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The EU's Socio-economic Development Against the Backdrop of the War in Ukraine

Abstract
The war in Ukraine affects the European Union (EU) member states asymmetrically. The purpose of the study is to determine changes in the development of the EU countries in three key directions: 'economy and environment', 'business and trade', and 'people and work'; to identify clusters of countries with similar transformations; and to model the impact of the studied indicators on the level of public debt amid the war in Ukraine. The research methodology includes the definition of a complex indicator of changes in the socio-economic development of EU countries, correlation and cluster analysis, and modelling the influence of the studied factors/indicators on the level of public debt. Research of changes in the context of the proposed complex indicators and their components under conditions of war showed that the changes in the areas under review varied for EU countries. Against the backdrop of the war in Ukraine, 17 EU countries faced a slowdown in their socio-economic growth, among which Poland was the most severely affected. Modelling made it possible to determine that, amid the war, the most important factors for the EU public debt are inflation, labour market conditions, and the possibilities of the balance of payments and the international investment position incorporated into GDP. The conducted research proves that the war in Ukraine increases the scale and relevance of general challenges that cannot be addressed at the national level. Strengthening the European defence against external aggression is the entire task of the EU.

Keywords
development | public debt | inflation | clustering | war

JEL Codes
O11, O52

1. Introduction

The war in Ukraine is a human tragedy for the people of Ukraine, but its economic implications are global. The war in Ukraine has not only changed European security policy, but it also has worldwide consequences that could cause new security threats (Genschel, 2022; Götz & Staun, 2022). From the very beginning, the European Union (EU), especially Poland, has been actively providing humanitarian support to the people in Ukraine (who pay the highest price), as well as to the countries that are hosting the refugee crisis in Europe

(Byrska, 2022). Less consideration has been given to the global impact of the war on increasing poverty, hunger, and social unrest. The war is fuelling a three-dimensional crisis (food, energy, and financial) that hits the most vulnerable people, countries, and economies of the world (Ben Hassen & El Bilali, 2022). All of this takes place at a time when developing countries are still struggling with a range of challenges not created by them—the COVID-19 pandemic, climate change, and lack of access to proper resources for financial recovery in a context of constant and growing inequality (Osendarp et al., 2022). The war in Ukraine causes trade and investment disruptions throughout the world, affecting car manufacturers in Europe, as well as food and fuel consumers worldwide. No country, region, or industry has been left untouched by the war. The possibility of a food crisis is the biggest concern (Pörtner et al., 2022). Prices for wheat and other grains have already increased. In 2019, Russia and Ukraine together accounted for 25% of world wheat exports and 14% of corn shipments. Disruptions in global and regional supply chains have caused raw material shortages and higher prices. Ukraine is a key supplier of input materials, including ignition cables for cars, neon gas for semiconductors, and iron ore for steel mills. Companies producing transport equipment, machinery, electronics, and food are particularly dependent on Russian metals, chemicals, fertilizers, and other goods (Ben Hassen & El Bilali, 2022).

The rapidly changing geopolitical environment causes serious challenges to EU economic policy. During the financial and COVID-19 crises, many countries in the EU were already heavily indebted (Anghel & Jones, 2022). The next shock has already afflicted society: the war in Ukraine weakens economic development and requires new spending on weapons, aid for refugees, and larger investments in new energy infrastructure. Even in less turbulent times, the EU member states violated the provisions of the Stability Pact (Genschel, 2022). Returning to the old criteria now seems to be even more illusory. This aspect fosters scientific interest in the impact of the war in Ukraine on the EU's socio-economic development. This study can fill the above-mentioned gap by achieving its main goal—to determine changes in the development of the EU countries in three key directions: 'economy and environment', 'business and trade', and 'people and work', and the connection among them; to identify clusters of countries with similar transformations; and to model the impact of the studied indicators on the level of public debt amid the war in Ukraine. The scientific value of the study lies in the opportunity to assess changes in EU socio-economic development in the context of individual countries, to cluster them, and to identify the most important factors of public debt. The study can become the basis to form and justify political and economic actions to improve the efficiency of EU development and restoration to eliminate the consequences of the war.

The war in Ukraine has not only had devastating human consequences but also significant global economic implications, impacting industries and countries around the world. However, while there has been some focus on providing humanitarian aid and addressing the immediate effects of the war, there has been less consideration of its long-term impact on the socio-economic development of the EU and its member states. This study can provide insights into how the war has affected the EU's economic policy and development, helping to identify the most important factors contributing to public debt and informing political and economic actions to improve the efficiency of EU development and restoration efforts in the aftermath of the war. Overall, this study's significance lies in its potential to fill an important knowledge gap and provide actionable insights to policymakers seeking to address the long-term economic effects of the war in Ukraine on the EU and its member states.

2. Literature Review

A bibliographic analysis of publications was conducted in the VOSviewer program in order to determine the degree of development of the proposed research topic. The analysis was carried out in the publications for three keywords: 'Ukraine', 'War', and 'Europe'. During the period of the outbreak of hostilities on the territory of Ukraine in 2014–2022, there were already 85 publications in the Scopus database, which made it possible to form five clusters (Figure 1).

The number of publications increased significantly in 2022 with the start of the full-scale war in Ukraine. The largest (red) cluster includes publications related to the war in Ukraine, namely, geopolitics, energy security, and international relations. When considering the cluster with the keyword 'Europe', the majority of the publications are related to people, refugees, and social well-being.

