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QUANTIFYING THE ECONOMIC SURVIVE ACROSS THE EU USING MARKOV PROBABILITY CHAINS

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Abstract. The multiple global crisis has made the economies of the world's countries, including EU's economy, vulnerable through the downgrading of the pandemic and the subsequent outbreak of geo-political conflict. These two events had the effect of decelerating the European economy and increasing the poverty level of the population, even that these developments are weaker than in rest of the world. The main objective of the present scientific approach is to identify a risk function based on Markov probability chains and to assess the possibilities of economic recovery through a package of policies structured over different time horizons. The used methods consist of meta-analysis, statistical analysis and geo-spatial and temporal modelling. The results of the study capture the integrated developments of risk-generating macroeconomic elements such as inflation, unemployment, public debt growth in a regionally segregated manner. These elements are useful for supranational decision-makers to increase the economic survival rate after multiple shocks through our proposed policy package.

Keywords: crisis, shocks, Markov chains, econometric model, public policy, decision makers.

JEL Classification: O11, F63, F43.

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1. Introduction

The current global context is vulnerable to economic, geo-political and environmental challenges that have led the world's states and various regional organizations to turn to policies of economic recovery and fiscal rebalancing. The vulnerabilities of the pandemic period have induced unprecedented global budget destabilization. This destabilization has placed financial demands on the world's states both in terms of preventing the spread of disease and in terms of economic support for health systems (as a result of the pandemic, there have been economic imbalances in trade in tangible goods and imbalances in the labor market), which have ultimately led to a shift in the structure of economic mechanisms towards the digital market. In addition, the outbreak of conflict in Ukraine has generated major geo-political disruptions, particularly in Europe, leading to a significant energy crisis and a refugee crisis, which have further destabilized social policies at the European level. From an environmental point of view, environmental impacts and climate challenges have impacted the performance of the primary agricultural sector, generating inflation and rising food costs.

In this context of extreme vulnerability, rating agencies have downgraded country indices for almost all national economies, thus signaling vulnerabilities at macroeconomic and regional level during 2020–2022. According to the International Monetary Fund (International Monetary Fund, 2022), the main global trade indicators (Purchasing Managers' Index (PMI); Consumer Sentiment; Business Sentiment; Number of increases and cuts in policy rates) have decelerated by up to 30%, with the euro area and the UK being the most affected in this picture. The major rating agencies (Trading Economics, 2023), as a result of multiple uncertainties in the pandemic and post-pandemic period, have given negative outlooks even to major European economies such as France (S&P), Austria (Fitch), UK (Moody's and Fitch), Italy (Moody's) or Belgium (Fitch).

During the same period, there has also been a shift in the monetary policies of G20 economies towards tightening amid losses in financial stability, rising inflation, reduced investor risk appetite and destabilizing capital flows. Amid the economic crisis induced by the war in Ukraine, the natural gas price index has risen 7-fold, almost double the IMF's July 2022 forecast, with challenges to the price of Brent crude oil leading to changes in fuel subsidy policies for the population. At the same time, inflation caused by rising food and energy prices is at an all-time high, according to the IMF, rising by more than 15% between 2020 and 2022 in the EU, higher than inflation in sub-Saharan countries and Central and East Asia.

Also, according to the same source, economic deceleration bottomed out in Q3. 1 of 2022 for all major global economic players (USA, Japan, euro area, UK and Canada). Thus, the most affected economy was the UK economy, followed by the American and European economies, and the least affected was the Japanese economy.

In this context, the Economic Sentiment Indicator (ESI) becomes an important tool for measuring and analyzing the overall economic confidence levels of businesses and consumers, thus providing valuable insights into market trends and potential growth prospects. By collecting data from various sectors such as industry, services, retail, and construction, the ESI offers a comprehensive perspective on the overall health of an economy. This allows policymakers and economists to identify potential risks and take necessary measures to stimulate growth or address any economic downturns (Mattera et al., 2023). Moreover, the Economic Sentiment Indicator serves as a powerful tool in understanding and navigating the complexities of the economic landscape. For example, if the ESI indicates a decline in consumer confidence and expectations for future economic growth, policymakers may implement measures such as reducing interest rates or increasing government spending to boost consumer spending and stimulate the economy. On the other hand, if the ESI shows a positive sentiment and strong business expectations, investors may be more inclined to invest in new ventures or expand existing operations, leading to increased job creation and economic expansion (Hahn & Kang, 2023). By analyzing the ESI data, policymakers can identify areas where the labor lacks necessary skills and take steps to upskill or reskill workers, improving productivity and ensuring that the analyzed country remains competitive in the global market. Understanding the skill gaps in different segments of society can help policymakers to develop targeted policies and programs to bridge these gaps, promoting equal opportunities for all citizens and reducing socioeconomic disparities (Seo, 2022).

Our research is based on Markov probability chains as a sophisticated approach that allows for a comprehensive analysis of the region's economic stability. By modeling the transition probabilities between different economic states, such as recession, growth, or stagnation, policymakers and economists can gain valuable insights into the resilience of individual countries and the EU as a whole. This method provides a quantitative framework to assess the likelihood of economic survival and inform decision-making processes aimed at promoting sustainable growth and stability in the EU. Furthermore, by incorporating various socioeconomic factors such as inflation rates, unemployment levels, and government policies into the analysis, policymakers can better understand the drivers of economic stability in the region. This holistic approach allows for a more nuanced understanding of the interconnectedness of different economies within the EU and the potential ripple effects of economic shocks. This comprehensive analysis can guide policymakers in implementing targeted interventions and policies to mitigate risks and foster a resilient and prosperous economic landscape in the EU. By considering both macroeconomic and microeconomic factors, policymakers can gain a deeper understanding of how different policies impact various sectors and industries. This knowledge can be instrumental in designing tailored interventions that address specific challenges faced by different member states. Additionally, this comprehensive analysis can help identify potential vulnerabilities and risks, enabling policymakers to proactively implement measures to safeguard economic stability and prevent future crises. Overall, by taking a holistic approach to economic analysis, policymakers can pave the way for a more resilient and prosperous European Union. Our scientific approach aims to critically assess the impact of geo-political shocks by means of Markov functions and to make a geo-spatial assessment of the impact of these shocks according to the capabilities of the regional economies affected by the shock, namely in the euro area. In order to do this, our analysis will use the above presented economic environment and context.

In this context, we can define as main objective of this paper the identification of a risk function based on Markov probability chains in order to assess the possibilities of economic recovery through a package of policies structured over different time horizons.

Our analysis aims to achieve the following objectives:

O1. Identifying main directions regarding the impact of Economic Sentiment Indicator (ESI).

O2. Quantifying the impact of public debt on economic development.

O3. Measuring the main economic indicators regarding labor and inflation.

O4. Modeling cyclical developments and circular economy.

O5. Development of a risk exposure model by applying the Markov function, its testing and implementation.

O6. Drawing up a table of public policy proposals to overcome the multiple crisis situation induced by the geo-political shock.

The novelty of this approach lies in the introduction of Markov chains as a tool for analyzing economic development and the current challenges it has to face, a method not used so far in this geopolitical context. This new approach covers the gap identified in the literature, regarding the use of accurate instruments in order to point out the economic vulnerabilities due the economic shocks and offers solutions to build a more sustainable economy.

The contribution of the paper to the existing literature aims at systematizing the literature in the field, establishing the vulnerabilities facing current economic development and defining new research hypotheses congruent with the current socio-economic context. By using the PRISMA method of analysis we believe that we can obtain the necessary results to complete the existing literature and make public policy proposals on economic survival across the EU.

The study continues with the literature review, the presentation of Data, models and methods, the presentation of Results and discussion and the formulation of Conclusions and public policy directions based on the observations drawn from the scientific analysis.

2. Literature review

The analysis of the literature conducted on 25433 articles published in journals rated Web of Science in the period 2020–2022 shows that the field studied is of extreme interest, the Hirsh index exceeding 100 points and the citation rate on the index being 8.65 times.

In terms of cluster structure, 9 clusters were identified for 137 items selected according to the co-occurrence criterion, as follows:

Cluster 1 (38 items) includes items on economic growth, economic performance, uncertainties and economic policies under uncertainty, including items on monetary policies, elements of uncertainty and risk, prices and elements of fiscal policy;

Cluster 2 (22 items) includes items on the banking crisis, economic development, financial crisis, governance, investment and the relationship to the pandemic crisis;

Cluster 3 (17 items) covers elements of macroeconomic policies, unemployment, welfare and social protection;

Cluster 4 (16 items) covers items on costs, debt, economic governance, euro instability and crisis, macroeconomic and economic recovery policies;

Cluster 5 (12 items) groups elements of convergence, crisis management, fiscal austerity, recession, regional economic resilience and public policy;

Cluster 6 (11 items) includes analysis of elements of austerity, challenges, economic recession, strategies and trends;

Cluster 7 (9 items) looks at economic resilience, labor market, migration, environmental and regional policies;

Cluster 8 (7 items) analyses the economic crisis in terms of risk factors, inequality and quality of life, also highlighting elements of socio-economic status;

Cluster 9 (5 items) highlights the links between inequality, reforms, national welfare and youth unemployment.

These aspects are shown in Figure 1.

In order to identify the most relevant research in the literature, the PRISMA method was used to narrow the scope of the critically reviewed literature according to the inclusion and exclusion stages shown in Figure 2.

The identified clusters as areas of research interest have been grouped into study sections, resulting in 5 areas that will be critically evaluated to obtain the main results from the literature to support the hypotheses (see Table 1).

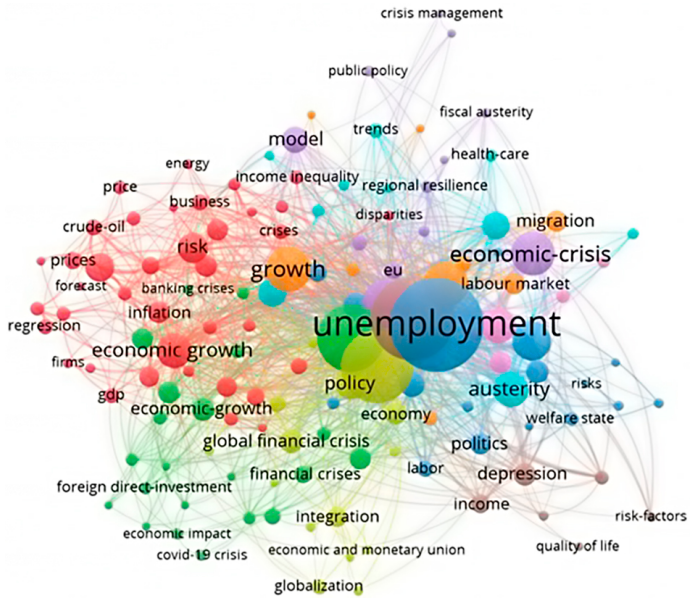


Figure 1. Meta-analysis of the literature on the impact of uncertainty on public policy modalities

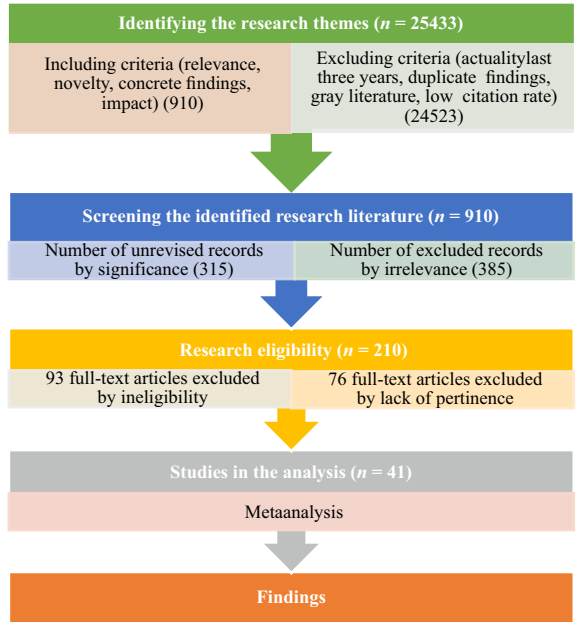


Figure 2. PRISMA method in selecting the core of the reviewed literature

Based on the data in Table 1, we will perform a critical analysis of the 41 literature sources in the context of the five selected variables. In this endeavor, we will consider the most representative articles, following which the main findings will be presented in detail and critically analyzed in terms of their integrative contribution to the development of the field.

Table 1. Definition of meta-analytical research areas

Variable	Cluster metaanalysis
Economic Sentiment Indicator (ESI)	Cluster 4 (16 items) covers items on costs, debt, economic governance, euro instability and crisis, macroeconomic and economic recovery policies; Cluster 5 (12 items) groups elements of convergence, crisis management, fiscal austerity, recession, regional economic resilience and public policy; Cluster 6 (11 items) includes analysis of elements of austerity, challenges, economic recession, strategies and trends; Cluster 8 (7 items) analyses the economic crisis in terms of risk factors, inequality and quality of life, also highlighting elements of socio-economic status.
Impact of public debt	Cluster 1 (38 items) includes items on economic growth, economic performance, uncertainties and economic policies under uncertainty, including items on monetary policies, elements of uncertainty and risk, prices and elements of fiscal policy; Cluster 2 (22 items) includes items on the banking crisis, economic development, financial crisis, governance, investment and the relationship to the pandemic crisis; Cluster 4 (16 items) covers items on costs, debt, economic governance, euro instability and crisis, macroeconomic and economic recovery policies; Cluster 5 (12 items) groups' elements of convergence, crisis management, fiscal austerity, recession, regional economic resilience and public policy.
Employment and unemployment	Cluster 3 (17 items) covers elements of macroeconomic policies, unemployment, welfare and social protection; Cluster 7 (9 items) looks at economic resilience, labour market, migration, environmental and regional policies; Cluster 9 (5 items) highlights the links between inequality, reforms, national welfare and youth unemployment.
Prices and inflation	Cluster 1 (38 items) includes items on economic growth, economic performance, uncertainties and economic policies under uncertainty, including items on monetary policies, elements of uncertainty and risk, prices and elements of fiscal policy; Cluster 2 (22 items) includes items on the banking crisis, economic development, financial crisis, governance, investment and the relationship to the pandemic crisis; Cluster 4 (16 items) covers items on costs, debt, economic governance, euro instability and crisis, macroeconomic and economic recovery policies.
Cyclical developments and circular economy	Cluster 1 (38 items) includes items on economic growth, economic performance, uncertainties and economic policies under uncertainty, including items on monetary policies, elements of uncertainty and risk, prices and elements of fiscal policy; Cluster 2 (22 items) includes items on the banking crisis, economic development, financial crisis, governance, investment and the relationship to the pandemic crisis; Cluster 5 (12 items) groups elements of convergence, crisis management, fiscal austerity, recession, regional economic resilience and public policy; Cluster 6 (11 items) includes analysis of elements of austerity, challenges, economic recession, strategies and trends; Cluster 8 (7 items) analyses the economic crisis in terms of risk factors, inequality and quality of life, also highlighting elements of socio-economic status.

