,1	-0,1	-0,3	-0,2	-0,2	-0,3	0,5	-0,4	-0,3	0,0	0,0	0,0	-0,1	0,8	0,3	-0,6	-1,9	-0,7	-0,8
SVN	-0,36	41	2,0	-0,5	-0,3	-0,2	-0,1	0,0	0,0	-0,3	-0,1	-0,3	0,6	1,5	-0,3	0,0	-0,4	-0,3	-0,1	-0,1	0,0	0,6	-2,2	-0,4	0,0
SVK	-0,09	53	5,4	-0,3	-0,4	-0,4	-0,3	0,3	0,1	0,1	0,0	1,0	0,0	0,6	0,6	-0,8	0,4	-0,2	0,2	1,4	3,5	-0,8	2,1	0,0	**-7,5**
CYP	0,59	64	0,8	0,7	1,5	0,6	0,6	-0,3	1,1	0,6	0,6	-0,1	1,5	2,5	-0,5	0,3	1,2	1,2	1,4	-0,4	-2,9	1,5	-0,6	0,5	0,0
MLT	0,80	113	0,4	-0,4	0,5	-0,7	1,1	0,1	0,3	0,1	0,3	-0,2	1,4	-0,3	0,8	0,5	**5,1**	0,4	-0,6	-0,2	1,5	1,8	-1,3	1,6	1,0

Resistance of National Industries during 2011–2012 Recession

Country	National resistance	KSI	Population	A01	C10	C13	C16	C19	C20	C24	C25	C26	C29	D	F	G	H49	H50	H52	I	J62	K	L	M	R
HUN	-0,99	47	10,0	-0,6	-0,2	-0,1	-0,4	**-45,0**	0,7	-0,1	-0,6	-1,8	0,4	-3,6	-0,6	-0,8	-0,3	0,2	-0,7	-0,6	**-28,2**	-1,3	-1,6	-2,3	-1,6
SVN	-0,67	33	2,1	-0,4	-0,8	-0,1	0,0	**-100,0**	0,0	0,3	-0,1	0,1	-0,4	-1,7	-0,5	-0,2	-0,6	-1,0	0,0	-0,4	**-9,8**	-1,1	-2,2	-1,7	-0,4
CYP	-0,61	64	0,8	-1,2	-1,0	-0,1	-1,3	**-21,0**	-0,1	-0,1	-0,5	**-5,8**	-3,2	2,3	-1,2	-0,9	-1,5	0,5	0,1	-0,7	**-6,1**	-1,0	-0,2	-1,1	-1,4
CZE	-0,61	37	10,5	-1,0	-0,7	0,4	-0,5	-2,6	0,1	-0,2	0,2	1,0	-0,2	-1,4	-0,6	-1,0	-0,5	-0,9	-0,2	-0,2	**-29,4**	-0,5	-0,7	-2,5	-1,3
POL	-0,17	39	38,1	-0,1	0,6	0,3	0,4	**-5,8**	0,6	0,1	0,5	0,0	-0,5	-1,0	-0,3	-0,5	0,5	3,0	0,1	-0,1	1,7	0,2	-2,7	-0,8	0,8
SVK	0,07	59	5,4	0,1	-0,5	0,4	-0,6	**-41,5**	-1,2	0,2	0,6	-0,2	2,0	0,4	-1,4	-0,5	-0,8	2,3	-0,4	0,7	**11,1**	0,3	-0,1	1,3	-1,6
LTU	0,42	68	3,1	-0,1	0,3	0,6	0,1	1,0	-0,3	1,0	-0,1	-1,0	1,4	-1,4	0,0	-0,7	1,6	-0,5	1,6	0,9	-2,4	1,2	0,4	-1,0	2,4
EST	0,46	51	1,3	0,6	0,0	0,6	0,2	**28,9**	1,0	0,2	-0,4	0,5	-0,8	1,2	1,2	1,0	0,7	-0,4	1,1	0,9	**17,8**	0,2	0,1	-0,4	0,5
LVA	0,56	65	2,1	1,0	0,0	0,7	0,0	**221,0**	1,0	1,6	0,9	1,6	0,3	0,0	0,3	2,0	0,5	**12,5**	0,4	1,6	-1,7	-0,8	-0,8	-1,0	0,6
MLT	0,62	116	0,4	-0,4	0,6	0,5	-0,5	-4,3	-0,7	-2,7	0,4	1,0	-0,3	4,0	0,5	0,8	2,0	-0,4	4,3	0,4	**19,6**	0,3	1,0	1,0	0,1