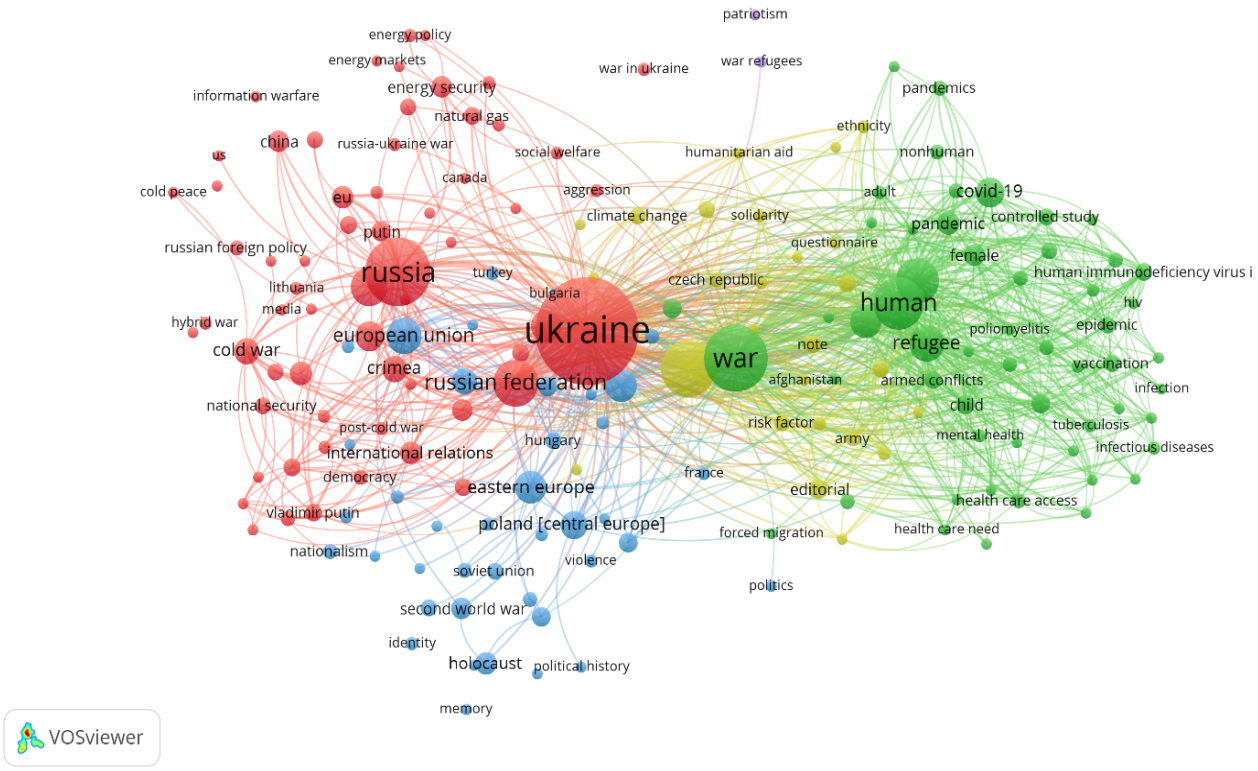

Figure 1. Clustering of Publications in the Scopus Science Metric Database for 2014–2022
Source: Formed by the authors based on bibliographic data in the Scopus database

The Russian military invasion of Ukraine has more or less fundamentally changed the economic framework for companies in several countries and has resulted in a high level of political and economic uncertainty (Weitz, 2022). In addition to the pressures still existing after the COVID-19 pandemic, several service providers are still waiting for businesses to recover after the fifth wave of infection––which is still active––has subsided, and in numerous cases, industrial production is not operating in the usual manner due to disrupted logistics networks and a lack of resources. Therefore, there is a danger of further business risks and adjustment burdens for companies in the EU (Ngoc et al., 2022). The economic consequences of the war in Ukraine depend primarily on the political constellations that will occur in the coming weeks or months, and on the adaptation speed of the domestic economy (Prohorovs, 2022). A rapid return to economic cooperation, as anticipated prior to active hostilities, now seems rather unlikely. How quickly alternative suppliers will be found or developed is as difficult to estimate as the evolution of energy prices (Genschel, 2022). In particular, the possible reduction of gas supplies from Russia to Europe will result in a considerable shift in the economic prospects (Lambert et al., 2022). Without further escalation of the conflict between Russia and NATO countries driven by economic reasons, restrictions should be expected to remain in the event of a continuing conflict or a 'frozen conflict'. This would also supposedly apply to Russia under the existing regime (in the unlikely event of Russia withdrawing from the treaty) (George & Sandler, 2022). Against the background of such political uncertainty, there is still a relevant question about what economic consequences will occur in the short and medium term for Ukraine, Russia, the economies of Eastern and Western Europe, and the global economy generally. In conformity with these policy options and the world economic implications, the degree of economic uncertainty for the development of the EU can vary widely across member states.

Companies can be affected by an international event, including the current war, through multiple transmission mechanisms. First of all, there is a loss of sales markets in the region of the direct crisis and, in a general sense, a decrease in export activity amid a general weakening of the world economy. This constitutes a negative demand shock for affected companies and, by extrapolation, for the entire national

economy (Pitigala, 2022). Second, there is a loss of supply of inputs or raw materials from the crisis region or other countries/regions due to growing global shortages or limited logistics (Ngoc et al., 2022). These disruptions in global value chains imply a negative supply shock for affected companies and the economy as a whole. Already in the previous year, weak points in the supply of raw materials or intermediate products hampered an economic recovery (Tárik, 2022). Third, the increase in the cost of intermediate resources and raw materials/energy resulting from the above-mentioned shortage has caused additional problems for enterprises (Korosteleva, 2022). Even if companies do not suffer direct resource shortages or shutdowns, their cost estimates may get worse due to an overall increase in the energy price level or producer prices (Benton et al., 2022). In this context, it is possible to speak of higher financing costs for companies if, for example, conflicts result in higher risk premiums in financial markets, or if the corresponding crisis region is highly important for international financial markets. These pressures also generally correspond to a negative supply shock. Fourth, there is a reduction in production activities in the crisis region. Especially in the event of armed conflict, productive capacity in the affected countries is significantly reduced (Costantini et al., 2022). This affects not only domestic but also multinational companies and damages their business and income development through lost profits or ad hoc write-offs of capacity that can no longer be used. The companies have suspended their production or business activities in Russia for an indefinite term due to the conflict. To the extent that a company's own foreign production is significant for domestic value creation, such internal disruptions exacerbate the problems described in value chains (Jagtap et al., 2022). Furthermore, there is also the risk that international staff will no longer be available. This applies especially to those industries that temporarily or permanently employ skilled workers from the crisis region in the EU. For example, this refers to a large share of truck drivers working in this country. This war-related shortage of skilled workers also serves as a negative 'supply shock' (Szajna & Kostrzewski, 2022).

The direct impact on the EU's foreign trade will probably play only a negligible role, as not much of the EU's foreign trade turnover has been achieved recently with Russia. The share of Ukraine in exports has a noticeably weaker economic dynamic in Central and Eastern Europe, and in the global economy as a whole, as a result of the Russian invasion of Ukraine, and it may burden EU foreign trade (Estrada & Koutronas, 2022). Regardless of the current global geopolitical situation, weak supply points have already resulted in the rapid growth of EU producer prices during recent months. EU companies are already experiencing supply shortages. The production processes of the car industry, which were disrupted throughout 2021 and are still damaged, mainly due to a shortage of semiconductors, will again be affected by the lack of components from the crisis region (Celi et al., 2022). A variety of raw materials that play a major role in industrial production processes will have to be organised elsewhere. Software service providers in Ukraine are also withdrawing from the business, and this is affecting all industries in this country. Russia plays a considerable role in imports and the economy of the EU as a whole in terms of raw materials, especially energy raw materials (Willett, 2022). A significant share of the gas and oil consumed by the EU is supplied by Russia. Supply uncertainty and high energy prices have a direct impact on the production capacity and competitiveness of companies that are forced to rely on comparatively large amounts of energy (Sturm, 2022).

Russia's invasion of Ukraine has not only serious political and humanitarian consequences, but also considerable economic implications for Europe. The scale of the consequences cannot yet be predicted. Depending on the political and military escalation, the energy supply can be threatened by the loss of gas supplies. Further significant price increases cannot be excluded (Lambert et al., 2022). Energy markets have already demonstrated significant turbulence during the escalation of the crisis. New record prices were mainly observed in the European gas market, and they are significantly higher than previous price levels. Concerns about supply restrictions, whether due to a supply freeze from Russia or a Western embargo, have contributed to price surges (Pereira et al., 2022). The problems already existing in international supply chains in 2021 will be further exacerbated by new weak supply points. Important supplies of raw materials have disappeared from Russia. Critical materials and intermediate products have also been supplied from Ukraine until now. Palladium, nickel, neon, or cable harnesses are examples of new weak points. If these weak points last longer, there is a risk of long-term production losses in the German economy since replacements can only be mobilised to a limited extent. Anxiety in industry and industry-related service providers tended to rise amid the war (Oxford Analytica, 2022).