2.1. Economic Sentiment Indicator (ESI)

In the context of the economic downturn, the role of the European Commission in conducting relevant business and consumer surveys becomes even more important according to some authors (Lukac & Cizmesija, 2021).

The statistical data obtained in this way are processed using econometric models. In this context, the authors highlight the complexity of the Economic Sentiment Indicator (ESI) for

quantifying global economic activity, which is why they propose two models for constructing the ESI. The first model is based on minimizing the sum of the absolute values of the estimation errors, while the second model considers maximizing the number of correctly predicted directions of change in GDP growth. The models use quarterly data and have allowed forecasts up to four quarters ahead. In our present scientific approach, we also use quarterly data, but the analysis period is updated. Moreover, we analyze the ESI in direct connection with other relevant indicators for characterizing the present economic downturn. The correlation between ESI and GDP is also analyzed by other authors (Čižmešija & Škrinjarić, 2021), who use the Diebold and Yilmaz method. Quarterly data covers the EU and separately ten Central and Eastern European countries. The analysis concludes that the spillover effects between ESI and GDP growth are time-varying for all countries observed, with the amendment that the effects increase from the last economic downturn to the present. An approach based on the same ESI indicator is carried out by other analysis (Cieślik & Ghodsi, 2021) and targets the decisions of multinational firms to undertake FDI in EU countries. The analysis covers the period 2003–2017 and the statistical data are processed using the Pseudo Poisson Maximum Likelihood (PPML) method. There is a direct incentive for multinational companies to undertake FDI in an EU country where ESI has a high value.

A comparative analysis of the ESI indicators published monthly by the European Commission for each Member State is made in an interesting study (Michis, 2021). The analysis concludes that there are considerable differences between Member States regarding short-term ESI. These differences tend to diminish in the long term and are influenced by the geographical proximity of the countries compared and their level of economic development. The same ESI indicator is correlated with the Economic Policy Uncertainty Index (EPU) in Europe by other authors (Arreola Hernandez et al., 2022). The statistical database covers official monthly reports from eleven European countries over the period 1987–2019. The results of the analysis highlight the strong correlation of ESI indicators in Germany, France and Italy, with German and French ESI having the strongest influence on the EU and euro area economy. On the other hand, ESI indicators in France and Italy have the greatest influence on the European UPE index. An interesting approach (Simionescu & Raišienė, 2021) quantifies the social tensions caused by the COVID-19 pandemic through ESI and target employment expectations vs. tensions related to new anti-pandemic restrictions. The analysis is based on data retrieved from Google Trends which are further processed by Panel Autoregressive Distributed Lag (panel ARDL) and Bayesian multilevel models. The results of the analysis reflect that the pandemic had a negative impact on expectations for employment, unemployment and inflation in EU Member States between March 2020 and May 2021. Such developments can be mitigated by implementing economic policies to reduce labor market tensions and improve employment expectations.

A complex meta-analysis (Sorić et al., 2022) interrelates ESI and cyclical developments in 17 EU countries. The authors use national accounts and sample data and conclude that the ESI is the driving force of the general business cycle. In this context, it would seem that the euro area can implement, due to the high degree of economic and monetary integration, a common monetary policy of the European Central Bank capable of acting effectively as a counter-cyclical tool when an individual economy faces a recession.

From the literature review, it appears that there is a deficiency in the partial approach to the issue of ESI at the level of only some Member States and not at EU27 level. Moreover, the statistical period over which the information is collected and processed is not long enough to support a meaningful analysis. In this context, in this scientific approach, we have extended the analysis of the ESI to the whole EU27 and to each Member State and have referred to official statistical information over a period of 14 years. In pus, we highlighted the impact of the ESI at the level of each Member State through econometric modelling.

This analysis pointed out that the Economic Sentiment Indicator (ESI) is a complex tool for quantifying global economic activity and performance. This approach supports our first work hypothesis:

H1. *Under conditions of uncertainty, the economic deflator tends to reduce its economic performance in direct proportion to the Economic Sentiment Indicator (ESI).*

2.2. Impact of public debt

There is a strong correlation between public debt and economic growth in the Member States (Onofrei et al., 2022). The authors have used statistical data from 1995–2019. The analysis uses general government gross public debt (as a percentage of GDP) and real GDP per capita growth rate as basic indicators and performs modelling using ARDL autoregressive distributed lag models. The results of the analysis confirm that an increase in public debt is negative and significantly associated with economic growth in the short and long term. The sustainability of public debt is the subject of an analysis covering the period 2000–2019 (Grosu et al., 2022). As methods of analysis, the authors use panel data regression and time series estimates using penalized spline regression. The results argue for a more active involvement of countries in stabilizing public debt and maintaining prudent fiscal policy. In the framework of economic convergence of Member States, increasing public debt affects economic growth (Rant et al., 2021). Moreover, higher public debt ratios exacerbate the effects of private debt on convergence during financial crises. In cases where public debt reaches very high levels, convergence can stop.

The effect of over-indebtedness and its connection with declining private investment is analyzed at the EU28 level over the period 1995–2016 (Vanlaer et al., 2021). According to the analysis, the authors conclude that a 10% increase in public debt reduced public investment by €18.32 billion. In the case of private investments, the impact of over-indebtedness is not significant. On the other hand, attracting foreign capital offsets a contraction in the domestic stock of financial resources due to higher levels of public debt. The impact of public debt on economic growth rates for 31 EU and OECD countries is quantified using a panel VAR model (Jacobs et al., 2020). The authors introduce into the analysis the real long-term government debt rate and the long-term government bond interest rate. The result of the analysis is to find a causal relationship between economic growth and public debt. The direct negative impact of growth on government debt is compounded by an increase in the long-term real interest rate, which in turn reduces interest-sensitive demand and leads to a further increase in the government debt ratio. The pandemic impact on Member States' economies is analyzed in conjunction with stimulus packages to avoid catastrophic economic collapse (Fedajev

et al., 2022). These differentiated packages have accentuated the disparities between Member States and further hindered the convergence process at European level. The analysis is based on statistical data from 2004–2020 and provides recommendations to policy makers for overcoming the crisis and achieving a satisfactory level of real and nominal convergence. The whole cluster approach uses a hierarchical agglomerative classification (HAC) on 2020 data. A less optimistic approach to the pandemic crisis is taken by some authors (Anghel et al., 2022) who consider that increasing levels of public debt financing and contingent liabilities may trigger another EU debt crisis. This is at a time when Member States are increasingly using public guarantees and other "hidden" extra-budgetary instruments. If public guarantees are covered by the budget, there will be an unprecedented increase in public debt that will affect the euro area in particular. The solution offered by the authors is to implement uniform rules and standards for reporting contingent liabilities at EU level.

From the literature review, it appears that authors are predominantly interested in studying the impact of public debt on economic development, ignoring some social effects and not offering solutions to overcome economic crises. Through our study, we have quantified through econometric modelling the impact of public debt, but also offered proposals for public policies dedicated to economic recovery. As a result, the second hypothesis can be defined as:

H2. *The influence of uncertain conditions on the economic deflator has the direct effect of increasing government debt.*

2.3. Employment and unemployment

Total, permanent and temporary employment in the context of European labor law is the subject of an interesting analysis (Arestis et al., 2020). Based on the panel analysis, the authors investigate the relationship between changes in employment protection for permanent and temporary workers and employment dynamics across the three mentioned above categories. Employment under the impact of the pandemic crisis in Germany, Spain and Italy is analyzed by other authors (Fana et al., 2020). The analysis is then extended through the same approach to the UK, Poland and Sweden. The authors conclude that the impact on employment is asymmetric within and between the countries analyzed. The European countries most affected by the pandemic are those that have had the most because of their productive specialization and labor market institutions. Even greater effects occurred in Member States facing pre-pandemic high unemployment and precarious working conditions (with reference to temporary contracts). From a demographic point of view, the employment rate and economic instability affect the fertility of the population (Alderotti et al., 2021). In this context, unemployment is considered a negative factor on fertility. The authors conduct a meta-analysis of European studies in the field and conclude that job instability has a non-negligible negative influence on fertility. By gender, male unemployment is more damaging to fertility. This phenomenon manifests itself much more strongly in southern European Member States, where social protection for families and the unemployed is weaker than in the rest of the EU. In the context of the Green Deal, the European green economy is seen as capable of creating enough jobs to gradually solve youth unemployment. Another analysis (Sulich et al., 2020) focuses on

Poland, the Czech Republic and Belgium and is initiated on selected groups in the European Classification of Economic Activities (NACE). The results of the analysis show that young people find their first jobs in the green sector in a higher proportion in Poland and Belgium (15%) compared to the Czech Republic (1.83%).

A comparative analysis of the place of agriculture in relation to the other sectors of the EU economy is based on indicators of employment and gross value added. The author (Kołodziejczak, 2020) covers the period 2000–2018 and starts from the assumption that gross value added/person employed in agriculture is equal to the average level achieved in industry and services. The analysis produces a new quantification indicator (the excess employment rate in the agricultural sector (EERAS) and concludes that excess labor in this sector can only be absorbed by relevant policies to improve the economic and social sustainability of agriculture. The EU enlargements of 2004 and 2007 were faced with fears of too large an influx of labor from the new member states. Some authors (Ulceluse & Kahanec, 2022) use data from the Labor Force Survey for the period 2004–2019. The authors conclude that negative effects on the labor factor after the two enlargements were felt more in Romania and Bulgaria and much less in the countries that joined the EU in 2004. Labor factor employment and labor market functioning in terms of entrepreneurial activity and economic development are analyzed under an interesting approach (Abdesselam et al., 2020). The authors focus on European "entrepreneurial" economies and differentiate them into five such entrepreneurial regimes. In doing so, the authors use indicators specific to economic development, labor market functioning and formal and informal institutional environments, as well as variables specific to the entrepreneurial population. The analysis concludes that the five entrepreneurial regimes are underpinned by the indicators of Innovation, Employment, Formal Institutions, Entrepreneurship and Governance and offers proposals to governmental and supranational policy makers for the implementation of public policies to promote entrepreneurial activity and reduce unemployment. The labor factor-wages-unemployment connection is the subject of a large analysis (Južnik Rotar et al., 2022) at EU level and covers the period 2006–2018. The authors analyze observed variables and latent variables based on structural equations and an extensive meta-analysis. The results of the analysis support the view that innovation and the budget deficit have significant but opposite effects on wages, while the effect of the unemployment rate is insignificant. As a result, the authors believe that it is extremely important to promote public policies that stimulate innovation and ensure macroeconomic stability, efficient markets and an adaptable and skilled workforce. Unemployment analyzed from the perspective of the risk of unemployment at European level and Member States' unemployment programmes is the subject of research by other authors (Burgoon et al., 2022). The authors cover 13 Member States and analyze government assistance in six crucial areas of anti-poverty policy. The results of the analysis point to the fact that overall support for unemployment policies depends on certain combinations of public policies, the generosity of the anti-unemployment programme and the limitation of coverage to countries providing education and training. The variation between the Member States surveyed in support for anti-poverty policies is considered modest. Unemployment shocks in some European Union countries during the recession are analyzed using synthetic control methodology (distributional analyses), (Ayala et al., 2022). The authors aim to quantify the impact of unemployment

on the poverty status of the population through sensitivity analysis. The main conclusion of the analysis is that unemployment shocks have a significant and rapid sensitivity on the depreciation of poverty.

An interesting econometric analysis (Bal-Domańska, 2022) aims to assess the correlations between the youth unemployment rate and the market and macroeconomic determinants (economic growth and productivity of the economy). The analysis covers the EU from 2008–2018. A first result of the analysis supports the idea that the improvement of the situation of young people on the labor market can be efficiently supported by the development of the economy in general and the knowledge-based economy in particular. The branches with the greatest impact in reducing the unemployment rate among young people are the productive-industrial sector (for young female people) and the construction sector (for young male people).

It can be seen from the literature review that the authors are mainly concerned with analyzing the two indicators by specific groups of Member States and less so at EU level. From our point of view, we have addressed in an integrative way the effects of unemployment on the European economy as a whole and at the level of each Member State. Econometric modelling allowed us to highlight the connections between employment and unemployment and the other indicators selected for analysis, as well as to develop scenarios of future developments. According to these conclusions, the third hypothesis can be defined as:

H3. *Increasing geo-political uncertainties have a direct and immediate effect on the vulnerability of social conditions and rising unemployment.*

2.4. Prices and inflation

The asymmetric effects of fiscal policy on inflation and economic activity are analyzed for the 12 Member States that joined the EU in 2004 and 2007 (Asandului et al., 2021). The modelling is based on a Pooled Mean Group (PMG) estimator. The results of the analysis show that fiscal policy negatively influences both inflation and economic activity in the long run, while the effects are not significant in the short run. In the context of the economic crisis, another research (Beck, 2020) reiterated the scientific interest in business cycle correlation as the European Central Bank implements a common monetary policy. The results of the analysis are contradictory. They show evidence of both convergence and decoupling of European business cycles depending on the time period examined, the sample of countries and the methodology used. Statistical analysis of 2000–2018 data supports the existence of two distinct business cycles in the euro area and Central and Eastern Europe, as well as progressive decoupling in the European Union and Central and Eastern Europe.

The Gini indicator and the systematic change in expenditure shares and prices are the subject of research (Gürer & Weichenrieder, 2020) by covering 25 Member States over the period 2001–2015. The analysis is based on EU household budget statistics and EU harmonized index of consumer prices data. It shows that over the period under review the consumption bundles of the poorest components of the EU population increased by 11.2%, which caused the Gini indicator to change by 0.04 points. Another author such (Batrancea, 2021) draws attention to changes in consumption behavior as a result of the latest global developments. The

analysis covers the EU28 and aims to quantify the impact of economic growth and inflation on ESI and household consumption between December 2019 and October 2020. The authors conclude that the negative impact of inflation on ESI was much greater than the positive impact of economic growth over the analyzed period. Some authors are involved in providing an optimal quantification procedure for central bank survey results to predict inflationary trends based on a set of regression procedures and probabilistic models. Other analysis (Rutkowska et al., 2022) covers the EU from January 2002 to June 2019. The conclusion of the analysis is to apply probabilistic procedures rather than regression methods. Applying trade theory empirically demonstrate the effects of value chain integration on EU producer price dynamics (Friesenbichler et al., 2021). Considering the EU as a well-integrated region, the authors conclude that upstream integration and EU membership dampens inflation, while downstream integration contributes to higher price levels.