Resistance of National Industries during 2014–2015 Recession

Country	National resistance	KSI	Population	A01	C10	C13	C16	C19	C20	C24	C25	C26	C29	D	F	G	H49	H50	H52	I	J62	K	L	M	R
LVA	-0,40	66	2,0	-0,2	-0,4	-0,6	-0,1	0,6	0,2	-1,2	-0,9	2,5	-1,5	-0,9	-0,6	-0,2	-0,4	0,0	-0,4	0,2	0,4	0,3	-1,7	-1,6	1,1
EST	-0,14	51	1,3	0,6	-0,3	0,4	0,2	0,4	-1,3	0,6	-0,2	-3,1	-0,6	-0,7	-0,4	-0,2	-0,4	-0,2	0,3	-0,1	-1,0	0,3	0,3	-0,3	0,5
LTU	-0,04	63	2,9	0,2	-0,2	0,4	0,4	0,2	0,1	-0,6	1,3	**5,0**	-1,2	0,0	-0,5	0,7	0,2	-1,3	0,0	0,8	2,2	-0,3	0,2	0,8	0,3
CZE	0,04	42	10,5	0,2	-0,1	0,1	0,2	-0,1	-1,0	-0,2	0,2	0,0	0,3	0,1	0,3	-0,2	0,1	1,0	0,4	0,5	-0,5	-0,1	0,0	-0,5	-0,3
HUN	0,10	48	9,9	0,0	0,2	0,2	0,3	-0,1	-0,6	0,0	0,3	-1,0	0,7	-0,1	0,0	0,0	-0,2	-0,6	0,0	0,4	-0,2	-0,2	0,2	0,0	0,4
POL	0,11	41	38,0	-0,2	0,0	0,4	0,2	0,1	-0,1	0,1	0,4	-1,3	0,3	0,8	-0,1	0,3	0,1	-2,2	-0,2	0,1	2,3	-0,3	0,4	0,0	-0,1
SVN	0,12	36	2,1	0,0	0,2	0,2	-0,3	1,8	-0,8	2,4	-1,1	-2,7	-0,9	-0,3	-0,3	0,0	0,0	-0,3	0,3	0,1	0,1	-1,1	-0,2	-0,5	0,1
SVK	0,31	61	5,4	0,7	-0,5	0,0	0,4	0,3	-1,0	-0,2	0,4	-1,9	0,7	0,2	1,9	0,0	0,2	-2,0	-0,1	0,1	1,5	-0,1	0,2	1,1	1,5
CYP	0,34	67	0,9	0,5	0,1	0,9	-0,2	1,9	0,3	-0,3	-0,3	**15,8**	-0,7	-1,6	0,1	0,2	-0,2	-1,1	1,4	0,2	3,7	1,2	-1,4	1,1	0,3
MLT	1,10	117	0,4	-0,3	0,3	0,0	0,3	-0,3	-0,9	-1,2	1,7	-0,7	-1,8	-0,4	0,3	1,0	1,1	1,2	1,7	0,4	2,6	-0,3	1,4	0,6	2,8