The war in Ukraine has brought a different context to the Eurozone—hard security. Under these circumstances, economic policy is subordinated to the security needs of the population which affects the Eurozone in two ways. On the one hand, it becomes an important element of a security package, since it not only provides a stronger political link, for example, of the EU peripheral countries (particularly Finland and the Baltic countries) with the rest of the EU, but also, like Poland and Hungary at the beginning of the Russian invasion, ensures exchange rate stability. On the other hand, EU 19 is not the appropriate format and does not possess the required tools to respond to this crisis (Astrov et al., 2022). It has also proved impossible to use monetary policy instruments, such as currency swaps for the Ukrainian central bank or making the Ukrainian currency (*hryvnia*) convertible for Ukrainian refugees through the central banks of the Eurosystem (Anghel & Jones, 2022; Miao & Fei, 2022).

Despite considerable scientific interest in the impact of the war in Ukraine on the EU economy, the level of socio-economic development of the EU countries remains insufficiently studied. The results of previous studies made it possible to formulate the purpose of this study, which is to determine changes in the development of the EU countries in three key directions: 'economy and environment', 'business and trade' and 'people and work', and the connection among them; to identify clusters of countries with similar transformations; and to model the impact of the studied indicators on the level of public debt amid the war in Ukraine. The following hypotheses were formed in order to achieve the above-mentioned purpose:

> H1: All EU countries have slowed the pace of socio-economic development amid the war in Ukraine.
>
> H2: The most influential factors of the public debt of the EU countries in wartime are the conditions in the area of 'people and work' development.

3. Materials and Methods

3.1. Research Stages

The research methodology includes five successive stages.

Stage 1: a collection of statistical data on the EU countries during the hostilities in Ukraine. At this stage, key indicators, which were used in the research, were determined. The study applied those indicators for which data from February through September 2022 are available for all EU countries. Thus, a system of indicators was formed from three groups that demonstrate the 'Recovery Dashboard' (Eurostat, 2022).

Group 1: economy and environment (Table 1):

- GDP: GDP and main components (percentage change from previous period)
- HICP: harmonised index of consumer prices (annual rate of change)
- ES: economic sentiment indicator
- AQ: air quality, nitrogen dioxide concentrations in European capital cities (micrograms per cubic metre)
- CF: commercial flights (percentage change compared to same month in 2019)
- EA: electricity available to internal market (percentage change of the current month)
- NFA: quarterly non-financial accounts for general government (percentage of gross domestic product)

Group 2: business and trade (Table 2):

- PI: production in industry (percentage change over previous period)
- RNB: registrations of new businesses (percentage change over previous period)
- DB: declarations of bankruptcies (percentage change over previous period)
- PS: production in services (percentage change over previous period)
- PC: production in construction (percentage change over previous period)
- TVS: turnover and volume of sales in wholesale and retail trade index of deflated turnover (percentage change over previous period)
- TN: nights spent at tourist accommodation establishments (percentage change)
- EX: exports, trade by Broad Economic Categories (BEC) product group (growth rate M/M-1 of the seasonally and calendar-adjusted trade value)

Table 1. Initial Data on the Economy and Environmental Indicators[a]

Country	GDP	HICP	ES	AQ	CF	EA	NFA
Belgium	0.2	12.1	84.8	25.7	–14.1	–4.33	0.9
Austria	0.2	11.0	86.5	15.7	–16.9	–2.34	1.9
Bulgaria	0.6	15.6	99.3	17.2	–22.3	–2.26	–1.5
Croatia	–0.4	12.6	102.1	32.6	–3.4	0.07	1.7
Cyprus	1.3	9.0	101.7	17.5	–13.2	10.33	–4.2
Czech Republic	–0.2	17.8	88.4	21.8	–30.9	–1.68	0.0
Denmark	0.3	11.1	76.9	15.9	–15.9	–1.64	1.6
Estonia	–1.8	24.1	82.5	14.2	–20.3	4.70	2.6
Finland	–0.2	8.4	83.6	14.2	–32.6	–7.16	2.1
France	0.2	6.2	96.2	29.6	–14.0	–1.56	–4.4
Germany	0.4	10.9	92.4	21.0	–23.0	–3.60	–0.3
Greece	–0.5	12.1	105.0	33.9	3.5	–10.14	3.0
Hungary	–0.4	20.7	93.9	21.5	–18.9	2.21	–2.3
Ireland	2.3	8.6	95.0	17.1	–10,3	6.34	–1.2
Italy	0.5	9.4	96.1	26.0	–6.9	–0.71	–3.1
Latvia	–1.7	22.0	91.2	19.4	–36.7	–3.80	0.9
Lithuania	0.4	22.5	95.2	16.2	–16.1	–9.92	4.8
Luxembourg	1.1	8.8	92.1	19.3	–3.4	–2.49	2.2
Malta	1.3	7.4	94.7	25.9	–15.3	35.48	2.9
Netherlands	–0.2	17.1	90.8	24.3	–13.1	4.58	1.4
Poland	1.0	15.7	88.4	26.0	–10.6	1.51	–0.8
Portugal	0.4	9.8	99.9	16.7	–1.2	1.26	1.9
Romania	1.2	13.4	102.7	31.6	–12.3	–7.36	–1.4
Slovakia	0.4	13.6	86.7	15.4	–18.8	–10.46	–2.4
Slovenia	–1.4	10.6	89.9	21.1	–29.9	–2.05	–3.6
Spain	0.1	9.0	96.7	22.0	–8.5	–4.53	–7.6
Sweden	0.6	10.3	82.6	17.0	–25.5	–3.12	5.4

Source: Formed by the authors based on Eurostat, 2022.

[a]Fragment, September 2022.

- IM: imports, trade by BEC product group (growth rate M/M-1 of the seasonally and calendar-adjusted trade value)
- MB: main balance of payments and international investment position items as share of GDP (percentage of gross domestic product)

Group 3: people and work (Table 3)

- EM: excess mortality by month (percentage)
- UE: unemployment by sex and age (percentage of population in the labour force)
- LM: labour market slack by sex and age (from 20 to 64 years) (percentage of extended labour force)
- TE: total employment (resident population concept, LFS) (from 20 to 64 years, percentage of total population)
- YP: young people neither in employment nor in education and training by sex and age (from 15 to 29 years, percentage of total population)
- UTE: labour market transitions from unemployment to employment (percentage)
- UTI: labour market transitions from unemployment to inactivity (percentage)

Table 2. Initial Data on Indicators of Business and Trade[a]