The imperfections of inflation and CPI calculation procedures are highlighted by other author (Arlt, 2021), who refers to the possibility of operating with false cycles of annual inflation rates related to incorrect quantification of the seasonality of variables. The conclusion of the analysis is that current estimates of annual inflation rate parameters are biased and imprecise, allowing only incorrect short-term forecasts. Economic theory states that following the adoption of the euro, convergence of inflation rates in the euro area would become feasible. This approach does not take into account the effects of fixed exchange rates and the different geographical and historical linkages that can lead to different degrees of regional inflation convergence (Hegerty, 2020). The analysis focuses on five Central and Eastern European countries that are members of the euro area and concludes that no inflation in the euro area has a break point that corresponds specifically to euro adoption. On the other hand, after 2013 general and regional convergence increased.

The same overriding concern for the analysis of inflation by groups of Member States is also apparent from the literature review above. This model of analysis does not allow for evidence on the regional (EU) scale of the related influences of inflation on socio-economic developments, which has been remedied in the present research.

2.5. Cyclical developments and circular economy

An interesting study conducted at EU27 level over the period 2000–2015 (Gootjes & de Haan, 2022) analyses the counter-cyclical or pro-cyclical nature of fiscal policy and the cyclical response of this policy. A first conclusion of this analysis is that budgetary outcomes are pro-cyclical in all Member States, while government efficiency and taxation seem to reduce fiscal pro-cyclicality more in the euro area and in times of economic crisis. The role of the bioeconomy in achieving economic growth is highlighted by some authors (Tibor & Grande, 2022). The analysis is aimed at Explocom GK, which uses biowaste to produce biochar through the pyrolysis process. Converting a fraction of the biochar produced into activated carbon increases the overall cost-effectiveness of the plant and reduces emissions from transporting activated carbon. The sustainability-circular economy correlation is discussed in a paper (Hartley et al., 2020), which weigh existing policies in this area against expectations for circular economy policies at EU level. The analysis concludes that the expectations of entrepreneurs in the circular economy are for "stronger standards and norms in production, expansion of

circular procurement, tax exemptions for circular products, liberalization of trade in waste and its facilitation through virtual platforms, support for eco-industrial parks and awareness-raising campaigns." The use of GDP in the context of quantifying the performance of the sustainable economy should be done with great caution (Paunica et al., 2021). The authors perform a careful analysis of the components of GDP, together with two indicators of final energy consumption using the Toda-Yamamoto method of Granger causality, for the period 1995–2019, and for the EU28. The analysis shows that Granger causality is demonstrated for the GDP of the Netherlands, Cyprus, Czech Republic, Estonia, Latvia and Portugal.

Economic resilience under alternative recessionary shocks is studied based on a spatial general equilibrium model applied to the EU (Di Pietro et al., 2021). The objectives of the analysis are to quantify the vulnerability, resilience and recovery capacity of the regions. These aspects lead to the conclusion that factor mobility varies according to the nature of the external shock, pre-shock regional characteristics and factor mobility. An important current element in sizing GDP is the use of e-commerce by businesses in the European Union. According to other authors (Soava et al., 2022), the importance of e-commerce in economic growth can be quantified using the Digital Economy and Society Index (DESI). The analysis covers EU countries over the period 2003–2020 and forecasts to 2025 using six regression models for empirical estimation. Two interesting conclusions derive from this analysis. The first one finds that the share of firms engaged in e-commerce activities and turnover from e-commerce sales varies significantly by firm size. The second states that there will be significant growth in e-commerce in most European countries by 2025. The concern of the United Nations for sustainable economic development at the global level is highlighted with the reservation regarding the choice of gross domestic product (GDP) per capita as an indicator for SDG 8 ("Decent work and economic growth"), (Coscieme et al., 2020). The authors believe that pursuing GDP growth in its current form of calculation is at odds with achieving environmental and welfare goals and inequality reduction targets, including at EU level. Some authors (Beck, 2021) consider that business cycle divergence is a robust feature of GDP time series in the European Union and that an analysis of the determinants of this divergence is needed. Based on the Bayesian dynamic factor model, the author concludes that the divergence of business cycles in the European Union is due to a rapid decline in the share of manufacturing and an increase in the share of services, characterized by weak inter-sectoral linkages.

The discussions from sections 2.4 and 2.5 lead to the definition of a common hypothesis, as:

H4. *Under conditions of uncertainty, industrial production negatively affects economic growth and destabilizes the economic structure of the market.*

A shortcoming resulting from the literature review is that pre- and post-pandemic periods are not highlighted in the research studied. In the case of our scientific approach, this is solved, and the econometric modeling allowed to highlight the changes related to the two time periods mentioned above.

The analyzed data were collected for all 27 EU Member States and for the EU27 average, aiming at sizing the systemic risk equation with regional impact through variant analysis at Member State level, based on above *working hypotheses.*

3. Data, models and methods

3.1. Data and variables

For the collection of indicators and the construction of the database, we used the Eurostat data portal and collected the following quarterly information over a period of 15 years (2007–2022). This period was selected in order to cover representability (at least 10 years) and to put in analysis our study's goal to quantify the new challenges for the economic survive in EU. As a result, this selected period covers at least two economic crisis, a pandemic one and the geo-political one, as well (see Figure 3).

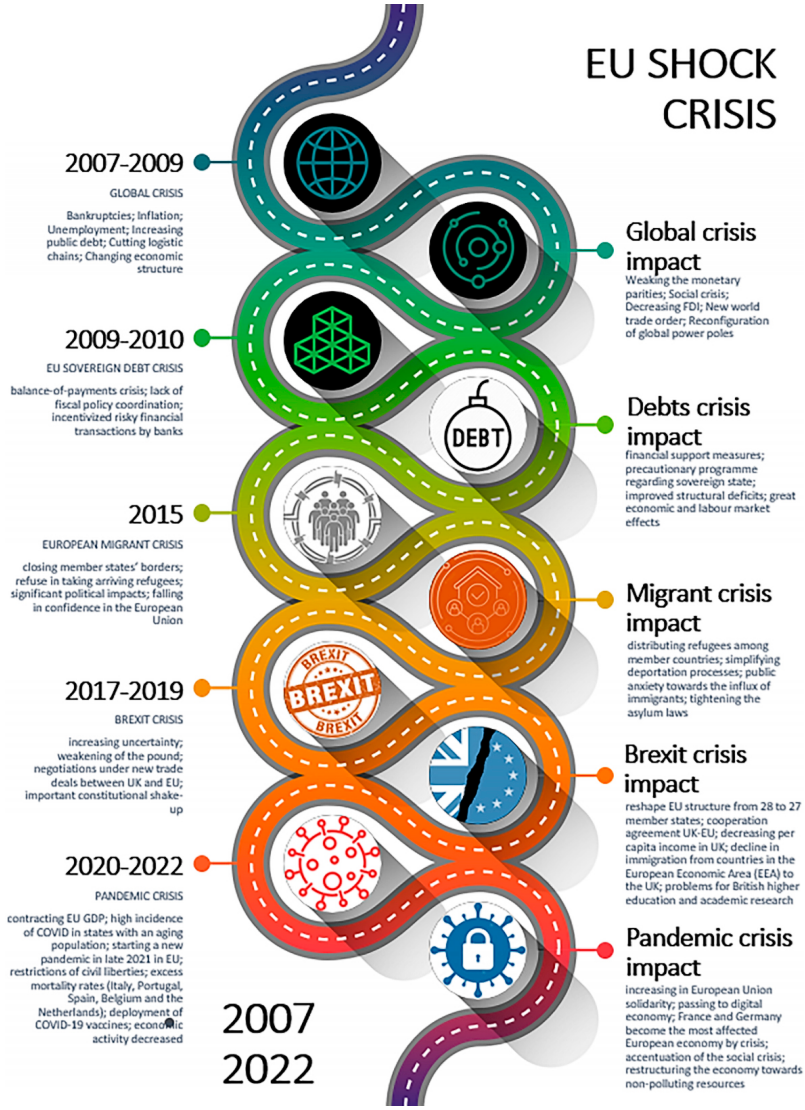


Figure 3. European multiple shocks during 2007–2021

In order to highlight the conceptual model of the research, we have elaborated the logical scheme that contains the scientific path of the research, the validation criteria regarding the relevance of the objectives, the hypotheses, the quantification of the importance of the methods and the structuring of the results. All these elements are presented in Figure 4.

We point out that the indicators selected for this analysis result from the literature review (see Table 2).

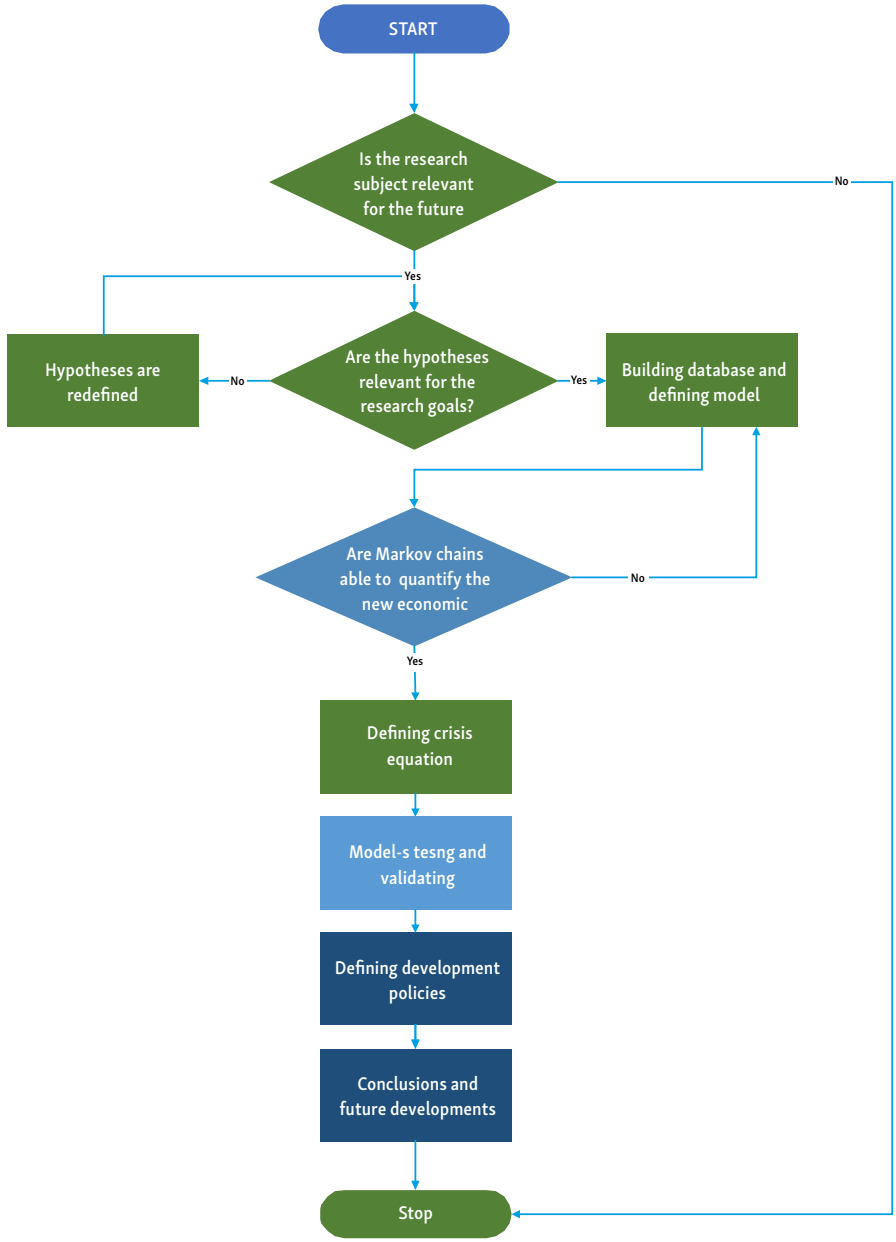


Figure 4. Logical scheme of the research

Table 2. Defining indicators for model building

Variable	Symbol	Description	Source
Economic Sentiment Indicator (ESI)	EIBSSI	Economic sentiment indicator (calculated based on a selection of questions from the industry, services, retail trade, construction and consumer surveys at country level and at aggregate level (EU and euro area) in order to track overall economic activity)	(Eurostat, 2023f)
Impact of public debt	GOVDEBT	Government consolidated gross debt (Percentage of gross domestic product)	(Eurostat, 2023e)
Employment and unemployment	EMP	Total employment (resident population concept from 20 to 64 years – percentage of total population	(Eurostat, 2023a)
	UNE	Unemployment rate	(Eurostat, 2023g)
Prices and inflation	PRCHICP	Harmonized Index of Consumption Price – (annual rate of change)	(Eurostat, 2023c)
Cyclical developments and circular economy	STSINPR	Production in industry (Percentage change on previous period)	(Eurostat, 2023d)
	GDP	Gross domestic product at market prices (Chain linked volumes, index 2015 = 100)	(Eurostat, 2023b)

A summary of descriptive statistics by region is presented in Appendix Table A1.

The present analysis uses the above key factors that contribute to the overall economic health of a country (Table 2) based of the following logical approach. The Economic Sentiment Indicator (ESI) provides valuable insights into the confidence levels of businesses and consumers, which in turn affects investment and spending decisions. The impact of public debt on the economy is significant, as it determines the government's ability to fund public services and make necessary investments. Employment and unemployment rates are important indicators of a country's labor market, reflecting the overall health of the economy and the livelihoods of its citizens. Prices and inflation play a crucial role in determining the purchasing power of consumers and the overall cost of living. Cyclical developments, such as economic booms and recessions, can have a profound impact on various sectors of the economy. Employment levels can fluctuate significantly during these periods, with booming economies leading to increased job opportunities and lower unemployment rates, while recessions often result in job losses and higher unemployment rates. These fluctuations can have ripple effects on other sectors, such as housing and consumer spending, further impacting the overall health of the economy. Therefore, closely monitoring and understanding these economic indicators is essential for policymakers and businesses to make informed decisions and implement effective strategies to promote economic growth and stability. For example, during periods of economic expansion, increased job opportunities lead to higher incomes, which can boost consumer spending. This increased consumer spending can then stimulate demand for goods and services, leading to growth in the manufacturing and retail sectors. Additionally, lower unemployment rates mean that more individuals have a steady income, reducing the burden on social welfare programs and increasing tax revenues for the government. On the other hand, during recessions, job losses and higher unemployment rates can lead to decreased consumer spending, as individuals have less disposable income.