Resistance of National Industries during 2018–2020 Recession

Country	National resistance	KSI	Population	A01	C10	C13	C16	C19	C20	C24	C25	C26	C29	D	F	G	H49	H50	H52	I	J62	K	L	M	R
CZE	-0,79	45	10,6	2,0	-0,4	0,2	-0,7	0,9	-0,3	-0,6	-0,3	-0,6	-0,1	-0,5	-0,3	-1,2	-0,4	-1,5	-0,4	-0,5	1,6	-3,1	2,4	**-36,0**	-0,6
SVK	-0,71	57	5,4	0,4	0,4	0,0	-0,2	0,2	-0,4	-0,4	-0,4	-1,0	0,3	-0,3	-0,7	-1,7	-0,9	-0,9	-0,1	0,3	-0,3	-2,2	-4,1	**-28,5**	0,1
SVN	-0,56	41	2,1	-1,9	-0,1	0,0	0,4	-0,7	0,0	-0,5	0,1	0,9	0,2	0,2	1,2	0,1	0,5	-2,1	1,2	0,0	0,8	3,8	1,5	2,5	-0,5
HUN	-0,41	45	9,8	-1,5	-1,7	-0,1	-0,9	0,5	-0,4	0,6	-0,4	0,5	0,4	0,5	2,2	-1,7	-1,7	-0,1	-0,2	0,3	-1,9	**-9,1**	-2,5	0,0	-0,4
LVA	-0,23	64	1,9	-0,4	0,9	0,1	-0,1	**18,3**	1,7	0,7	1,6	3,4	-0,1	-1,7	-2,3	1,1	-1,3	-2,2	-2,4	-0,3	-2,8	1,1	2,1	**30,9**	-0,4
POL	0,11	40	38,0	0,1	0,3	0,2	-0,1	0,0	0,2	-0,5	0,2	0,8	0,0	-1,4	0,9	2,1	1,1	-1,1	1,9	0,0	-0,4	**-8,5**	-3,1	**-9,6**	-0,2
CYP	0,17	74	0,9	-4,4	0,2	0,4	0,6	0,9	-0,6	-1,2	2,1	1,0	0,0	-0,7	2,2	-3,2	-1,3	-0,4	-0,2	-0,4	3,2	-4,0	**-5,9**	1,1	0,8
EST	0,47	50	1,3	-0,3	1,6	1,3	0,7	0,7	0,2	0,9	0,7	-0,3	0,2	-0,2	0,4	0,7	0,0	-2,4	-0,7	0,5	2,6	-1,1	1,4	**28,2**	0,3
LTU	1,15	58	2,8	0,8	3,4	1,6	0,2	1,0	0,5	1,0	0,9	2,6	0,6	-1,1	2,6	**6,2**	2,4	0,0	-1,7	0,8	0,6	2,6	2,5	**20,2**	0,6
MLT	1,29	119	0,5	**5,3**	**26,5**	**44,9**	2,9	2,1	1,2	-0,4	0,1	2,0	2,9	1,9	**10,6**	1,9	-2,4	-1,1	-3,2	0,7	**-10,7**	**5,8**	**5,9**	**13,4**	1,1

Annex 2-2. Country recoverability index, Krugman index of specialisation, population statistics (million) and recoverability results of national industries (see industry index under the table) after the three recessional shocks in the EU-25. NOTE: no statistics available yet for the post-COVID-19 period. Source – developed by authors.