Country	PI	RNB	DB	PS	PC	TVS	TN	EX	IM	MB
Belgium	7.6	–1.5	–14.7	–	–1.1	1.0	4.11	–7.9	–3.2	194.7
Austria	–2.2	–	–	–	–0.8	4.5	1.47	–0.9	0.1	124.9
Bulgaria	–2.6	3.1	–10.9	0.3	0.2	0.1	–18.55	2.8	10.9	135.4
Croatia	0.4	1.3			1.6	–1.1	7.42	–12.8	–7.4	148.6
Cyprus	–1.0	–	–	–	–	0.8	–8.09	34.0	–10.5	180.6
Czech Republic	0.0	–	–	–1.2	–1.7	0.9	–4.97	–2.4	2.5	144.0
Denmark	2.0	1.9	–11.1		0.8	–0.8	20.89	–0.3	–4.9	134.3
Estonia	–3.6	–5.4	–21.3	4.2	–	–0.2	–13.16	–1.2	–2.2	172.6
Finland	1.4	–	–	0.4	0.2	0.7	1.12	–1.7	–10.1	92.5
France	–0.9	8.3	10.9	–0.6	1.1	1.3	3.34	–2.3	0.6	77.6
Germany	1.3	–1.9	–2.3	0.5	0.4	1.5	–0.3	–0.5	–1.2	102.0
Greece	–4.9	–	–	–	–	–1.2	–3.51	3.7	2.3	114.7
Hungary	1.3	8.0	110.6	–1.1	2.4	0.4	–14.17	–3.0	3.6	187.7
Ireland	6.6	–35.6	–	–	–	–1.8		–4.4	–2.5	240.5
Italy	–1.8	–3.5	–8.0		1.1	–0.3	–1.66	–0.8	–4.5	79.1
Latvia	–0.8	–1.4	1.7	3.5	–	1.2	–24.96	–9.3	2.9	151.0
Lithuania	–7.2	–1.0	4.0	0.1	–	0.7	–16.88	–3.4	2.6	176.2
Luxembourg	1.9	–3.6	–10.9		–2.1	3.4	10.66	0.0	–1.6	360.9
Malta	1.0	–	–	–	–	1.6	–11.8	–6.8	–14.0	274.9
Netherlands	1.7	6.6	12.0	–	1.3	1.4	9.06	–0.5	0.0	182.5
Poland	–0.2	6.2	–5.1	7.3	–5.8	1.8	–0.35	0.9	1.4	124.7
Portugal	–2.1	6.8	–2.9		–2.8	–1.9	–0.05	–1.3	–5.9	109.5
Romania	–0.5	13.8	–36–1	2.5	3.9	–0.7	–21.54	–3.8	–2.9	88.2
Slovakia	–0.7	–8.7	–18.9	–1.4	–0.5	–1.2	–17.88	–0.9	4.0	189.3
Slovenia	–0.4	–4.8	–16.9	–0.7	–0.4	–3.5	1.34	–17.0	–6.8	176.8
Spain	–0.5	–4.0	66.1		–2.0	0.4	–2.48	–0.5	–1.6	85.6
Sweden	1.7	–	–	2.3	2.2	–0.7	4.12	–0.1	0.0	102.5

Source: Formed by the authors based on Eurostat, 2022.
[a]Fragment, September 2022.

Despite the large number of indicators used, the research is limited to their set at the time of the study. Over time, the statistical data set can be replenished, given the expansion of the indicators' range and their time intervals.

Stage 2: correlation analysis of the formed system of indicators. This involves determining the links between the indicators identified in the previous stage amid the war in Ukraine. For this purpose, a correlation matrix was built using the R programming language. This process enabled the identification of indicators with a high correlation coefficient and their exclusion from subsequent modelling.

Stage 3: determination of integral indicators of socio-economic development of the EU countries to identify changes in the socio-economic development of the countries under study in three directions and in general. Based on the data obtained at the first stage of the study, we formed integral indicators for each of the groups by determining changes in the values of the indicators, normalizing them, and determining the average value:

Table 3. Initial Data on Indicators of People and Work[a]

Country	EM	UE	LM	TE	YP	UTE	UTI
Belgium	6.80	5.90	10.60	71.40	9.50	21.70	23.10
Austria	13.70	4.20	9.50	77.60	8.60	38.60	21.10
Bulgaria	–7.00	4.50	7.70	75.00	15.00	9.20	9.00
Croatia	1.50	6.30	11.40	69.50	12.80	21.20	15.30
Cyprus	6.80	7.30	12.30	77.80	14.50	21.50	5.00
Czech Republic	2.10	2.40	4.80	81.60	11.50	26.70	10.80
Denmark	10.80	4.30	7.50	80.60	7.00	48.80	17.00
Estonia	17.60	5.80	8.40	81.90	10.00	33.20	19.10
Finland	10.10	6.80	12.40	78.40	9.30	32.40	21.20
France	6.60	7.60	14.00	73.90	12.00	28.10	22.40
Germany	11.60	3.00	6.20	81.40	8.00	32.70	24.60
Greece	6.80	12,40	17,70	66,60	15,40	14,10	15,70
Hungary	2.50	3.10	5.10	80.20	10.40	24.00	20.70
Ireland	12.20	4.20	9.70	78.90	8.40	36.60	27.90
Italy	6.30	8.00	19.10	64.80	20.20	17.60	38.70
Latvia	6.60	6.40	10.70	77.30	11.10	31.80	27.10
Lithuania	4.60	5.40	8.50	79.60	10.10	31.,40	13.90
Luxembourg	8.80	4.30	9.80	75.20	6.10	30.90	22.90
Malta	17.00	2.90	4.10	81.20	7.10	13.80	15.90
Netherlands	13.90	3.40	8.70	82.90	5.00	41.10	25.40
Poland	7.20	2.70	4.60	76.90	11.00	17.30	29.60
Portugal	24.40	6.00	11.10	77.40	8.50	24.10	21.20
Romania	–7.10	5.40	8.40	68.40	20.60	14.90	15.00
Slovakia	7.70	6.10	7.30	77.30	12.10	11.60	0.80
Slovenia	10.70	4.40	6.80	77.80	9.00	26.10	30.20
Spain	16.30	12.60	20.20	69.90	11.80	25.90	20.10
Sweden	4.60	7.60	12.10	82.30	5.30	29.00	19.90

Source: Formed by the authors based on Eurostat, 2022.
[a]Fragment, September 2022.

ID1: group 'economy and environment'

ID2: group 'business and trade'

ID3: group 'people and work'

ID: a complex integral indicator of the three groups

Based on the obtained integral indicators, analysis and visualization were carried out by plotting the results obtained on a map in the R programming language.

Stage 4: cluster analysis, which made it possible to identify four key groups of the countries under study, taking into account changes in their components of socio-economic development against the backdrop of the war in Ukraine.

Stage 5: modelling the influence of the studied factors/indicators on the level of public debt during the Central European War. The OLS model was applied for this purpose using the R programming language. Quarterly government debt (GD), the percentage of gross domestic product, was used as a dependent variable. The independent variables are indicators of the socio-economic development of the EU countries, except for those with a high correlation between them. This stage of the study is aimed at

determining the most significant factors among the investigated indicators and their impact on the level of public debt. Meanwhile, an insignificant factor was excluded for each subsequent model until the moment of absolute significance of all the constituent model components. Thus, a tenfold formation was carried out before obtaining a proper model.