This can result in reduced demand for goods and services, leading to further job losses in affected sectors.

On this above literature review, the opportunity of the study proposed by the authors in this paper is demonstrated.

3.2. Model and methods

We used the risk design methodology based on the analysis of probabilities of impact of crisis situations using the Markov chain method, as follows:

- for the situation of economic security in the absence or under the minimal impact of risk factors, the probable function of the economic shock is defined:

$$P\left(A \cup B\right) = P\left(A\right) + P\left(B\right),\ A \cap B = \varnothing, \tag{1}$$

  where: A – economic development in line with common economic policies already implemented; B – the disruptive factor (geo-political conflict); P – probability function with minimal residual impact in changing common economic policies.
- for the situation of economic insecurity in which there are effects of geopolitical conflict on common economic policies, the likely function of economic shock is:

$$P\left(A \cup B\right) = P\left(A\right) + P\left(B\right) - P\left(A \cap B\right), A \cap B \neq \varnothing. \tag{2}$$

In the case of the regional distribution, the likely risk function is varied at the regional level through the preceding measures of protection from induced economic shock, as follows:

$$P\left(X\right) = \sum_{i=1}^{n} P\left(A_i\right) P_{A_i}\left(X\right), A_i \cap A_{i+k} \neq \varnothing, \forall\, i \in 1, n, \lim_{i \to n}\left(i + k\right) \to n; \tag{3}$$

$$P_X\left(A_i\right) = \frac{P\left(A_i\right) P_{A_i}\left(X\right)}{\sum_{k=1}^{n} P\left(A_k\right) P_{A_k}\left(X\right)}, \tag{4}$$

where: X – regional factor; A_i – current economic development according to common economic policies already implemented in region i; $P_{A_i}\left(X\right)$ – the level of disruption of economic policies at regional level; $P_{A_k}\left(X\right)$ – the level of economic policy disruption at the regional level prior to the triggering of the shock generator; A_k – economic development preceding geo-political shock according to common economic policies already implemented in region i.

As described above, the assessment of the impact of the economic shock is made by comparing the dynamics of economic policies and their effectiveness at times before and after the onset of the shock. Given that the geo-political conflict was triggered in February 2022 by Russia's invasion of Ukraine, the analysis of the economic policy disruption was carried out using the 2007–2021 and 2007–2022 evolution trends, these trends of the indicators presented above being integrated in a multiple correlative regression in which the dependent variable was established as the GDP economic deflator, a variable extremely sensitive to changes in economic policy.

Thus, based on the method of least squares, a first regression comparison between the model indicators and the dependent variable GDP at the EU27 level was carried out, as follows:

$$\begin{cases} EUGDP_{2022} = 0.619 * EUEIBSSI_{2022} + 0.953 * EUEMP_{2022} + \\ 0.352 * EUGOVDEBT_{2022} + 0.233 * EUPRCHICP_{2022} - \\ 0.169 * EUSTSINPR_{2022} - 0.728 * EUUNE_{2022} \\ EUGDP_{2021} = 0.668 * EUEIBSSI_{2021} + 0.935 * EUEMP_{2021} + \\ 0.345 * EUGOVDEBT_{2021} + 0.01 * EUPRCHICP_{2021} - \\ 0.248 * EUSTSINPR_{2021} - 0.133 * EUUNE_{2021} \end{cases}, \quad (5)$$

where: *EUGDP* – Gross domestic product at market prices (dependent variable); *EUEIBSSI* Economic sentiment indicator; *EUGOVDEBT* – Government consolidated gross debt; *EUEMP* – Total employment; *EUPRCHICP* – Harmonized Index of Consumption Price; *EUSTSINPR* – Production in industry; *EUUNE* – Unemployment by sex and age (regressors).

The method of analysis was selected because it allows the changes in risk to be highlighted, while allowing for testing the stationarity of the data series, homogeneity and statistical validation through null hypothesis testing. The regression equations were statistically tested, with the results indicating a high significance level of both regressions, above 95%, with a statistical F function value of 214 points in year 2022 and 182 points in year 2021. The results are presented in Table 3.

By applying the ANOVA test, statistically significant results were obtained both in terms of the distribution of regression squares and the distribution of errors, which fell within the chosen significance threshold of 5%, allowing the rejection of the null hypothesis and maintaining the alternative hypothesis, statistically validating the proposed econometric model (see Table 4).

Table 3. Model summary

Model [a,b,c]	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
2022	0.979	0.959	0.955	1.1613	0.959	214.395	6	56	0.000	0.925
2021	0.977	0.954	0.949	1.1665	0.954	182.795	6	52	0.000	0.948

Note: a. Predictors: (Constant), EUEMP, EUSTSINPR, EUPRCHICP, EUGOVDEBT, EUEIBSSI, EUUNE; b. Dependent variable: EUGDP; c. Quarterly time series 2007–2021 and 2007–2022.

Table 4. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
2022	Regression	1734.700	6	289.117	214.395	0.000
	Residual	74.169	56	1.349		
	Total	1808.869	62			
2021	Regression	1492.279	6	248.713	182.795	0.000
	Residual	72.112	52	1.361		
	Total	1564.391	58			

Note: a. Dependent variable: EUGDP; b. Predictors: (Constant), EUEMP, EUSTSINPR, EUPRCHICP, EUGOVDEBT, EUEIBSSI, EUUNE; c. Quarterly time series 2007–2021 and 2007–2022.

From Equation (5), it can be seen that under the impact of the geo-political shock the positive direct correlations are affected, being influenced by the rising inflationary phenomenon (from 1% correlation with GDP in 2021, to over 23% correlation with GDP in 2022). Moreover, Economic Sentiment Indicator (ESI) and social impact are affected by increasing unemployment rate which have an indirect negative correlation of 13% in 2021, so that in 2022, the negative trend correlation is 72%. The correlation table after simulation, carried out by means of IBM-SPSS 25, using the selected variables for the European averages for the period 2007–2021 and the period 2007–2022 is presented in Table 5.

More statistical tests (standard errors, significance, alternative hypothesis validation and the result of Kolmogorov-Smirnov test) are presented in Appendix Table A2 and Figure A1. The data in Table 1 have been evaluated in terms of distributions between the period prior to the onset of the economic shock and the current period, resulting in the radial risk amplification below diagram (see Figure 5).

The risk amplification diagram shows that, with the exception of government debt, the other analysed components of economic policy have undergone an amplification of the effects of risks, departing from the level achieved at the time before the outbreak of the geo-political conflict. This shows that under the impact of risk, economic policies tend to destabilise, losing the elements of strategic guidance previously subsidised by multiannual funding programmes. According to the diagram, it can be seen that under the impact of risks, the economy tends to uniformly react to risk in the first wave, which means on the one hand that the market economy is a model of economy with high systemic entropy, the level of shock propagates rapidly in all interconnected areas of the economy, and on the other hand that the global dimension shows higher vulnerability to risk than the classical (traditional) national economy, this aspect being assimilated to the stabilization vulnerabilities of global-value chains.

Table 5. Simulative correlations using the uniform distribution method (results of the estimation of Eq. (5))

Indicators		EU-EIBSSI	EU-EMP	EU-GDP	EU-GOVDEBT	EU-PRCHICP	EU-STSINPR	EU-UNE
2022	EUEIBSSI	1.000	0.497	0.619	0.183	0.111	–0.071	–0.335
	EUEMP	0.497	1.000	0.953	0.365	0.248	–0.062	–0.772
	EUGDP	0.619	0.953	1.000	0.352	0.233	–0.169	–0.728
	EUGOVDEBT	0.183	0.365	0.352	1.000	–0.187	0.187	0.242
	EUPRCHICP	0.111	0.248	0.233	–0.187	1.000	–0.075	–0.394
	EUSTSINPR	–0.071	–0.062	–0.169	0.187	–0.075	1.000	0.051
	EUUNE	–0.335	–0.772	–0.728	0.242	–0.394	0.051	1.000
2021	EUEIBSSI	1.000	0.511	0.668	0.160	0.083	–0.042	–0.013
	EUEMP	0.511	1.000	0.935	0.329	–0.090	–0.090	–0.026
	EUGDP	0.668	0.935	1.000	0.345	0.010	–0.248	–0.133
	EUGOVDEBT	0.160	0.329	0.345	1.000	–0.391	0.164	0.150
	EUPRCHICP	0.083	–0.090	0.010	–0.391	1.000	–0.121	–0.165
	EUSTSINPR	–0.042	–0.090	–0.248	0.164	–0.121	1.000	0.727
	EUUNE	–0.013	–0.026	–0.133	0.150	–0.165	0.727	1.000
	SUNE	–0.420	–0.732	–0.667	0.343	–0.258	0.117	0.043
	Correlations between simulated inputs may differ from correlations specified for those inputs in the simulation plan.							

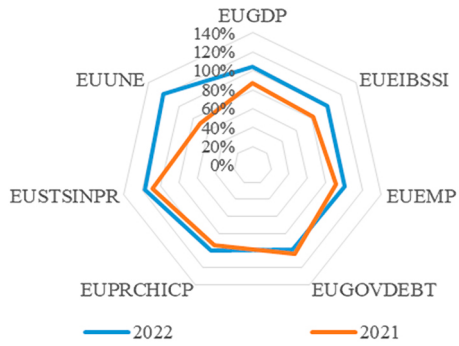


Figure 5. Risk amplification diagram

4. Results and discussion

4.1. Main results

The risk function can be validly determined by comparing the probability of risk exposure at the level of simulated correlation coefficients at time *t*0 (2021) prior to the onset of the geopolitical conflict situation with time *t* (2022) after the onset of the conflict.

It can be seen that at the European level the economic function has changed as a result of risk exposure (see Table 6), as follows:

- the level of correlation of the economic deflator at the European level as a dependent variable in relation to risk exposure indicators (government debt and inflation) has increased significantly as a result of the outbreak of geo-political conflict, demonstrating that sustainable economic growth is significantly disturbed by the impact of war, which subsequently induces the possibility of multiple chain crises;
- the correlation level of the ESI indicator tends to increase in conditions of increasing risk correlation of the economic deflator, but this increase contains a reflexive component (4% compared to 18%) motivated by inertia and the punctual interest of investors in the market. This aspect demonstrates that under conditions of geo-political risk the vulnerability manifested at the regional market level is taken up in a chain at least at time *t* + 1, which induces rank 2 economic crises with impact on socio-economic indicators after the stabilization of the geo-political shock;
- at the level of the employed labour force indicator, following the outbreak of the conflict, there is a deceleration of the correlation with economic growth (–2% compared to 18%) and a maintenance of the correlation with the ESI indicator, which remains unchanged at the level of the *t*0–*t* correlation parameter. This shows that the labour market at the onset of the geo-political shock suffers a residual setback related to the economic deceleration at time *t*, the impact being felt at the earliest at time *t* + 1, when the second-tier economic crisis occurs.

The other indicators such as industrial production show an upward trend (29% compared to 18%) correlating with the deceleration of economic growth, which shows that in situations of geo-political conflict. As it is showed in Figure 4, industrial crisis is followed by changes in the behaviour of industrial agents which are manifested in the first wave of the crisis.

The unemployment indicator shows an increase in correlation with economic deceleration (20% compared to 18%) which shows that in situations of geo-political conflict social policy is affected in the first wave of the crisis.

Schematically, the issues presented in Table 4 fit into the following crisis diagram (see Figure 6).

Table 6. Risk exposure by applying the Markov function

Moment	Indicators	EU-GDP	EU-EIBSSI	EU-EMP	EU-GOVDEBT	EU-PRCHICP	EU-STSINPR	EU-UNE	Mean
$P_{A_i}(X)$ 2021	EUGDP	100%	98%	101%	95%	70%	83%	76%	87%
	EUEIBSSI	98%	100%	98%	107%	113%	152%	–78%	82%
	EUEMP	101%	98%	100%	95%	55%	80%	112%	90%
	EUGOVDEBT	95%	107%	95%	100%	104%	110%	109%	104%
	EUPRCHICP	70%	113%	55%	104%	100%	107%	84%	94%
	EUSTSINPR	83%	152%	80%	110%	107%	100%	100%	108%
	EUUNE	76%	–78%	112%	109%	84%	100%	100%	71%
	Mean	87%	82%	90%	104%	94%	108%	71%	91%
$P_{A_i}(X)$ 2022	EUGDP	100%	102%	99%	102%	116%	112%	96%	105%
	EUEIBSSI	102%	100%	98%	99%	103%	94%	113%	101%
	EUEMP	99%	98%	100%	95%	105%	106%	101%	101%
	EUGOVDEBT	102%	99%	95%	100%	87%	94%	115%	98%
	EUPRCHICP	116%	103%	105%	87%	100%	109%	98%	100%
	EUSTSINPR	112%	94%	106%	94%	109%	100%	194%	116%
	EUUNE	96%	113%	101%	115%	98%	194%	100%	120%
	Mean	105%	101%	101%	98%	100%	116%	120%	106%
	EUGDP	100%	102%	99%	102%	116%	112%	96%	105%

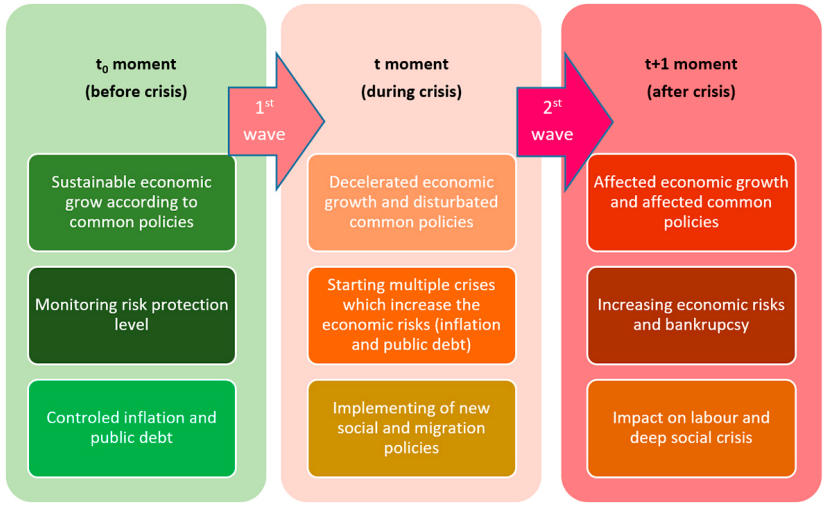


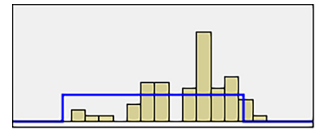
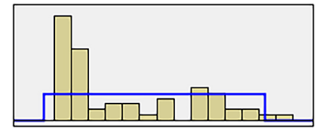
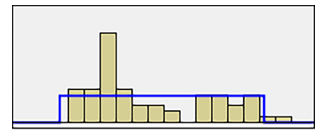
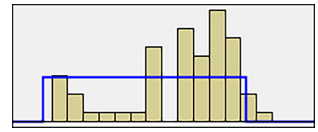
Figure 6. Geo-political crisis diagram

In Figure 4, we present European multiple shocks during 2007–2022. According to data synthesised from the European history of the shock effects of the impact of crises, it has been observed that from one crisis to another, some elements of vulnerability not addressed by public recovery policies are taken over. For example, the 2009 crisis weakened Member States' financial systems which led to the sovereign debt crisis in 2010. In 2015, the migrant crisis overlapped with unaddressed vulnerabilities, leading to a decrease in citizens' trust in European mechanisms. This drop in confidence has led to the Brexit crisis. The pandemic crisis was an unplanned event that intensified previous economic vulnerabilities through lock downs and reduced economic capacity of firms. In Figure 6, the diagram of the geopolitical crisis in the year 2022 with ex-ante and ex-post effects is presented and it can be seen that especially the elements of vulnerability are distributed to economic phenomena, an aspect that links to the global economic crisis in Figure 4 from 2008–2009.