Recoverability of National Industries during 2009–2011 Recession

Country	National Recovery	KSI	Population	A01	C10	C13	C16	C19	C20	C24	C25	C26	C29	D	F	G	H49	H50	H52	I	J62	K	L	M	R
CYP	-1,68	61	0,8	-1,5	-3,0	-4,6	-4,2	-0,5	-2,0	-0,9	-2,3	**-22,5**	-2,6	-2,4	-1,9	-2,7	-2,7	-2,1	0,9	**-7,2**	2,5	**24,8**	-2,4	3,2	**73,0**
SVN	-1,20	39	2,0	-0,6	0,0	-0,6	1,0	-2,4	0,0	0,9	0,5	**37,4**	-0,7	0,3	-4,6	-1,6	2,5	-0,1	0,9	-1,1	-1,3	**14,4**	-2,9	-1,4	**-8,9**
HUN	-0,47	42	10,0	-0,6	-0,7	-0,2	-1,3	-0,1	0,5	-0,1	0,4	**15,8**	0,1	-2,1	-3,9	-2,2	-0,3	-1,7	-1,5	-2,2	-2,0	**-23,3**	-3,3	-4,3	**-12,9**
SVK	0,50	56	5,4	-2,4	-0,3	-0,7	-1,5	-0,6	0,8	-0,2	-0,4	**-9,1**	1,3	0,7	-2,7	1,5	-2,0	-0,1	-0,4	**-13,3**	-0,3	2,9	**10,3**	-3,7	0,2
MLT	0,80	113	0,4	-0,9	1,0	3,8	-3,5	-2,1	-1,9	-1,7	-0,8	**25,2**	1,7	-0,1	1,2	0,0	-2,2	-1,2	-1,0	**20,2**	**6,4**	**7,6**	1,8	**7,7**	**78,3**
LVA	1,30	61	2,1	2,5	-1,1	0,7	**5,6**	-1,1	-0,7	0,2	3,9	**91,6**	3,8	-0,4	2,3	-1,2	**5,3**	-4,5	0,6	**6,6**	**5,2**	-0,9	2,4	-0,5	**-5,8**
CZE	1,58	35	10,5	2,3	-0,1	0,3	-0,2	0,4	0,7	0,4	0,8	**12,8**	0,7	3,0	0,8	3,5	1,2	-1,7	-0,2	-4,7	0,7	**18,4**	**5,4**	0,6	1,8
POL	1,65	36	38,0	1,8	2,8	-0,2	1,2	0,9	0,5	0,9	1,2	**27,7**	0,1	-0,3	**6,4**	-2,1	-1,6	-1,8	3,1	**16,3**	3,3	**-8,8**	**7,8**	-1,2	**-7,1**
LTU	2,03	60	3,1	1,5	1,8	0,1	2,7	0,7	1,3	-0,3	2,3	**12,5**	**7,0**	-2,0	2,6	1,8	2,0	-0,2	1,1	1,7	1,0	**-20,3**	-3,2	-0,9	**-30,4**
EST	3,62	41	1,3	2,7	0,7	0,7	**5,1**	0,0	1,3	1,4	3,5	**589,5**	5,0	3,2	2,7	0,0	2,7	-0,4	0,6	**14,5**	2,2	**6,9**	**7,8**	1,3	**17,6**

Recoverability of National Industries during 2012–2014 Recession

Country	National Recovery	KSI	Population	A01	C10	C13	C16	C19	C20	C24	C25	C26	C29	D	F	G	H49	H50	H52	I	J62	K	L	M	R
CYP	-2,29	65	0,9	3,8	-2,4	**-11,9**	**-7,4**	-1,5	**-7,7**	-4,3	**-37,1**	**-8,6**	-0,6	**-11,6**	**-22,5**	-0,3	0,5	-0,1	0,0	-0,7	0,4	1,3	**-20,2**	-0,7	-2,3
CZE	-1,95	39	10,5	-2,9	-2,7	0,1	-1,5	0,5	0,7	-0,3	-0,3	-1,2	2,3	**-8,0**	**-8,8**	-0,9	-4,3	1,7	-0,6	-2,1	-1,7	-1,5	**-8,7**	-1,5	-1,4
LVA	-0,59	64	2,0	3,4	0,7	**-6,8**	4,9	**153,8**	-0,6	**-7,9**	**7,7**	**21,1**	2,2	**-5,2**	**12,4**	-0,2	-2,7	3,0	-1,2	2,2	-0,6	0,8	**20,9**	-2,5	1,2
SVN	0,25	36	2,1	0,3	-0,8	**-6,5**	-1,0	**8,8**	0,8	1,6	**5,5**	1,1	-0,8	-3,0	-4,4	-1,4	-0,3	-4,8	-0,3	0,0	-0,5	1,0	-2,9	1,0	-1,5
POL	0,45	40	38,1	0,3	-0,2	**8,5**	4,0	-0,3	0,0	0,5	4,4	1,6	0,4	-3,6	-0,4	1,4	**6,2**	**16,6**	1,7	-0,5	0,7	0,1	**14,5**	-1,9	-0,7
SVK	1,09	64	5,4	3,9	2,3	-2,4	**9,2**	0,5	**-5,8**	1,0	**42,5**	0,9	0,2	**-8,1**	**12,1**	-2,3	**6,5**	-0,4	-0,7	1,6	1,9	0,6	**6,0**	**9,0**	4,2
LTU	1,16	70	3,0	3,5	3,8	2,4	**6,0**	-0,6	-2,9	-0,9	**13,9**	-0,2	**8,0**	2,2	**26,5**	-0,4	**9,4**	4,5	-2,1	**5,0**	1,4	0,3	**28,8**	2,6	**-7,6**
HUN	1,28	48	9,9	-0,4	-0,7	3,4	1,5	0,1	3,5	1,8	**13,4**	**-6,5**	**7,1**	**-7,7**	**23,8**	-0,4	-0,3	1,4	2,3	-0,7	-0,5	-1,3	-2,7	0,8	0,8
EST	2,31	51	1,3	1,7	3,7	0,9	**6,5**	1,7	-1,3	**9,5**	**12,4**	2,2	0,2	0,7	1,9	1,1	0,0	0,3	-1,6	0,5	4,3	-1,2	**7,8**	2,8	2,1
MLT	6,06	113	0,4	-2,0	-0,5	**-20,1**	-0,1	0,9	3,8	-0,7	**-11,3**	**-7,7**	**13,0**	-4,0	**18,4**	1,0	**-8,0**	**8,5**	**-6,4**	0,2	1,2	-0,5	**12,3**	3,8	**7,0**