The methodology used in this research has several merits over other techniques. First, the study uses a systematic and comprehensive approach by collecting statistical data from various sources, which allows for a more objective and accurate analysis of the EU's socio-economic development during the war in Ukraine. The use of multiple indicators and groups of indicators also provides a more comprehensive picture of the EU's socio-economic situation, which is not limited to a single factor. Second, the study employs a correlation analysis to identify the links between the indicators, which helps to avoid the inclusion of redundant or highly correlated variables in subsequent models. This ensures that the selected variables are not only statistically significant but also relevant to the research question. Third, the study uses integral indicators to analyse changes in the EU's socio-economic development in different directions, which provides a more holistic view of the situation. The use of cluster analysis also allows for the identification of different groups of countries based on their socio-economic development, which can inform policy decisions. Finally, the study applies an OLS model to determine the most significant factors influencing the level of public debt, which provides a quantitative analysis of the relationship between the selected variables and the dependent variable. The tenfold formation process used in the modelling also ensures the robustness of the results and minimises the risk of overfitting. Overall, the methodology used in this research is systematic, comprehensive, and quantitative, which allows for a more objective and accurate analysis of the EU's socio-economic development during the war in Ukraine.

3.2. Research Limitations

Despite the systematic and comprehensive approach used in this study, there are several limitations that should be taken into account when interpreting the results:

1. The study is based on a limited set of indicators, which may not fully capture the complex socio-economic dynamics of the EU member states during the war in Ukraine. While the selected indicators cover a broad range of areas, such as economy, environment, business, trade, and people, there may be other factors that could significantly impact the EU's socio-economic development but were not included in the study.
2. The study is limited by the time period of the data collection. The data used in this study cover the period from February through September 2022, which is a relatively short time frame. It is possible that the socio-economic situation in the EU member states may have changed significantly before or after this period, which could affect the study's findings.
3. The study's methodology relies on statistical data, which may be subject to errors or inaccuracies. While the study uses data from reliable sources such as Eurostat, there may be issues with data quality or consistency across countries that could affect the study's results.
4. The study's findings are based on the analysis of correlations and statistical models, which do not necessarily prove causality. While the study identifies significant relationships among the variables, it is important to note that these relationships may be influenced by other factors that were not included in the analysis.
5. The study is limited by its focus on the EU member states and does not take into account the impact of the war in Ukraine on other countries or regions. It is possible that the conflict in Ukraine may have had wider implications for the global economy or geopolitical stability, which were not considered in this study.

Overall, while this study provides valuable insights into the EU's socio-economic development during the war in Ukraine, it is important to recognise its limitations and the need for further research to fully understand the complex dynamics of this situation.

4. Results

A correlation analysis was carried out in order to determine the interrelationship between the studied indicators of the socio-economic development of the EU. The results of the above-mentioned analysis indicated a reasonably close link between labour market slack and the unemployment rate (0.905);

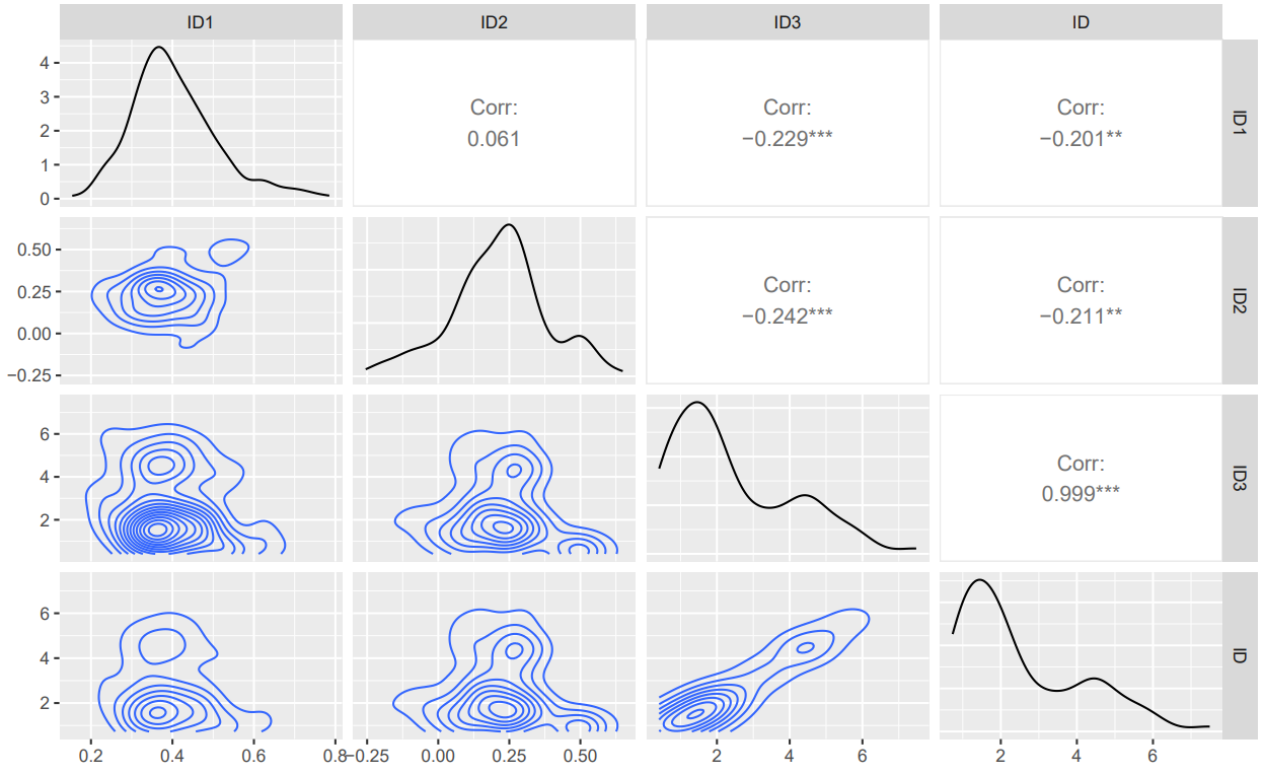

Figure 2. Correlation Matrix of the EU Socio-economic Development Indicators Under Study
Note. ID1, integral index for group 'economy and environment'; integral index for ID2, group 'business and trade'; integral index for ID3, group 'people and work'; ID, a complex integral indicator of the three groups
Source: Formed by the authors

total employment –0.643); young people neither in employment nor in education and training and total employment (0.739). In this regard, they cannot be included in the modelling process; therefore, they were excluded. The results of the correlation analysis of the integral indicators for the three groups of factors under study and the complex indicator of socio-economic countries' development are shown in Figure 2.

The conducted analysis demonstrates the absence of close interrelationships among the investigated indicators during the studied period. Correlation coefficients do not exceed 0.5. There is a very strong correlation between the composite indicator and the group 'people and work' index.

In order to determine the qualitative transformations in the socio-economic development of the EU amid the war in Ukraine, the changes in the proposed complex indicator and its components for the five months of Russia's invasion of Ukraine (February through September) were considered. At the same time, the authors of the article consider changes in the integral indicators of economy and environment, business and trade, and people and work (Figure 3).