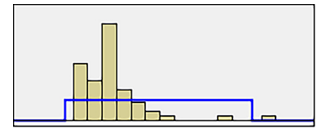
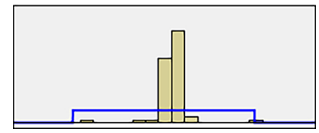
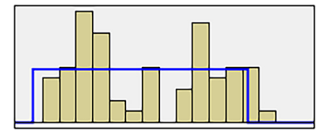
At the level of our proposed application, the risk probability values, magnitude and standard deviation of risk were calculated in Table 7 using the correlation smoothing method.

The analysis of standardized correlations shows that the quarterly level of the dependent variable (GDP economic deflator) over the statistical period under analysis shows the highest distributions of sustainability in relation to the regressor variables. They allow the framing of common economic development policies at a unitary representative level in relation to the set objective, the average being close to 100 points (the best represented level in relation to the variables of the proposed model).

Table 7. Risk histogram

Variables	Markov chain calculation	Amplitude	Mean and standard deviation	Histogram (uniform correlation)
EUEIBSSI	A = 9.25 P = 0.0 (K = 0.3 P = 0.0)	max = 116.0 min = 69.3	mean = 99.61 stddev = 10.25	
EUEMP	A = 16.39 P = 0.0 (K = 0.37 P = 0.0)	max = 74.8 min = 66.6	mean = 69.23 stddev = 2.46	
EUGDP	A = 3.96 P = 0.01 (K = 0.24 P = 0.0)	max = 111.91 min = 92.95	mean = 100.66 stddev = 5.4	
EUGOVDEBT	A = 7.42 P = 0.0 (K = 0.31 P = 0.0)	max = 92.3 min = 62.3	mean = 80.93 stddev = 8.0	

End of Table 7

Variables	Markov chain calculation	Amplitude	Mean and standard deviation	Histogram (uniform correlation)
EUPRCHICP	A = 32.45 P = 0.0 (K = 0.54 P = 0.0)	max = 9.6 min = –0.1	mean = 1.97 stddev = 1.7	
EUSTSINPR	A = 15.99 P = 0.0 (K = 0.38 P = 0.0)	max = 10.0 min = –10.1	mean = –0.03 stddev = 2.02	
EUUNE	A = 0.36 P = 1.0 (K = 0.11 P = 0.4)	max = 11.7 min = 6.1	mean = 8.85 stddev = 1.68	

In second place in terms of policy consistency is the ESI index, which proves to follow most closely the even distribution of economic growth, which denotes that sustainable economic growth intrinsically leads to a steady inflow and perpetual investor interest in the region.

In third place is the maintenance of public debt and government deficit within normalised parameters, although this is affected by the impact of the pandemic on the European economy through the variability of the indicator over the last period.

Also a strength is the common policy on social protection and prevention of unemployment, which can be appreciated at a level of good practice until the outbreak of the pandemic.

At the other end of the spectrum, industrial production indices show a variability independent of sustainable development policy at the European level, with significant disturbing factors of variation due to industrial structure, high energy consumption, and regional disparities.

5. Patent policy simulations

Common socio-economic policies at the regional level refine the geo-political risk function through the impact of regional disparities, with different investor interest compared to the European average in terms of both gross and simulated correlation values (see Figure 7). We define Member States' ratings as follows: EU – European Union; B – Belgium; BG – Bulgaria; CZ – Czech Republic; DK – Denmark; D – Germany; EST – Estonia; EIR – Ireland; GR – Greece; ES – Spain; F – France; HR – Croatia; IT – Italy; CY – Cyprus; LV – Latvia; LT – Lithuania; L – Luxembourg; HU – Hungary; MT – Malta; NL – Netherlands; A – Austria; PL – Poland; PT – Portugal; RO – Romania; SL – Slovenia; SK – Slovakia; FI – Finland; S – Sweden.

If at the EU level the correlation level of the indicators for the period 2007–2022 is around the Pearson correlation coefficient of 0.6 (60%), correlated with the GDP economic deflator, it is observed that at the regional level, the level of correlation with the dependent variable decreases to 0.2 Pearson correlation points in the case of less developed Member States, while Western countries manage to maintain this indicator within the European average.

Thus, the impact on economic activity induced by the outbreak of geo-political conflict is reflected in the level of investor interest at the level of the EU average if the level of development allows confidence in the opportunities offered by the Member State to be maintained (higher level of development) and tends to decrease with the level of development of the Member State. This shows that in situations of geo-political conflict less developed countries will be affected at time t (the first wave of the crisis), while more developed countries tend to postpone economic decline and investor migration to time $t + 1$ (the second wave of the crisis). Croatia's situation is a special case due to its performance in the tourism industry and the boom in merchandise exports. Moreover, Croatia has become in 2021 an energy powerhouse with its floating liquefied natural gas (LNG) and invested heavily in wind, solar and geothermal energy (Balkan Green Energy News, 2021).

The common EU unemployment policy is marked by strong regional disparities, which can be seen in Figure 8.

At EU level, the correlation with the GDP economic deflator is inversely proportional and developed countries (Austria, Netherlands, Germany, France) show a correlation closer to the European average while developing countries (Romania, Bulgaria, Greece or countries affected by pandemics such as Italy and Luxembourg) show variations with larger amplitudes. This aspect demonstrates that social policy shows reflexivity in adapting to geo-political shock if other stress factors such as pandemics had already made their effects felt prior to its onset, which leads to the hypothesis that multiple crises make countries in which the economic structure is sensitive or vulnerable prior to the crisis socially vulnerable.

Indistinct production is marked by strong regional disparities, being atypical of economies with a less efficient industrial structure, especially in the energy segment, which shifts the timing of bankruptcies from $t + 1$ to t. Countries with performing economies (Netherlands, Germany, Denmark) will succeed in postponing the economic shock induced in wave 2 of the crisis (see Figure 9).

Also in the case of the risk marker consumer price index there is an asymmetric distribution influenced by regional disparities at European level. The direct effect of the geo-political conflict manifested against the backdrop of the embargo on imports of energy products from Russia generated the European energy crisis, which led to a significant increase in consumer prices and subsequently triggered social tensions in the EU. This has led to systemic changes in energy policies, with the EU strongly promoting the reduction of energy consumption and the strengthening of the green energy industry. At Member State level, the most affected in terms of the correlation of consumer prices with the GDP economic deflator are Bulgaria, Romania, Poland, Malta and the Baltic countries. In these countries, the need for social protection has led to the application of compensatory government measures that have had the indirect effect of increasing public debt and the budget deficit. From the crisis equation point of view, the onset of the social crisis is anticipated for these countries at time t compared to $t + 1$ (see Figure 10).

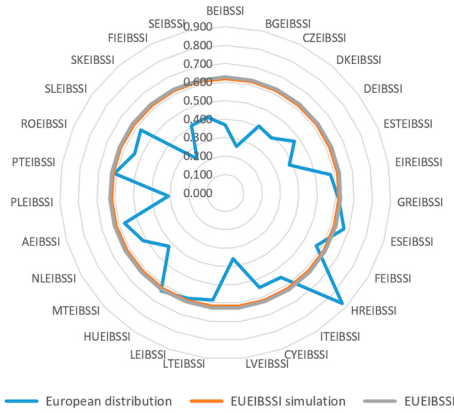


Figure 7. Diagram of the ESI index under regional impact

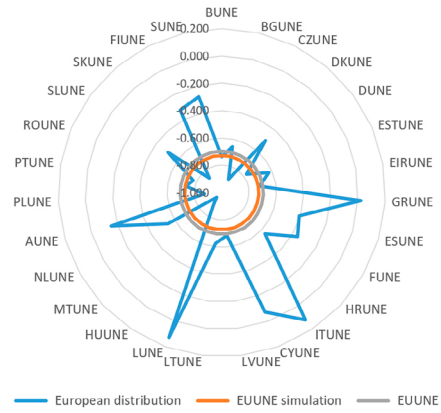


Figure 8. Unemployment rate diagram under regional impact

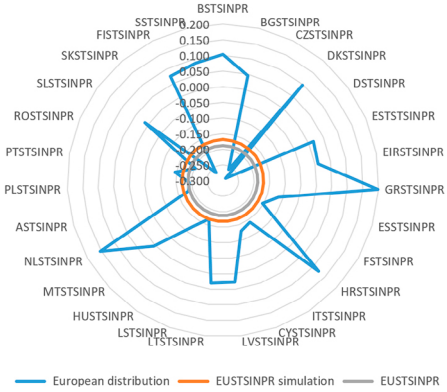


Figure 9. Industrial production diagram under regional impact

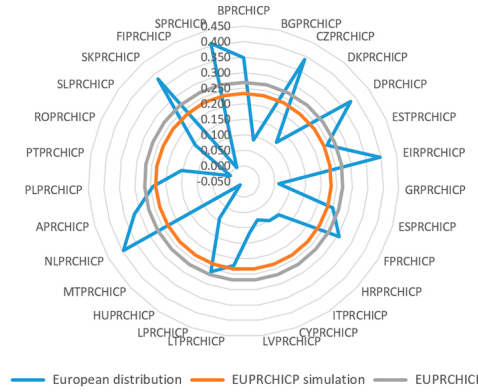


Figure 10. Regional inflationary price diagram

Regarding the GDP economic deflator as a dependent variable, the first observation drawn from the study is that the level of raw correlations and simulated correlations is identical at the European level, which means that from the point of view of the influence of the geo-political shock, the net variation between the two assessments allows a maximum accuracy in forecasting the dynamics of the deflator, which means that it will take the geo-political shock directly and at the highest level. The first component affected by the outbreak of war is sustainable economic growth. At the regional level, the countries show an increased European cohesion compared to the other indicators, being particularly vulnerable the countries that accumulated pressure on the deflator during the pandemic period (Italy, Portugal) or those that had significant structural problems (Greece, Cyprus), (see Figure 11).

The government debt crisis in EU countries follows the economic deflator at the European average level, with an identity between the gross simulation value and the smoothing simulation value. Regional disparities are significant and lead to trend reversals. In developed countries (Denmark, Germany, Austria, Netherlands) the inverse proportional trend of evolu-

tion of public debt with economic growth is maintained, while in countries such as Romania, Bulgaria, Estonia, etc. there is a directly proportional increase in the correlation of the deflator with the evolution of public debt in conditions of geopolitical shock. This aspect allows to demonstrate the hypothesis on the impact of multiple crises differentiated in relation to the national independence of public debt, dynamizing the onset of crises in less developed countries and delaying this onset in more developed countries (see Figure 12).

In terms of regional policy on access to the labour market, structural differences affect in particular countries whose economies are mainly oriented towards tourism (Greece, Croatia, Cyprus, and Slovenia). For the rest of the countries, there is a relative cohesion of labour factor policy with the common policy (see Figure 13).

The regional analysis showed that the impact of geo-political conflict is spatially and temporally differentiated according to the regional capacity and the level of disparity of Member States' capacities. Thus, the study hypotheses demonstrated at the global level have the following particularities:

- Hypothesis H1 was demonstrated by the proposed model at the level of the dependent variable, which has a direct correlation with the ESI indicator, an aspect sensitized by the regional disparity, which transfers the reduction in economic performance by decreasing investor interest from time $t + 1$ for developed economies to time t for less developed countries.

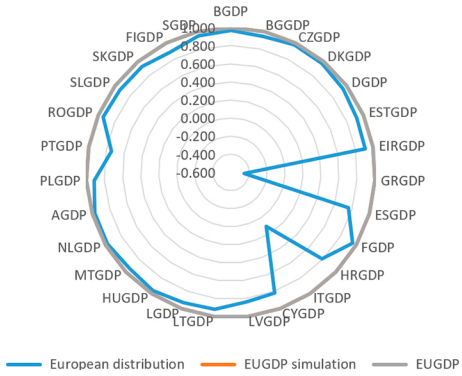


Figure 11. GDP fluctuation diagram at regional level

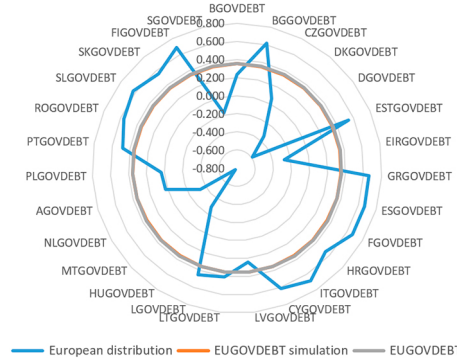


Figure 12. Regional public debt fluctuation diagram

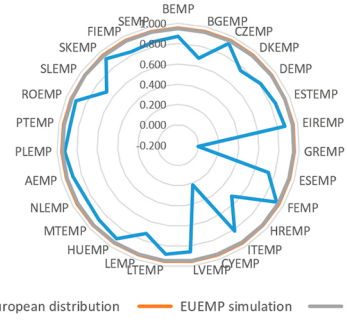


Figure 13. Labor fluctuation diagram at regional level

- In the case of hypothesis H2, the model showed that at the onset of the geo-political crisis there is an increase in public debt and the emergence of inflation. At the regional level, it has been shown that economic stability at time *t*0 prior to the shock generates a reduction in the hyperinflationary lag to time *t* + 1. For less developed economies, on the other hand, inflation is accelerating and the pressure of government debt is increasing, as events induced by the geo-political shock tend to destabilize the fragile equilibrium achieved at the time of accession to EU policies.
- Hypothesis H3 has been demonstrated by calculating the standardized probabilities when implementing the proposed model, the social crisis and unemployment being differentially felt in terms of time of occurrence in developed countries, in less developed countries or in countries where the previous shock (pandemic shock) has produced significant effects not yet experienced (the cases of Italy and Spain).
- In terms of the proposed model, hypothesis H4 on the negative impact on economic growth by unbalanced supply-demand market mechanisms was demonstrated, with the representation diagrams being regionally differentiated according to the regional capacity of The study represents a novel concept with significant current impact as it highlights geo-spatially the impact of geo-political shocks and allows decision makers to adjust public policies in order to overcome multiple crises triggered by shocks.