Recoverability of National Industries during 2015–2018 Recession

Country	National Recovery	KSI	Population	A01	C10	C13	C16	C19	C20	C24	C25	C26	C29	D	F	G	H49	H50	H52	I	J62	K	L	M	R
LVA	-0,03	64	2,0	1,3	-0,1	-1,2	1,0	-4,4	1,8	-3,3	0,6	3,2	4,7	-1,3	-0,3	0,1	-1,0	-1,4	-0,3	-0,1	0,3	-1,0	0,3	0,0	0,5
HUN	0,66	49	9,8	0,7	0,6	1,2	1,9	1,0	-0,4	1,1	1,4	1,6	-0,6	-0,2	2,3	0,7	0,3	-0,6	-0,5	0,3	0,2	1,7	3,6	1,0	2,3
SVK	0,79	61	5,4	2,5	1,3	4,0	0,0	0,8	-0,4	1,0	0,6	-3,6	0,8	0,7	0,1	3,5	0,6	1,6	0,8	0,9	0,1	-0,1	1,7	0,4	**5,8**
CZE	0,83	45	10,6	0,5	-0,2	0,7	0,0	**-5,4**	**8,9**	0,5	0,3	2,6	0,7	0,7	0,4	0,7	0,1	-0,1	0,6	1,4	0,0	2,0	2,2	0,4	0,4
EST	0,84	53	1,3	2,8	-0,1	1,7	1,7	-0,5	-0,6	-0,7	0,2	-3,9	1,6	2,7	2,1	0,9	-0,2	0,6	0,7	0,9	1,8	4,0	3,7	2,0	1,0
SVN	0,97	40	2,1	2,0	0,2	3,1	1,7	-1,0	0,1	0,9	0,4	3,4	2,5	-0,6	1,0	0,9	0,6	**-5,5**	2,3	0,8	0,5	-0,8	2,7	0,5	0,6
POL	1,03	40	38,0	1,2	1,4	1,3	0,5	1,0	0,5	1,4	1,1	0,2	0,7	-2,4	0,2	0,9	2,0	1,4	1,0	1,9	0,8	2,9	2,3	2,2	2,6
LTU	1,09	60	2,9	-1,4	-0,6	-0,8	0,4	0,6	-0,2	-0,1	1,4	4,9	4,2	1,0	1,1	0,3	3,5	-1,7	1,0	2,1	1,7	1,6	1,7	1,2	2,7
MLT	1,81	120	0,5	-0,1	0,0	3,0	2,0	3,5	0,6	**6,4**	2,3	-4,7	-1,2	1,8	0,9	0,9	3,9	3,2	**5,8**	1,3	0,4	1,0	**5,4**	3,2	2,1
CYP	2,17	73	0,8	0,6	1,4	2,8	4,5	**149,7**	0,9	**14,5**	2,8	**13,2**	3,6	4,7	3,0	0,9	2,3	0,4	1,6	1,5	1,5	4,6	-2,1	1,6	1,4