The conducted analysis demonstrates the differences in the investigated areas for the EU countries. Poland (–38%) and Latvia (–29%) proved to be the most strongly affected by the Central European War crisis as to the economy and environment. In the area of business and trade, there is no significant decline for most EU countries, but negative effects are still noticeable for Portugal (–12%), Luxembourg (–10.1%), Ireland (–8.7%), the Netherlands (–8.4%), Slovenia (–6%), Germany (–5.6%), Spain (–5.2%), Belgium (–5.2%), Austria (–3.4%), and France (–2.1%). Meanwhile, some countries, in contrast, faced a significant jump in business and trade development: Bulgaria (31%), Romania (30.8%), and the Czech Republic (13%). In people and work development, EU countries also demonstrate considerable distinctions. Austria (56.3%), Greece (44.4%), Malta (28.9%), and Germany (28.6%) recorded the maximum growth. Bulgaria (–24.4%) tends to see the most negative effect. In general, amid the war in Ukraine, 17 EU countries faced a slowdown in their socio-economic growth, among which Poland was the most severely affected (–18.6%). However, the maximum decline in development for a number of affected countries

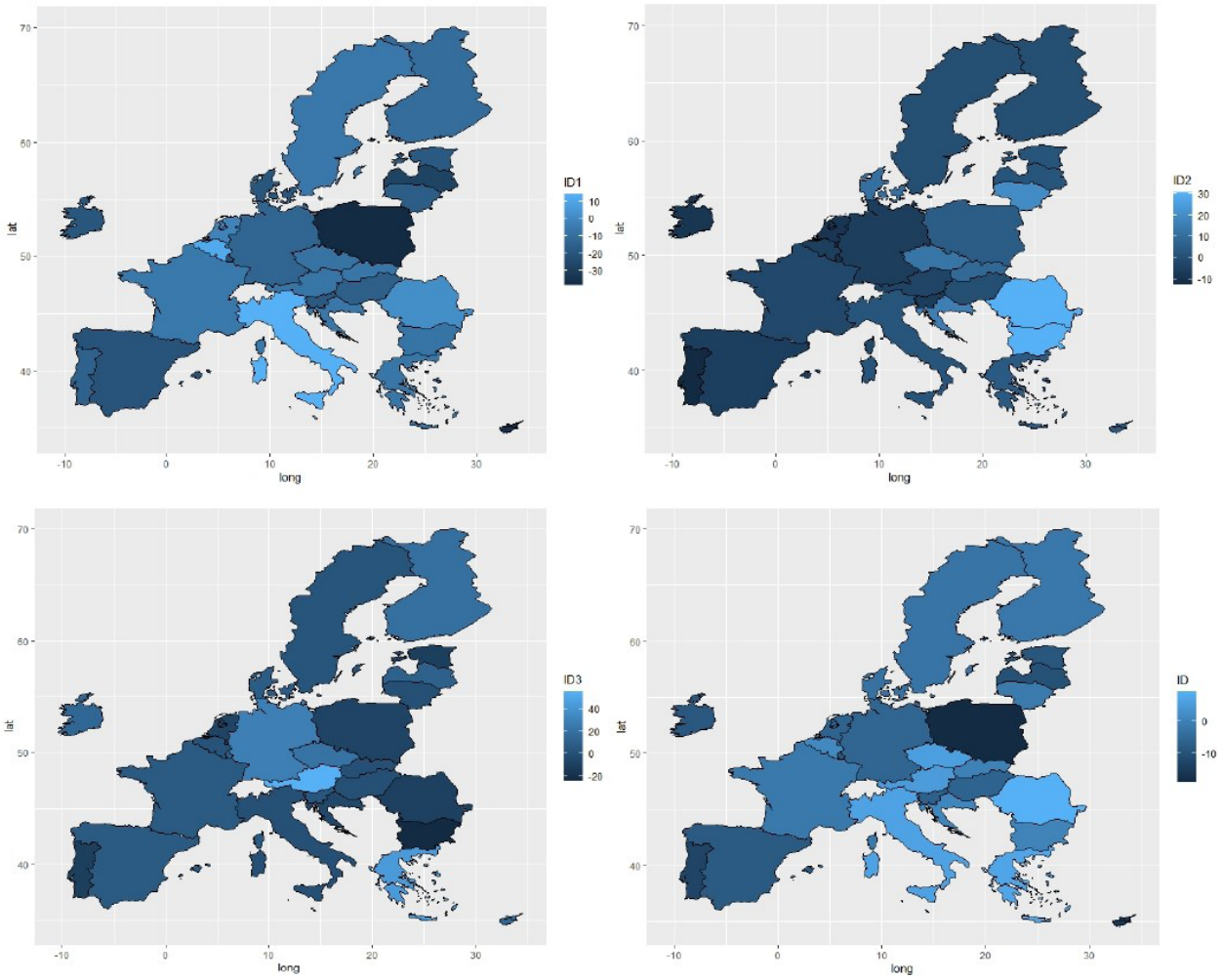

Figure 3. Map of Changes in the EU Socio-economic Development Indicators Against the Background of the War in Ukraine (February–September 2022)
Note. ID1, integral index of economy and environment; ID2, integral index of business and trade; ID3, integral index of people and work; ID, complex index of socio-economic development
Source: Formed by the authors

is at the level of 5%–10%: Estonia, Ireland, Portugal, Slovenia, Luxembourg, the Netherlands, Hungary, and Germany. Despite the vast majority of the affected countries, Romania and the Czech Republic managed to increase their socio-economic development amid the war, despite their close proximity to the ongoing hostilities area. The key success factor for Romania was the development of business and trade, and for the Czech Republic, Greece, and Malta, it was people and work. Only Italy increased the level of development based on the 'economy and environment' area. Thus, the first hypothesis is rejected, since the study identified the member countries that did not slow in socio-economic development against the backdrop of the Central European War. A cluster analysis was carried out in order to determine the general characteristics of the EU countries in terms of key components of socio-economic development. The results of the analysis are displayed in Figure 4; they show groups of countries with similar changes in development against the backdrop of the war in Ukraine.

Cluster analysis enabled the identification of four key clusters of the studied countries. The red cluster includes the most affected EU countries during the crisis as a result of the war in Ukraine and shows significant asymmetries in socio-economic development. It is generally important to emphasise that all EU countries, except for Italy, experienced negative consequences for their development in their