On the basis of the analyzed indicators, the present scientific approach allows the realization of relevant proposals for dedicated public policies. Thus, the EIBSSI analysis allows highlighting socio-economic vulnerabilities at regional level in EU Member States. In terms of policy consistency ESI index quantifies the distribution of economic growth, which denotes that sustainable economic growth intrinsically leads to a steady inflow and perpetual investor interest in the region. This approach was able to support our policies' proposals in Figure 14 (see I.1.I.2, I.3, II.1, II.2 and III.4).

The analysis of GDP shows the highest distributions of sustainability in relation to the regressor variables. The results of the analysis lead to other policy proposals (I.1., I.4, II.4 and III.1). The public debt and government deficit analysis highlighted the seasonal vulnerabilities of the European economy in times of crisis, including pre- and post-pandemic ones. In order to ensure a sustainable economy, we believe that budget deficit management must be a priority for Member States, as reflected in policy proposals I.4, II.1 and III.2. Indicators on the labor factor demonstrate the sensitivity of the European economy to multiple shocks and highlight the need to improve social policies to prevent social crises such as the pandemic. These developments support our public policy proposals II.3, II.4, II.5, III.4 and III.5. At the other end of the spectrum, industrial production indices show a variability independent of sustainable development policy at the European level, with significant disturbing factors of variation due to industrial structure, high energy consumption, and regional disparities. Based on the evolution of these indicators we propose public policies such as I.3, I.5, III.1 and III.3. The model was based on 4 working hypotheses validated after the calculations, which led to the following picture of public policy proposals to overcome the multiple crisis situation induced by the geo-political shock (see Figure 14).

Policy proposals regarding ESI index under regional impact

- The reallocation of structural funds with priority to the regions which show the ESI lowest values. This targeted approach ensures that resources are directed towards areas that require more support for growth and improvement.

Policy proposals regarding regional unemployment impact

- Implementing policies addressed to high regional unemployment rates by providing subsidies to local businesses, encouraging job creation and economic growth.
- Offering specialized training programs and education initiatives to equip individuals in the regions with the skills needed for employment opportunities in emerging industries.

Policy proposals regarding regional industrial production

- Creation of special economic zones in underdeveloped regions able to offer incentives such as tax breaks and infrastructure development to attract industrial investment and stimulate economic growth in these areas.
- Implementation of environmental regulations and sustainability targets, which encourage industries to adopt cleaner technologies and reduce their carbon footprint, thus mitigating the negative environmental impacts of industrial production in the region.

Policy proposals regarding regional inflation disparities

- European Central Bank would work closely with national governments to implement fiscal policies which complement the monetary measures, ensuring a comprehensive and coordinated approach to address regional inflation disparities effectively.

Policy proposals regarding GDP fluctuation at regional level

- Using the European Regional Development Fund (ERDF) to reduce regional disparities and promote economic growth in less developed regions by providing financial support for infrastructure projects, such as building roads and improving transport networks, in regions with lower GDP to stimulate their economies and create job opportunities.
- Using the Cohesion Policy, which focuses on reducing economic and social disparities between regions in order to provide funding for various initiatives, including business development programs and investments in education and innovation, to boost the economic competitiveness of less developed regions.

Policy proposals regarding public debt at regional level

- EU would implement mechanisms to monitor and assess the financial health of regions, such as regular audits and reporting requirements. In cases where a region exceeds its debt ceiling, the EU could provide financial assistance or offer guidance on debt restructuring to help alleviate the burden.

Policy proposals regarding labor fluctuation at regional level

- Supporting policies regarding labor fluctuation at the regional level which can involve implementing flexible working arrangements and training programs to meet the specific needs of each region.
- Policies focused on promoting job mobility across regions through measures such as providing financial incentives for workers to relocate or offering support for businesses to expand operations in regions with higher unemployment rates.

Figure 14. Table of public policy proposals at regional level

6. Conclusions

The literature review examines the impact of various economic indicators on the EU economy, including employment, gross value added, and unemployment. Some studies also examines the role of agriculture in relation to other sectors, with the excess labour in agriculture which can only be absorbed by relevant policies. The connection between labour factor-wages-unemployment, highlight the importance of public policies which stimulate innovation and ensure macroeconomic stability. The results of the literature research show that overall support for unemployment policies depends on certain combinations of public policies, the generosity of the anti-unemployment program, and the limitation of coverage to countries providing education and training. The study of the literature examines the correlations between youth unemployment rate and market and macroeconomic determinants, finding that the development of the economy in general and the knowledge-based economy can efficiently support the improvement of young people's situation on the labor market. Some researchers conclude that the effects of fiscal policy on inflation and economic activity are

both long-term and short-term. The meta-analysis concludes that negative impact of inflation on ESI was much greater than the positive impact of economic growth over the last decade. The analysed authors also highlight the imperfections of inflation and CPI calculation procedures, which can lead to false cycles of annual inflation rates due to incorrect quantification of seasonality. Other studies examine the counter-cyclical or pro-cyclical nature of fiscal policy and the cyclical response of this policy. The authors conclude that budgetary outcomes are pro-cyclical in all Member States, while government efficiency and taxation seem to reduce fiscal pro-cyclicality more in the euro area and during times of economic crisis. Economic resilience under alternative recessionary shocks is studied by other authors who find that factor mobility varies according to the nature of the external shock, pre-shock regional characteristics, and factor mobility. The United Nations' concern for sustainable economic development at the global level is highlighted with the reservation regarding the choice of GDP per capita as an indicator for SDG 8 ("Decent work and economic growth"), as it may be at odds with achieving environmental and welfare goals and inequality reduction targets, including at the EU level. The main objective of the study was to quantify the geo-political shocks and to transpose them in a geo-spatial and temporal manner based on the analysis of the literature, which showed that although there is a significant concern in the global scientific community for monitoring the effects of crisis-induced risks, the theory of shocks has not been sufficiently exploited in view of the events unfolding in recent times. On the other hand, six specific research objectives was defined and analysed. The overarching framework for these objectives was to provide a comprehensive understanding of the current economic climate and its potential implications. The Economic Sentiment Indicator (ESI) allows for a thorough analysis of consumer and business confidence, providing valuable insights into market trends and future economic performance (O1). Quantifying the impact of public debt on economic development enables policymakers to make informed decisions regarding fiscal policies and debt management strategies (O2). By measuring key economic indicators such as labor and inflation, policymakers can assess the health of the economy and identify areas of concern (O3). Furthermore, modeling cyclical developments and exploring the concept of a circular economy allows for a deeper understanding of economic cycles and the potential for sustainable growth (O4). The development of a risk exposure model using the Markov function provides a systematic approach to assessing and managing potential financial risks. This model takes into account various factors, such as market volatility, credit risk, and liquidity risk, to determine the level of exposure a company or institution has to potential financial losses. By regularly updating and reviewing this model, decision-makers can make informed choices regarding risk mitigation strategies and ensure the long-term stability of their organization (O5). The implementing effective of risk management practices can enhance investor confidence and attract capital for further economic development (O6).

The authors have projected the Markov risk equations and shown that they can be evaluated at the regional level with consideration of economic policy disturbances through multiple correlation regression functions. Thus, a risk exposure model was developed by applying the Markov function, implemented on the basis of data reported in the period 2007–2022, and projections of the inflationary shock were made using the method of simulated correlations and the method of distribution smoothing.

The limitations of this study derive from the relatively small number of indicators analysed and from the fact that it is only focused on the EU area; the authors propose to develop this concept at the level of other global economic actors in future research.

The authors declare that there are no conflicts of interest.

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References

Abdesselam, R., Bonnet, J., & Renou-Maissant, P. (2020). What are the drivers of business demography and employment in the countries of the European Union? *Applied Economics*, *52*(37), 4018–4043. https://doi.org/10.1080/00036846.2020.1730756

Alderotti, G., Vignoli, D., Baccini, M., & Matysiak, A. (2021). Employment instability and fertility in Europe: A meta-analysis. *Demography*, *58*(3), 871–900. https://doi.org/10.1215/00703370-9164737

Anghel, D. G., Boitan, I. A., & Marchewka-Bartkowiak, K. (2022). Growing fiscal risk in European Union resulting from government contingent liabilities in the pandemic crisis – assessment and policy recommendations. *Economic Research-Ekonomska Istraživanja*, *35*(1), 2292–2312. https://doi.org/10.1080/1331677X.2021.1941178

Arestis, P., Ferreiro, J., & Gómez, C. (2020). Quality of employment and employment protection. Effects of employment protection on temporary and permanent employment. *Structural Change and Economic Dynamics*, *53*, 180–188. https://doi.org/10.1016/j.strueco.2020.02.008

Arlt, J. (2021). The problem of annual inflation rate indicator. *International Journal of Finance & Economics*. https://doi.org/10.1002/ijfe.2563

Arreola Hernandez, J., Kang, S. H., Jiang, Z., & Yoon, S.-M. (2022). Spillover network among economic sentiment and economic policy uncertainty in Europe. *Systems*, *10*(4), Article 93. https://doi.org/10.3390/systems10040093

Asandului, M., Lupu, D., Maha, L.-G., & Viorică, D. (2021). The asymmetric effects of fiscal policy on inflation and economic activity in post-communist European countries. *Post-Communist Economies*, *33*(7), 899–919. https://doi.org/10.1080/14631377.2020.1867430

Ayala, L., Martín-Román, J., & Navarro, C. (2022). Unemployment shocks and material deprivation in the European Union: A synthetic control approach. *Economic Systems*, Article 101053. https://doi.org/10.1016/j.ecosys.2022.101053

Bal-Domańska, B. (2022). The impact of macroeconomic and structural factors on the unemployment of young women and men. *Economic Change and Restructuring*, *55*(2), 1141–1172. https://doi.org/10.1007/s10644-021-09341-9

Balkan Green Energy News. (2021, March 30). *Croatian government has realized renewables are the cheapest solution*. https://balkangreenenergynews.com/croatian-government-has-realized-renewables-are-the-cheapest-solution/

Batrancea, L. (2021). Empirical evidence regarding the impact of economic growth and inflation on economic sentiment and household consumption. *Journal of Risk and Financial Management*, *14*(7), Article 336. https://doi.org/10.3390/jrfm14070336

Beck, K. (2020). Decoupling after the Crisis: Western and Eastern business cycles in the European Union. *Eastern European Economics*, *58*(1), 68–82. https://doi.org/10.1080/00128775.2019.1656086

Beck, K. (2021). Why business cycles diverge? Structural evidence from the European Union. *Journal of Economic Dynamics and Control*, *133*, Article 104263. https://doi.org/https://doi.org/10.1016/j.jedc.2021.104263

Burgoon, B., Kuhn, T., Nicoli, F., & Vandenbroucke, F. (2022). Unemployment risk-sharing in the EU: How policy design influences citizen support for European unemployment policy. *European Union Politics*, *23*(2), 282–308. https://doi.org/10.1177/14651165221075251

Cieślik, A., & Ghodsi, M. (2021). Economic sentiment indicators and foreign direct investment: Empirical evidence from European Union countries. *International Economics*, *168*, 56–75. https://doi.org/https://doi.org/10.1016/j.inteco.2021.07.001

Čižmešija, M., & Škrinjarić, T. (2021). Economic sentiment and business cycles: A spillover methodology approach. *Economic Systems*, *45*(3), Article 100770. https://doi.org/https://doi.org/10.1016/j.ecosys.2020.100770

Coscieme, L., Mortensen, L. F., Anderson, S., Ward, J., Donohue, I., & Sutton, P. C. (2020). Going beyond Gross Domestic Product as an indicator to bring coherence to the Sustainable Development Goals. *Journal of Cleaner Production*, *248*, Article 119232. https://doi.org/10.1016/j.jclepro.2019.119232

Di Pietro, F., Lecca, P., & Salotti, S. (2021). Regional economic resilience in the European Union: A numerical general equilibrium analysis. *Spatial Economic Analysis*, *16*(3), 287–312. https://doi.org/10.1080/17421772.2020.1846768

Eurostat. (2023a). *Employment and activity by sex and age – quarterly data*. https://ec.europa.eu/eurostat/databrowser/view/lfsi_emp_q/default/table?lang=en

Eurostat. (2023b). *GDP and main components* (*output, expenditure and income*). https://ec.europa.eu/eurostat/databrowser/product/page/NAMQ_10_GDP__custom_3605558

Eurostat. (2023c). *HICP – monthly data* (*annual rate of change*). https://ec.europa.eu/eurostat/databrowser/product/page/PRC_HICP_MANR__custom_217634

Eurostat. (2023d). *Production in industry – monthly data*. https://ec.europa.eu/eurostat/databrowser/product/page/STS_INPR_M__custom_3378105

Eurostat. (2023e). *Quarterly government debt*. https://ec.europa.eu/eurostat/databrowser/product/page/GOV_10Q_GGDEBT__custom_1208817

Eurostat. (2023f). *Sentiment indicators – monthly data*. https://ec.europa.eu/eurostat/databrowser/product/page/EI_BSSI_M_R2__custom_217532

Eurostat. (2023g). *Unemployment by sex and age – monthly data*. https://ec.europa.eu/eurostat/databrowser/product/page/UNE_RT_M__custom_3605577