Industry index based on CPA classification of ICIO tables:

A01	Agriculture, hunting, forestry
C10	Food products, beverages, and tobacco
C13	Textiles, textile products, leather, and footwear
C16	Wood and products of wood and cork
C19	Coke and refined petroleum products
C20	Chemical and chemical products
C24	Basic metals
C25	Fabricated metal products
C26	Computer, electronic and optical equipment
C29	Motor vehicles, trailers, and semi-trailers
D	Electricity, gas, steam, and air conditioning supply
F	Construction
G	Wholesale and retail trade; repair of motor vehicles
H49	Land transport and transport via pipelines
H50	Water transport
H52	Warehousing and support activities for transportation
I	Accommodation and food service activities
J62	IT and other information services
K	Financial and insurance activities
L	Real estate activities
M	Professional, scientific, and technical activities
R	Arts, entertainment, and recreatio

References

Angulo, A. M., Mur, J., & Trivez, F. J. (2018). Measuring resilience to economic shocks: an application to Spain. *The Annals of Regional Science*, 60, 349–373. https://doi.org/10.1007/s00168-017-0815-8

Boschma, R., Coenen, L., Frenken, K. & Truffer, B., (2017) Towards a theory of regional diversification: combining insights from Evolutionary Economic Geography and Transition Studies, *Regional Studies*, 51(1), 31–45. https://doi.org/10.1080/00343404.2016.1258460

Briguglio, L., Cordina, G., Farrugia, N., & Vella, S. (2014). Economic vulnerability and resilience: concepts and measurements. *In Measuring Vulnerability in Developing Countries* (pp. 47–65). Routledge.

Classification of Products by Activity' (CPA) - statistical classification of products by activity is the classification of products (goods as well as services) under the EU regulation No. 1209/2014, http://data.europa.eu/eli/reg/2014/1209/oj

Conroy, M. E. (1975). Regional economic diversification. New York: Praeger.

Cuadrado-Roura, J. R., & Maroto, A. (2016). Unbalanced regional resilience to the economic crisis in Spain: a tale of specialisation and productivity. *Cambridge Journal of Regions, Economy and Society*, 9(1), 153–178. https://doi.org/10.1093/cjres/rsv034

Delgado-Bello, C., Sáchez, A. M., & Ubeda, M. A. (2023). Resilience and economic structure: The case of the Chilean regions during the Asian crises and the Great Recession of 2008. *Papers in Regional Science*, 102(1), 31–51. https://doi.org/10.1111/pirs.12719

Di Caro, P. (2017). Testing and explaining economic resilience with an application to I talian regions. *Papers in Regional Science*, 96(1), 93–113. https://doi.org/10.1111/pirs.12168

Doran, J., & Fingleton, B. (2018). US metropolitan area resilience: insights from dynamic spatial panel estimation. *Environment and Planning A: Economy and Space*, 50(1), 111–132. https://doi.org/10.1177/0308518X17736067

European Commission, EU. (2008). Eurostat manual of supply, use and input-output tables. https://ec.europa.eu/eurostat/documents/3859598/5902113/KS-RA-07-013-EN.PDF.pdf/b0b3d71e-3930-4442-94be-70b36cea9b39?t=1414781402000

European Neighbourhood Policy and Enlargement Negotiations (DG NEAR). European Commission. From 6 to 27 members. https://neighbourhood-enlargement.ec.europa.eu/enlargement-policy/6-27-members_en

Eurostat database. British city or region. https://ec.europa.eu/eurostat/databrowser/view/demo_ r_d3dens__custom_7807809/default/table

Eurostat (2011). Available from internet: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=National_accounts_-_an_overview