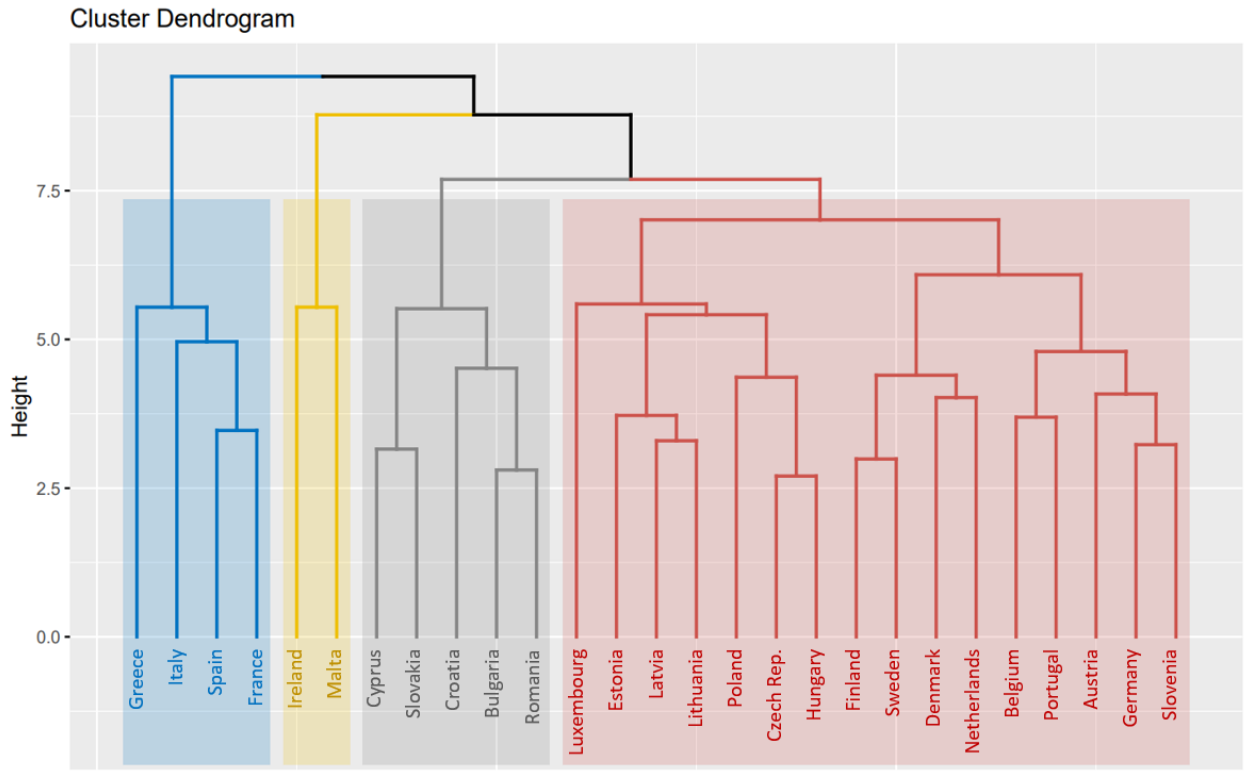

Figure 4. Dendrogram of EU Country Clustering by Socio-economic Development Indicators Against the Backdrop of the War in Ukraine (September 2022)
Source: Formed by the authors

individual components amid the war in Ukraine. Italy is the only country that increased the rate of its development in all three components during the war.

In order to determine the most important factors among the investigated indicators, modelling of their influence on the level of public debt (a dependent variable) was carried out. Meanwhile, an insignificant factor was excluded for each subsequent model until the moment of absolute significance of all the constituent model components. Thus, five models were formed (Table 4).

By excluding all insignificant factors, a model with a coefficient of determination from 0.62 to 0.6 is obtained. Meanwhile, the *p*-value is within acceptable limits—below 0.001 and 0.01. This factor confirms the adequacy of the developed model. At the same time, it should be highlighted that amid the war, the most important factors for the EU public debt are inflation, the labour market condition (availability of a working population and an increase in employment level), and the possibilities of the balance of payments and the international investment position incorporated into the GDP. At the same time, the second hypothesis of the study is confirmed, since the labour market is the most influential for the public debt of the EU countries in war conditions. The risk of stagflation,(i.e. a combination of higher inflation and weaker economic growth) is putting additional pressure on EU debt sustainability.

Socio-economic development depends on the capacity both of each country individually and of the EU as a whole to resist the crisis resulting from military hostilities within the territory of Ukraine. It is highly important for the member states to strengthen and effectively coordinate their economic policies, effectively address macroeconomic imbalances, and ensure reliable public funding. Therefore, the above-mentioned countries must improve the quality and composition of their public investments in order to provide the required funding to support the economy's social and environmental transition, thereby ensuring full employment, quality jobs, and fair transitions. Solidarity and common European action to mitigate new economic and social challenges will be of crucial importance. It will be extremely difficult for the local economy to handle the structural problems arising from transformations amid the war in Ukraine. Targeted horizontal strategies and support programs

Table 4. Modelling Government Gross Debt (% of GDP) Against the Backdrop of the War in Ukraine

Factor	Model 1	Model 2	Model 3	Model 4	Model 5
(Intercept)	65.45***	70.39***	70.39***	69.08***	70.87***
	(0.86)	(1.93)	(1.91)	(1.83)	(1.73)
GDP	2.65*	–2.33	–2.39	–2.66	–
	(1.16)	(2.39)	(2.33)	(2.14)	–
HICP	–5.22*	–11.86***	–11.81***	–10.67***	–5.72**
	(2.56)	(3.15)	(3.08)	(2.93)	(2.05)
ES	5.50**	2.16	2.14	3.28	4.35*
	(1.80)	(2.74)	(2.64)	(2.41)	(2.01)
AQ	4.12	–1.68	–1.66	–	–
	(2.19)	(2.88)	(2.83)	–	–
CF	14.50***	9.72***	9.60***	9.67***	10.56***
	(1.74)	(2.78)	(2.68)	(2.48)	(1.92)
EA	–7.76***	–0.41	–	–	–
	(1.41)	(2.16)	–	–	–
NFA	1.29	–10.07**	–10.08***	–10.07***	–7.76***
	(2.23)	(3.00)	(2.93)	(2.71)	(1.86)
PI	0.50	–0.34	–	–	–
	(1.09)	(2.06)	–	–	–
RNB	0.39	1.10	1.18	–	–
	(1.45)	(2.36)	(2.26)	–	–
DB	4.17**	2.45	2.41	2.51	–
	(1.27)	(2.28)	(2.20)	(2.04)	–
PS	–1.59	–	–	–	–
	(1.07)	–	–	–	–
PC	–0.29	–	–	–	–
	(0.99)	–	–	–	–
TVS	1.23	1.50	1.52	–	–
	(1.24)	(2.30)	(2.21)	–	–
TN	–5.94**	–8.30*	–8.23**	–6.13*	–
	(1.76)	(3.23)	(3.12)	(2.91)	–
EX	0.08	–	–	–	–
	(1.08)	–	–	–	–
IM	–1.73	0.19	–	–	–
	(1.06)	(2.14)	–	–	–
MB	18.67***	–11.46***	–11.45***	–10.58***	–9.10***
	(2.81)	(2.55)	(2.50)	(2.35)	(1.96)
EM	3.31**	2.83	2.79	2.50	–
	(1.19)	(2.16)	(2.09)	(2.00)	–
LM	21.35***	10.92***	11.06***	10.49***	16.23***
	(3.11)	(2.90)	(2.74)	(2.46)	(2.16)
YP	–16.56***	–7.09*	–7.08*	–6.10*	–
	(2.02)	(3.18)	(3.13)	(2.86)	–
UTI	11.54***	8.38***	8.29***	7.41***	–
	(2.10)	(2.42)	(2.37)	(2.13)	–
N	61	133	133	140	216
R2	0.95	0.71	0.71	0.71	0.61

Note. All continuous predictors are mean-centred and scaled by 1 standard deviation.

Source: Formed by the authors.

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

will be required to enable the local economy to meet these challenges, recover effectively, and eliminate the consequences of war, given the severe impact of high energy prices and skyrocketing inflation.