Fana, M., Torrejón Pérez, S., & Fernández-Macías, E. (2020). Employment impact of Covid-19 crisis: From short term effects to long terms prospects. *Journal of Industrial and Business Economics*, *47*(3), 391–410. https://doi.org/10.1007/s40812-020-00168-5

Fedajev, A., Radulescu, M., Babucea, A. G., Mihajlovic, V., Yousaf, Z., & Milićević, R. (2022). Has COVID-19 pandemic crisis changed the EU convergence patterns? *Economic Research-Ekonomska Istraživanja*, *35*(1), 2112–2141. https://doi.org/10.1080/1331677X.2021.1934507

Friesenbichler, K. S., Kuegler, A., & Reinstaller, A. (2021). Does value chain integration dampen producer price developments? Evidence from the European Union. *The World Economy*, *44*(1), 89–106. https://doi.org/10.1111/twec.12993

Gootjes, B., & de Haan, J. (2022). Procyclicality of fiscal policy in European Union countries. *Journal of International Money and Finance*, *120*, Article 102276. https://doi.org/10.1016/j.jimonfin.2020.102276

Grosu, A.-C., Pintilescu, C., & Zugravu, B. (2022). Trends in public debt sustainability in Central and Eastern EU countries. *Post-Communist Economies*, *34*(2), 173–195. https://doi.org/10.1080/14631377.2020.1867431

Gürer, E., & Weichenrieder, A. (2020). Pro-rich inflation in Europe: Implications for the measurement of inequality. *German Economic Review*, *21*(1), 107–138. https://doi.org/10.1515/ger-2018-0146

Hahn, D. H., & Kang, H. (2023). An empirical study on the short-term effects of economic sentiment on the direct and indirect investment markets in real estate. *Journal of Housing and Urban Finance*, *8*(1), 19–31. https://doi.org/10.38100/jhuf.2023.8.1.19

Hartley, K., van Santen, R., & Kirchherr, J. (2020). Policies for transitioning towards a circular economy: Expectations from the European Union (EU). *Resources*, *Conservation and Recycling*, *155*, Article 104634. https://doi.org/10.1016/j.resconrec.2019.104634

Hegerty, S. W. (2020). Structural breaks and regional inflation convergence for five new Euro members. *Economic Change and Restructuring*, *53*(2), 219–239. https://doi.org/10.1007/s10644-018-9241-x

International Monetary Fund. (2022). *World Economic Outlook: Countering the cost-of-living crisis*. https://www.imf.org/en/Publications/WEO/Issues/2022/10/11/world-economic-outlook-october-2022

Jacobs, J., Ogawa, K., Sterken, E., & Tokutsu, I. (2020). Public debt, economic growth and the real interest rate: A panel VAR approach to EU and OECD countries. *Applied Economics*, *52*(12), 1377–1394. https://doi.org/10.1080/00036846.2019.1673301

Južnik Rotar, L., Kontošić Pamić, R., & Bojnec, Š. (2022). Innovation and wages constrained with budgetary deficit and unemployment in the European Union countries. *Economic Research-Ekonomska Istraživanja*, *35*(1), 1561–1580. https://doi.org/10.1080/1331677X.2021.1985564

Kołodziejczak, W. (2020). Employment and gross value added in agriculture versus other sectors of the European Union economy. *Sustainability*, *12*(14), Article 5518. https://doi.org/10.3390/su12145518

Lukac, Z., & Cizmesija, M. (2021). (Re)Constructing the European Economic sentiment indicator: An optimization approach. *Social Indicators Research*, *155*(3), 939–958. https://doi.org/10.1007/s11205-020-02602-6

Mattera, R., Misuraca, M., Spano, M., & Scepi, G. (2023). Mixed frequency composite indicators for measuring public sentiment in the EU. *Quality & Quantity*, *57*(3), 2357–2382. https://doi.org/10.1007/s11135-022-01468-9

Michis, A. A. (2021). Wavelet multidimensional scaling analysis of European economic sentiment indicators. *Journal of Classification*, *38*(3), 443–480. https://doi.org/10.1007/s00357-020-09380-3

Onofrei, M., Bostan, I., Firtescu, B. N., Roman, A., & Rusu, V. D. (2022). Public debt and economic growth in EU countries. *Economies*, *10*(10), Article 254. https://doi.org/10.3390/economies10100254

Paunica, M., Manole, A., Motofei, C., & Tanase, G.-L. (2021). Resilience of the European Union economies. An analysis of the granger causality at the level of the gross domestic product. *Amfiteatru Economic*, *23*(15), 914–933. https://doi.org/10.24818/EA/2021/S15/914

Rant, V., Marinč, M., & Porenta, J. (2021). Debt and convergence: Evidence from the EU member states. *Finance Research Letters*, *39*, Article 101617. https://doi.org/10.1016/j.frl.2020.101617

Rutkowska, A., Szyszko, M., & Pietrzak, M. B. (2022). When all we have is not enough: A search for the optimal method of quantifying inflation expectations. *Economic Research-Ekonomska Istraživanja*, 1–20. https://doi.org/10.1080/1331677X.2022.2081231

Seo, B. (2022). *Machine-learning-based News Sentiment Index* (*NSI*) *of Korea* (Bank of Korea WP 2022-15). *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4230611

Simionescu, M., & Raišienė, A. G. (2021). A bridge between sentiment indicators: What does Google Trends tell us about COVID-19 pandemic and employment expectations in the EU new member states? *Technological Forecasting and Social Change*, *173*, Article 121170. https://doi.org/10.1016/j.techfore.2021.121170

Soava, G., Mehedintu, A., & Sterpu, M. (2022). Analysis and forecast of the use of e-commerce in enterprises of the European Union states. *Sustainability*, *14*(14), Article 8943. https://doi.org/10.3390/su14148943

Sorić, P., Lolić, I., & Logarušić, M. (2022). Economic sentiment and aggregate activity: A tale of two European cycles. *JCMS: Journal of Common Market Studies*, *60*(2), 445–462. https://doi.org/10.1111/jcms.13249

Sulich, A., Rutkowska, M., & Popławski, Ł. (2020). Green jobs, definitional issues, and the employment of young people: An analysis of three European Union countries. *Journal of Environmental Management*, *262*, Article 110314. https://doi.org/10.1016/j.jenvman.2020.110314

Tibor, S. T., & Grande, C. A. (2022). Industrial production of activated carbon using circular bioeconomy principles: Case study from a Romanian company. *Cleaner Engineering and Technology*, *7*, Article 100443. https://doi.org/10.1016/j.clet.2022.100443

Trading Economics. (2023). *Credit rating. Europe*. https://tradingeconomics.com/country-list/rating?continent=europe

Ulceluse, M., & Kahanec, M. (2022). Eastward enlargements of the European Union, transitional arrangements and self-employment. *Journal of Population Economics*. https://doi.org/10.1007/s00148-022-00904-2

Vanlaer, W., Picarelli, M., & Marneffe, W. (2021). Debt and private investment: Does the EU suffer from a debt overhang? *Open Economies Review*, *32*(4), 789–820. https://doi.org/10.1007/s11079-021-09621-x

APPENDIX

Table A1. Descriptive statistics- case summary by regions

Region	Descriptive statistics	EIBSSI	UNE	STSTRTU	STSINPR	PRCHICP	GDP	GOVDEBT	EMP
A	% of Total Sum	0.0360	0.0230	0.2570	0.2090	0.0350	0.0350	0.0430	0.0380
	Median	100.3000	5.4000	1.6000	0.4000	1.9000	99.1265	81.9000	74.4000
	Std. Error of Mean	1.3184	0.1008	0.4242	0.2481	0.1799	0.6495	0.7361	0.1586
	Std. Deviation	10.3807	0.7940	3.3405	1.9539	1.4167	5.1144	5.7964	1.2486
B	% of Total Sum	0.0360	0.0300	0.0410	–0.0590	0.0350	0.0350	0.0570	0.0350
	Median	99.9500	7.4000	0.1000	–0.1500	1.8000	97.9360	104.9000	67.4500
	Std. Error of Mean	1.2897	0.1424	0.2688	0.3684	0.2605	0.7112	0.8108	0.1922
	Std. Deviation	10.1549	1.1213	2.1163	2.9006	2.0510	5.5999	6.3839	1.5137
BG	% of Total Sum	0.0360	0.0360	0.0190	0.1000	0.0470	0.0350	0.0110	0.0350
	Median	97.8000	7.5000	0.3500	0.0000	2.1500	97.3625	19.9500	68.8500
	Std. Error of Mean	1.1956	0.3987	0.3012	0.3161	0.5179	0.9985	0.6697	0.5485
	Std. Deviation	9.4145	3.1394	2.3715	2.4894	4.0779	7.8625	5.2731	4.3192

Continue of Table A1

Region	Descriptive statistics	EIBSSI	UNE	STSTRTU	STSINPR	PRCHICP	GDP	GOVDEBT	EMP
CY	% of Total Sum	0.0350	0.0390	0.0200	–0.1210	0.0210	0.0390	0.0470	0.0370
	Median	98.7000	8.0500	0.1000	–0.0500	1.0500	108.2035	95.8000	74.3500
	Std. Error of Mean	1.3392	0.5183	0.2982	0.3279	0.2920	1.2945	2.9521	0.4617
	Std. Deviation	10.5452	4.0814	2.3477	2.5815	2.2990	10.1926	23.2450	3.6353
CZ	% of Total Sum	0.0350	0.0190	0.0120	0.1120	0.0430	0.0350	0.0200	0.0380
	Median	99.2500	4.8000	0.1500	0.5000	2.2500	95.8745	38.0500	73.9500
	Std. Error of Mean	1.3334	0.2462	0.2667	0.3714	0.3468	1.1380	0.7116	0.5110
	Std. Deviation	10.4992	1.9387	2.0997	2.9248	2.7307	8.9609	5.6028	4.0238
D	% of Total Sum	0.0370	0.0200	0.0560	0.0670	0.0290	0.0350	0.0390	0.0390
	Median	104.4500	4.6500	0.2000	0.1500	1.5500	98.5760	69.7500	76.7500
	Std. Error of Mean	1.1565	0.2114	0.2648	0.3187	0.2013	0.7635	0.8295	0.3448
	Std. Deviation	9.1060	1.6649	2.0851	2.5093	1.5850	6.0121	6.5311	2.7148
DK	% of Total Sum	0.0360	0.0250	0.0470	0.0050	0.0240	0.0360	0.0210	0.0390
	Median	101.9500	6.0000	0.2000	–0.1000	0.9000	98.5915	39.5500	76.2500
	Std. Error of Mean	1.2658	0.1748	0.3868	0.4618	0.2039	0.8899	0.7412	0.2104
	Std. Deviation	9.9668	1.3765	3.0456	3.6364	1.6057	7.0072	5.8362	1.6570
EIR	% of Total Sum	0.0360	0.0390	0.1370	–0.0600	0.0150	0.0350	0.0410	0.0360
	Median	100.8000	8.3000	0.6500	–0.5500	0.5500	82.6945	70.4000	70.0500
	Std. Error of Mean	1.3159	0.5083	0.4781	1.0852	0.2720	3.6983	3.5662	0.4962
	Std. Deviation	10.3612	4.0021	3.7645	8.5445	2.1418	29.1202	28.0805	3.9069
ES	% of Total Sum	0.0350	0.0750	–0.0410	–0.0740	0.0290	0.0360	0.0470	0.0330
	Median	100.9000	17.9500	–0.0500	0.0000	1.5000	101.0550	100.9000	64.2500
	Std. Error of Mean	1.3437	0.6381	0.4415	0.3288	0.2899	0.6261	3.5586	0.3933
	Std. Deviation	10.5800	5.0244	3.4761	2.5894	2.2830	4.9301	28.0205	3.0970
EST	% of Total Sum	0.0350	0.0330	0.0230	0.0610	0.0610	0.0360	0.0050	0.0380
	Median	98.5500	6.8000	0.1500	0.3000	3.2000	100.8105	9.1000	75.4000
	Std. Error of Mean	1.2000	0.4545	0.2238	0.3809	0.5406	1.6173	0.5571	0.5905
	Std. Deviation	9.4489	3.5784	1.7620	2.9993	4.2568	12.7345	4.3869	4.6496

Continue of Table A1

Region	Descriptive statistics	EIBSSI	UNE	STSTRTU	STSINPR	PRCHICP	GDP	GOVDEBT	EMP
EU	% of Total Sum	0.0360	0.0370	0.0260	–0.0130	0.0320	0.0350	0.0440	0.0350
	Median	101.9000	8.9000	0.1000	0.0500	1.7000	98.2145	82.9500	67.8000
	Std. Error of Mean	1.3121	0.2152	0.2114	0.2584	0.2179	0.6916	1.0242	0.3151
	Std. Deviation	10.3312	1.6948	1.6642	2.0349	1.7156	5.4455	8.0643	2.4813
F	% of Total Sum	0.0350	0.0380	0.0570	–0.0440	0.0250	0.0350	0.0510	0.0360
	Median	98.7000	9.2000	0.2000	–0.2000	1.3000	98.9655	95.5500	70.2000
	Std. Error of Mean	1.2204	0.1286	0.4880	0.3834	0.1644	0.5980	1.7592	0.1638
	Std. Deviation	9.6097	1.0126	3.8428	3.0188	1.2948	4.7088	13.8517	1.2901
FI	% of Total Sum	0.0350	0.0330	0.0200	0.0290	0.0300	0.0360	0.0320	0.0370
	Median	97.0000	8.0500	0.2500	0.4500	1.4000	102.2105	63.8000	72.5500
	Std. Error of Mean	1.3025	0.1296	0.1556	0.3507	0.1929	0.5252	1.6364	0.2382
	Std. Deviation	10.2561	1.0204	1.2254	2.7615	1.5190	4.1356	12.8853	1.8753
GR	% of Total Sum	0.0350	0.0760	0.0090	–0.0310	0.0220	0.0390	0.0890	0.0310
	Median	96.8500	18.9500	0.1500	–0.0500	0.9500	102.3330	176.1000	59.3500
	Std. Error of Mean	1.2061	0.8233	0.3637	0.3467	0.3351	2.0165	3.8736	0.7240
	Std. Deviation	9.4971	6.4829	2.8639	2.7298	2.6388	15.8782	30.5010	5.7006
HR	% of Total Sum	0.0360	0.0480	–0.0120	0.1610	0.0320	0.0370	0.0370	0.0320
	Median	98.0000	10.3500	0.1000	0.2500	1.5000	102.9175	73.5000	63.9000
	Std. Error of Mean	1.3163	0.4757	0.2663	0.3327	0.2959	0.8475	2.0796	0.4784
	Std. Deviation	10.3643	3.7460	2.0967	2.6197	2.3296	6.6734	16.3747	3.7671
HU	% of Total Sum	0.0360	0.0290	0.0490	0.0370	0.0600	0.0360	0.0410	0.0350
	Median	100.3000	7.2000	0.4000	0.0000	3.6000	97.3875	76.7500	69.2000
	Std. Error of Mean	1.4251	0.3597	0.1196	0.4789	0.3385	1.4262	0.6959	0.8540
	Std. Deviation	11.2214	2.8322	0.9413	3.7709	2.6653	11.2298	5.4792	6.7244
IT	% of Total Sum	0.0350	0.0410	–0.0360	–0.2070	0.0260	0.0360	0.0710	0.0310
	Median	100.6000	9.9000	0.0000	0.1000	1.2000	102.5010	134.6000	61.3000
	Std. Error of Mean	1.3137	0.2507	0.4205	0.5174	0.2196	0.4607	1.8315	0.1825
	Std. Deviation	10.3445	1.9737	3.3113	4.0741	1.7288	3.6272	14.4216	1.4368