Eurostat (2013). The European System of National and Regional Accounts (ESA 2010). https://doi.org/10.2785/16644. https://ec.europa.eu/eurostat/documents/3859598/5925693/KS-02-13-269-EN.PDF.pdf/44cd9d01-bc64-40e5-bd40-d17df0c69334?t=1414781932000

Eurostat (2023). https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:National_accounts_(NA)

Eurostat. NUTS - Nomenclature of territorial units for statistics. https://ec.europa.eu/eurostat/web/nuts/background#:~:text=NUTS%201%3A%20major%20socio%2Deconomic,small%20regions%20for%20specific%20diagnoses

Eurostat. Population in the Southern, Central and Eastern EU member states. https://ec.europa.eu/eurostat/databrowser/view/demo_pjan__custom_8274821/default/table?lang=en

Eurostat. Population density in the Central and Eastern EU member states in comparison to Great Britain. https://ec.europa.eu/eurostat/databrowser/view/demo_r_d3dens__custom_8219986/default/table?lang=en

Eurostat. Population density of Malta and Cyprus. https://ec.europa.eu/eurostat/databrowser/view/demo_r_d3dens__custom_8220085/default/table?lang=en

Fingleton, B., Garretsen, H., & Martin, R. (2012). Recessionary shocks and regional employment: evidence on the resilience of UK regions. *Journal of regional science*, 52(1), 109–133. https://doi.org/10.1111/j.1467-9787.2011.00755.x

General Industrial Classification of Economic Activities within the European Communities (NACE) - common statistical classification of economic activities in the European Community under the EU regulation No. 1893/2006. http://data.europa.eu/eli/reg/2006/1893/oj

Hundt, C., & Grun, L. (2022). Resilience and specialization-How German regions weathered the Great Recession. *ZFW-Advances in Economic Geography*, 66(2), 96–110. https://doi.org/10.1515/zfw-2021-0014

Joensen, T., & Taylor, I. (Eds.). (2021). Small states and the European migrant crisis: *Politics and governance*. Springer Nature. https://doi.org/10.1007/978-3-030-66203-5

Kim, J., Estrada, G., Jinjarak, Y., Park, D., & Tian, S. (2022). ICT and Economic Resilience during COVID-19: Cross-Country Analysis. *Sustainability*, 14(22), 15109. https://doi.org/10.3390/su142215109

Kok, C., Mongelli, F. P., & Hobelsberger, K. (2022). A tale of three crises: synergies between ECB tasks. ECB Occasional Paper, (2022/305). https://doi.org/10.2139/ssrn.4219400

Leontief, W. (1936) Quantitative Input-Output Relations in the Economic System of the United States, *Review of Economics and Statistics*, 18 (3), 105–125. https://doi.org/10.2307/1927837

Lewis, L.T., Monarch, R., Sposi, M., & Zhang, J. (2021). Structural Change and Global Trade. *Journal of the European Economic Association*, 20(1), 476–512. https://doi.org/10.1093/jeea/jvab024

Manis, J. (2005). An inquiry into the nature and causes of the wealth of nations by Adam Smith. An Electronic Classics Series Publication. USA: Hazleton.

Martin, R. (2012). Regional economic resilience, hysteresis and recessionary shocks. *Journal of economic geography*, 12(1), 1–32. https://doi.org/10.1093/jeg/lbr019

Martin, R., & Gardiner, B. (2019). The resilience of cities to economic shocks: A tale of four recessions (and the challenge of Brexit). *Papers in Regional Science*, 98(4), 1801–1832. https://doi.org/10.1111/pirs.12430

Martin, R., & Sunley, P. (2014). On the notion of regional economic resilience: Conceptualization and explanation. *Journal of Economic Geography* 15,1–42. https://doi.org/10.1093/jeg/lbu015

Martin, R., Sunley, P., Gardiner, B., & Tyler, P. (2016). How regions react to recessions: Resilience and the role of economic structure. *Regional studies*, 50(4), 561–585. https://doi.org/10.1080/00343404.2015.1136410

Martini, B. (2020). Resilience and economic structure. are they related? *Structural Change and Economic Dynamics* 54(C), 62–91. https://doi.org/10.1016/j.strueco.2020.03.006