5. Discussion

The study discusses the socio-economic development of the EU against the backdrop of the war in Ukraine. It presents the results of a correlation analysis, which indicates a lack of close interrelationships among the investigated indicators during the period studied. The study also examines the changes in the proposed complex indicator and its components for the five months of Russia's invasion of Ukraine (February–September 2022) and highlights the differences in changes in the investigated directions for the EU countries. This study, like many of the previous, emphasises the diversity of economic consequences of the war for the European economy (Genschel, 2022). Even prior to the war, global supply chains were under pressure. This resulted in a sharp increase in import and producer prices (Korosteleva, 2022). At the same time, there are great risks of declining real economic growth, caused not only by the current situation in Ukraine but also by other structural requirements such as decarbonisation or demographic ageing (Costantini et al., 2022; Pereira et al., 2022). Especially important is that Russia's invasion of a neighbouring country provoked another exogenous shock in the already damaged European economy, and the expected normalization of pandemic-related supply problems in 2022 and the consequent reduction in inflation and increased growth rates are distant prospects. Chaos in China is once again testing its mutual interdependence with the EU. In fact, the world economy is in a state of emergency. The war and its economic consequences are becoming a new challenge for Europe (Estrada & Koutronas, 2022).

Several researchers also highlight the role of recent changes in the economic environment for fiscal and economic policy in Europe. Due to the COVID-19 pandemic, public debt has increased considerably. If one supplements this with the debt of the Corona Next Generation EU rescue fund, the ratio increases even more (Anghel & Jones, 2022). Increased energy prices and the outbreak of war in Ukraine further exacerbate the state of public finances (Mbah & Wasum, 2022). Economic recovery has been heavily delayed, while many countries are taking steps to alleviate the situation of part of the population in conditions of rising energy prices. Furthermore, defence expenditures are increasing (Khudaykulova, Yuanqiong & Khudaykulov, 2022). Previous studies also focussed on the inflation rate against the background of the war. In May 2022, inflation reached 8% in the Eurozone. The main drivers were energy and food prices (Jones, 2022). However, there are also other factors, such as the disruption of value chains due to store closures in China because of the COVID-19 pandemic (Ngoc et al., 2022; Weitz, 2022). Interest rates in financial markets have been rising since the beginning of the year. There is much uncertainty about whether this increase in interest rates will be long-lasting and whether the rise in real interest rates will be sustainable, but if central banks really want to control inflation, they cannot avoid the drive to raise real interest rates (Jones, 2022). Furthermore, it has been suggested that the rules will not appropriately consider either the individual situation of each member state or the use of the debt assumed and will offer too little flexibility (Gonzalez, 2022). The European Commission makes country-specific guidance on fiscal policy and other economic policy reforms. The different starting positions of individual participating countries and the current economic situation are taken into account. Medium-term targets for the current budget deficit and the development of public spending are of vital importance (Alam et al., 2022; Liadze et al., 2022). Therefore, the results of this research are crucial and can considerably supplement the existing number of studies, since it contains the consideration of the indicators for all EU countries. The study demonstrates that socio-economic development depends on the capacity of each country individually and the EU as a whole to resist the crisis resulting from military hostilities against the territory of Ukraine. The study emphasises the importance of member states strengthening and effectively coordinating their economic policies, effectively addressing macroeconomic imbalances, and ensuring reliable public funding.

6. Conclusion

The war in Ukraine affects the EU member states asymmetrically. The immediate impact is experienced more by Russia's EU neighbours with the high level of energy dependency and trade relations. The inflation rate is correspondingly higher in the Baltic

countries, for example, where monetary policy again fell into the trap of fiscal dominance. Fiscal policy can alleviate such factors at the national level, but a single monetary policy with widely divergent EU member states will hardly do. The geopolitical shock amid the Central European War has made it particularly obvious that economic stability in the EU is closely intertwined with the security of supply. At the same time, the EU faces tremendous challenges, requiring large investment expenditures to cope with structural changes.

Correlation analysis confirmed a close relationship between the labour market slack and the unemployment rate, total employment, young people neither in employment nor in education and training, and total employment. A study of changes in the context of the proposed complex indicators and their relationship to war conditions demonstrated that the changes in the areas under review varied for EU countries. Poland's economy and environment proved to be the most strongly affected by the Central European War crisis. In the direction of business and trade, there is no significant decline for most EU countries, but some countries, such as Bulgaria, Romania, and the Czech Republic, in contrast, faced a significant jump in business and trade development. In people and work development, EU countries also demonstrate considerable asymmetries: maximum growth was recorded in Austria, Greece, Malta, and Germany. Bulgaria tended to experience the most negative effect. In general, amid the war in Ukraine, 17 EU countries faced a slowdown in their socio-economic growth, with Poland the most severely affected. Despite the vast majority of affected countries, Romania (through business and trade development) and the Czech Republic (through people and work development), and Italy (through economy and environmental development) managed to achieve successful results against the background of the war. Cluster analysis enabled the identification of groups of countries with similar development changes amid the war in Ukraine and the determination of the most affected ones. It is generally important to emphasise that all EU countries, except for Italy, experienced negative consequences for their development in their individual components amid the war in Ukraine.

Modelling the influence of the studied factors on the level of public debt made it possible to determine that amid the war, the most important factors for the EU public debt are inflation, the labour market condition (availability of a working population and an increase in employment level), and the possibilities of the balance of payments and the international investment position incorporated into the GDP. The risk of stagflation, that is, a combination of higher inflation and weaker economic growth, is putting additional pressure on EU debt sustainability. Socio-economic development depends on the capacity both of each country individually and of the EU as a whole to resist the crisis resulting from military hostilities on the territory of Ukraine. It is highly important for the member states to strengthen and effectively coordinate their economic policies, effectively address macroeconomic imbalances, and ensure reliable public funding. At the same time, the above-mentioned countries must improve the quality and composition of their public investments in order to provide the required funding to support the economy's social and environmental transition, thereby ensuring full employment, quality jobs, and fair transitions. Solidarity and common European action to mitigate new economic and social challenges will be of crucial importance.

The conducted research proves that the war in Ukraine increases the scale and relevance of general challenges that cannot be addressed at the national level. Ultimately, strengthening the European defence capability against external aggression is the entire task of the EU.

The limitations of this study are based on the set of indicators as part of the key components of socio-economic development at the time of the analysis. Therefore, the study is limited to the range of available indicators for the investigated period. Over time, the statistical data set can be replenished, given the expansion of the indicators' range and their time intervals.

Based on the findings of the study, several research perspectives can be identified for future research. The study focussed on the socio-economic development of the EU countries during the war in Ukraine, but further research could examine the impact of the conflict on other regions, such as Eastern Europe or the Balkans. Additionally, future research could investigate the long-term impact of the war on the socio-economic development of the affected regions. The study used a comprehensive methodology to analyse the EU's socio-economic development, but future research could consider other indicators and factors that may impact the EU's resilience when faced with economic shocks. Future research could consider the impact of different policy responses, such as fiscal or monetary

policy, on the EU's economic resilience. The study highlighted the importance of coordinated policy responses and solidarity among EU member states in the face of economic shocks. Future research could examine the effectiveness of different policy measures and identify best practices for promoting economic resilience and ensuring a fair and sustainable recovery for all EU member states. Overall, future research should continue to examine the impact of conflicts and other external shocks on the socio-economic development of regions and identify effective policy responses to promote economic resilience and social cohesion.

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