Continue of Table A1

Region	Descriptive statistics	EIBSSI	UNE	STSTRTU	STSINPR	PRCHICP	GDP	GOVDEBT	EMP
L	% of Total Sum	0.0360	0.0230	0.0510	–0.0810	0.0350	0.0350	0.0110	0.0360
	Median	98.5500	5.5000	0.3000	–0.0500	2.0000	98.7155	21.1500	71.4000
	Std. Error of Mean	1.2950	0.0971	0.6530	0.5239	0.2599	1.2011	0.6253	0.1701
	Std. Deviation	10.1968	0.7647	5.1421	4.1251	2.0461	9.4571	4.9234	1.3397
LT	% of Total Sum	0.0360	0.0400	0.0250	0.4520	0.0580	0.0350	0.0190	0.0370
	Median	100.1500	8.6000	0.3500	0.6500	2.5500	98.4585	37.8500	72.3500
	Std. Error of Mean	1.3499	0.5020	0.3200	0.5642	0.5223	1.6398	1.1713	0.6336
	Std. Deviation	10.6294	3.9524	2.5194	4.4425	4.1127	12.9120	9.2227	4.9886
LV	% of Total Sum	0.0350	0.0440	0.0330	0.0920	0.0580	0.0350	0.0200	0.0360
	Median	100.4500	9.6000	0.2000	0.0500	2.2500	101.6140	39.7000	70.8000
	Std. Error of Mean	1.2251	0.5444	0.3224	0.2677	0.6315	1.2704	1.4114	0.5919
	Std. Deviation	9.6466	4.2866	2.5383	2.1076	4.9725	10.0030	11.1134	4.6609
MT	% of Total Sum	0.0370	0.0220	0.0660	–0.0910	0.0290	0.0340	0.0320	0.0350
	Median	103.7500	5.6000	0.3500	–0.3500	1.3000	92.7530	61.4500	68.0500
	Std. Error of Mean	1.2296	0.1637	0.2804	0.4953	0.1844	2.8254	1.0851	0.9782
	Std. Deviation	9.6820	1.2891	2.2075	3.8996	1.4519	22.2470	8.5439	7.7026
NL	% of Total Sum	0.0360	0.0250	–0.0510	–0.0770	0.0310	0.0360	0.0310	0.0400
	Median	101.8000	5.7000	–0.0500	0.0500	1.7000	99.0200	57.3500	77.7000
	Std. Error of Mean	1.2289	0.1809	0.3194	0.2330	0.2559	0.7301	0.9368	0.2327
	Std. Deviation	9.6762	1.4247	2.5152	1.8347	2.0153	5.7490	7.3766	1.8326
PL	% of Total Sum	0.0360	0.0290	0.0420	0.2320	0.0440	0.0350	0.0280	0.0340
	Median	100.2500	7.3500	0.3000	0.7500	2.5000	96.7870	51.8500	65.3500
	Std. Error of Mean	1.2431	0.3578	0.2096	0.2850	0.3276	1.9248	0.5011	0.6091
	Std. Deviation	9.7884	2.8174	1.6501	2.2440	2.5798	15.1562	3.9456	4.7963
PT	% of Total Sum	0.0360	0.0450	–0.0160	0.0100	0.0220	0.0360	0.0630	0.0350
	Median	102.0000	10.5000	0.1000	0.1500	0.8500	104.1100	126.1500	68.4000
	Std. Error of Mean	1.3340	0.4506	0.3232	0.3878	0.2221	0.6133	2.7896	0.5389
	Std. Deviation	10.5043	3.5480	2.5445	3.0533	1.7489	4.8290	21.9654	4.2432

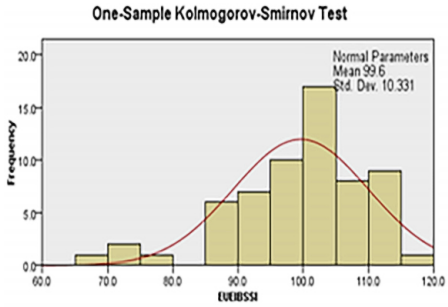
End of Table A1

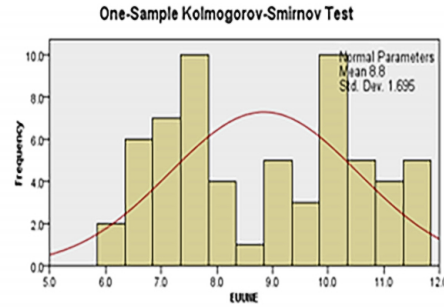
Region	Descriptive statistics	EIBSSI	UNE	STSTRTU	STSINPR	PRCHICP	GDP	GOVDEBT	EMP
RO	% of Total Sum	0.0350	0.0300	0.0810	0.1500	0.0610	0.0360	0.0180	0.0300
	Median	100.9500	6.9000	0.5500	0.0000	3.8000	97.9960	35.9500	58.2000
	Std. Error of Mean	1.1320	0.2001	0.2819	0.4683	0.3825	1.7547	1.3560	0.5996
	Std. Deviation	8.9135	1.5757	2.2195	3.6874	3.0117	13.8168	10.6770	4.7215
S	% of Total Sum	0.0360	0.0320	0.0360	0.0460	0.0280	0.0350	0.0210	0.0400
	Median	101.9500	7.7000	0.4500	0.3000	1.5000	96.6540	38.4500	79.5000
	Std. Error of Mean	1.2873	0.1174	0.1793	0.2982	0.1863	1.1152	0.3507	0.2121
	Std. Deviation	10.1366	0.9241	1.4114	2.3484	1.4670	8.7811	2.7612	1.6704
SK	% of Total Sum	0.0350	0.0430	0.0170	0.0320	0.0350	0.0340	0.0260	0.0360
	Median	99.4000	10.6000	0.3000	–0.5000	1.8000	95.9410	51.6000	69.4000
	Std. Error of Mean	1.1887	0.3966	0.2587	0.5624	0.2922	1.2598	1.3211	0.4359
	Std. Deviation	9.3598	3.1232	2.0366	4.4280	2.3007	9.9199	10.4023	3.4325
SL	% of Total Sum	0.0360	0.0280	0.0320	0.0640	0.0310	0.0370	0.0330	0.0360
	Median	100.5500	6.4000	0.2000	0.4500	1.7500	101.7335	68.3500	71.6500
	Std. Error of Mean	1.3402	0.2624	0.3765	0.3468	0.2754	1.1596	2.7282	0.4473
	Std. Deviation	10.5528	2.0665	2.9647	2.7304	2.1685	9.1307	21.4818	3.5221
Total	% of Total Sum	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	Median	100.4000	7.5000	0.2000	0.1000	1.7000	100.6025	60.5000	70.8000
	Std. Error of Mean	0.2419	0.1047	0.0640	0.0818	0.0635	0.2772	0.8939	0.1527
	Std. Deviation	10.0793	4.3622	2.6651	3.4095	2.6443	11.5478	37.2443	6.3622

Table A2. Statistic tests for projection of Eq. (5)

Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of EUEIBSSI is normal with mean 99.6 and standard deviation 10.331.	One-Sample Kolmogorov-Smirnov Test	0.046[1]	Reject the null hypothesis
2	The distribution of EUUNE is normal with mean 8.8 and standard deviation 1.695.	One-Sample Kolmogorov-Smirnov Test	0.002[1]	Reject the null hypothesis
3	The distribution of EUSTSTRTU is normal with mean 0.2 and standard deviation 1.664.	One-Sample Kolmogorov-Smirnov Test	3.741E-6[1]	Reject the null hypothesis
4	The distribution of EUSTSINPR is normal with mean –0.0 and standard deviation 2.035.	One-Sample Kolmogorov-Smirnov Test	1.607E-8[1]	Reject the null hypothesis
5	The distribution of EUPRCHICP is normal with mean 2.0 and standard deviation 1.716.	One-Sample Kolmogorov-Smirnov Test	2.091E-4[1]	Reject the null hypothesis
6	The distribution of EUGDP is normal with mean 100.7 and standard deviation 5.446.	One-Sample Kolmogorov-Smirnov Test	1.872E-5[1]	Reject the null hypothesis
7	The distribution of EUGOVDEBT is normal with mean 80.9 and standard deviation 8.064.	One-Sample Kolmogorov-Smirnov Test	0.001[1]	Reject the null hypothesis
8	The distribution of EUEMP is normal with mean 69.2 and standard deviation 2.481.	One-Sample Kolmogorov-Smirnov Test	4.377E-9[1]	Reject the null hypothesis

Note: Asymptotic significances are displayed; The significance level is 0.05; [1]Lilliefors Corrected.



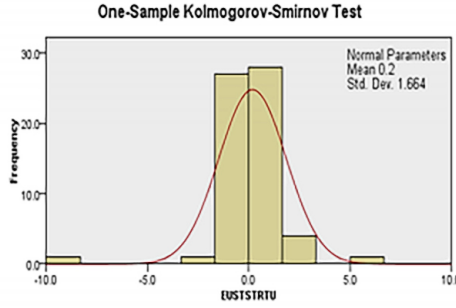


Total N		62
Most Extreme Differences	Absolute	.113
	Positive	.060
	Negative	-.113
Test Statistic		.113
Asymptotic Sig. (2-sided test)		0.046[1]

[1]Lilliefors Corrected

Total N		62
Most Extreme Differences	Absolute	.147
	Positive	.147
	Negative	-.120
Test Statistic		.147
Asymptotic Sig. (2-sided test)		0.002[1]

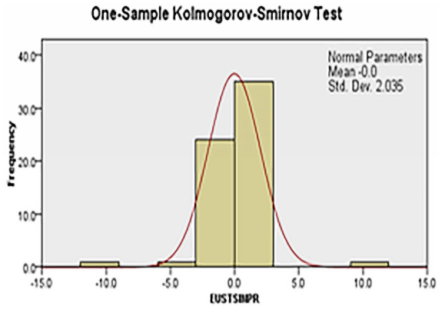
[1]Lilliefors Corrected



Total N		62
Most Extreme Differences	Absolute	.195
	Positive	.142
	Negative	-.195
Test Statistic		.195
Asymptotic Sig. (2-sided test)		0[1]

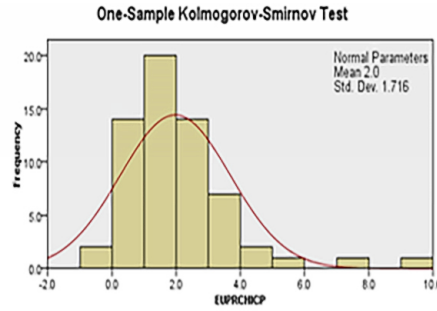
[1]Lilliefors Corrected

Figure A1. *To be continued*



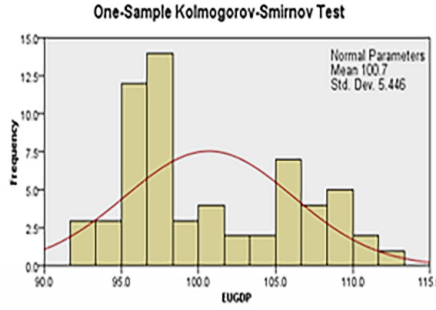
Total N		62
Most Extreme Differences	Absolute	.227
	Positive	.227
	Negative	-.205
Test Statistic		.227
Asymptotic Sig. (2-sided test)		0[1]

[1]Lilliefors Corrected



Total N		62
Most Extreme Differences	Absolute	.166
	Positive	.166
	Negative	-.114
Test Statistic		.166
Asymptotic Sig. (2-sided test)		0[1]

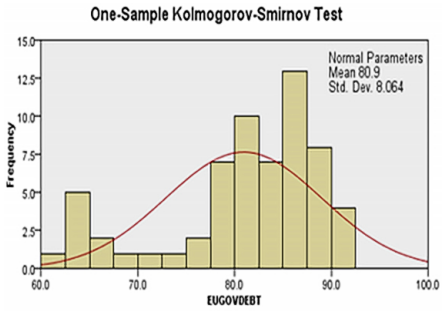
[1]Lilliefors Corrected



Total N		62
Most Extreme Differences	Absolute	.184
	Positive	.184
	Negative	-.105
Test Statistic		.184
Asymptotic Sig. (2-sided test)		0[1]

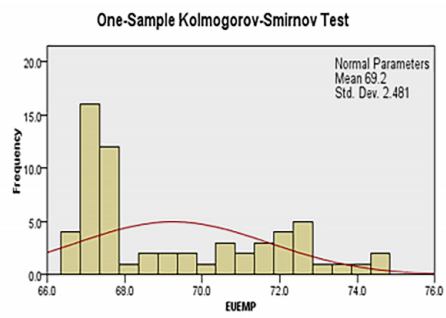
[1]Lilliefors Corrected

Figure A1. *To be continued*



Total N		62
Most Extreme Differences	Absolute	.152
	Positive	.106
	Negative	-.152
Test Statistic		.152
Asymptotic Sig. (2-sided test)		0.001[1]

[1]Lilliefors Corrected



Total N		62
Most Extreme Differences	Absolute	.234
	Positive	.234
	Negative	-.144
Test Statistic		.234
Asymptotic Sig. (2-sided test)		0[1]

[1]Lilliefors Corrected

Figure A1. One-Sample Kolmogorov-Smirnov projection of Eq. (5) items