Mascaretti, A., Dell'Agostino, L., Arena, M., Flori, A., Menafoglio, A., & Vantini, S. (2022). Heterogeneity of technological structures between EU countries: An application of complex systems methods to Input-Output Tables. *Expert Systems with Applications*, 206, 117875, ISSN 0957-4174, https://doi.org/10.1016/j.eswa.2022.117875

Ministry of Economy. Trade and Industry of Japan. How to View the Input-Output Tables. https://www.meti.go.jp/english/statistics/tyo/entyoio/result_3/reference1.pdf

OECD (2021). Strengthening Economic Resilience Following the COVID-19 Crisis A Firm and Industry Perspective. OECD Publishing. https://www.oecd-ilibrary.org/sites/2a7081d8-en/index.html?itemId=/content/publication/2a7081d8 -en# exec summ-d1e257

OECD (2022). Input-Output Tables (IOTs). https://www.oecd.org/sti/ind/input-outputtables.htm

OECD (2023). OECD Inter-Country Input-Output Database. http://oe.cd/icio

Oprea F, Onofrei M, Lupu D, et al. (2020) The determinants of economic resilience. The case of Eastern European regions. *Sustainability* 12(10). https://doi.org/10.3390/su12104228

Pamucar, D., Dey Sarkar, B., Shardeo, V., Kumar Soni, T., & Dwivedi, A. (2023) An integrated interval programming and input-output knowledge model for risk and resiliency management. *Decision Analytics Journal*, 9, 100317, ISSN 2772-6622. https://doi.org/10.1016/j.dajour.2023.100317

Papaioannou, S. K. (2023). ICT and economic resilience: Evidence from the COVID-19 pandemic. Economic Modelling, 128, 106500. https://doi.org/10.1016/j.econmod.2023.106500

Ray, D. M., MacLachlan, I., Lamarche, R., & Srinath, K. P. (2017). Economic shock and regional resilience: Continuity and change in Canada's regional employment structure, 1987-2012. *Environment and Planning A*, 49(4), 952–973. https://doi.org/10.1177/0308518X16681788

Simmie, J. & Martin, R. (2010). The Economic Resilience of Regions: Towards an Evolutionary Approach. *Cambridge Journal of Regions, Economy and Society*, 3, 27–43. https://doi.org/10.1093/cjres/rsp029

Van Leeuwen, E. S., Nijkamp, P., & Rietveld, P. (2005). Regional Input-Output Analysis, Kimberly Kempf-Leonard. Encyclopedia of Social Measurement, *Elsevier*, 317–323, ISBN 9780123693983, https://doi.org/10.1016/B0-12-369398-5/00349-2

Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, adaptability and transformability in social-ecological systems. *Ecology and society*, 9(2). https://doi.org/10.5751/ES-00650-090205

Wixted, B., Yamano, N., & Webb, C. (2006) Input- Output Analysis in an Increasingly Globalised World: Applications of OECD's Harmonised International Tables, OECD Science, Technology and Industry Working Papers, 2006/07, OECD Publishing. https://www.oecd-ilibrary.org/docserver/303252313764.pdf?expires=1701185783&id=id&accname =guest& checksum=98B850FB6771FC691923432200C8240F

Authors' Biographies

Andrius Montrimas is Phd student at School of Economics and Business, Academic Centre of Economics, Business and Management His field of scientific research: economic resilience, industrial portfolio, structural changes, sustainability, public investment. ORCID iD 0000-0003-3077-2178.

Jurgita Bruneckienė, Dr, is a Professor at School of Economics and Business, Academic Centre of Economics, Business and Management. Her field of scientific research: circular economy, regional competitiveness, smart economy, fair competition in the market. ORCID iD 0000-0002-8281-1813

Vilda Gižienė, Dr, is an Associate Professor at School of Economics and Business, Academic Centre of Economics, Business and Management; Field of scientific research: investment in human capital, labour market, macroeconomics, energy market. ORCID iD 0000-0003-0195-4538.

The article has been reviewed.
Received in November 2023; accepted in December 2023.