Macroeconomic Consequences of the War in Ukraine on Central and Eastern European Economies: A SVAR Analysis

Daniel Daianu[a], Tudor Grosu[b], Andrei Neacsu[c], Andrei Tanase[d*], Radu Vranceanu[e]
[a]Romanian Fiscal Council, 13, Calea 13 Septembrie Bucharest 050711. E-mail: *daniel.daianu@consiliulfiscal.ro*
[b]National Bank of Romania, 25, str. Lipscani, Bucharest, 030031, E-mail: *tudor.grosu@bnro.ro*
[c]Bucharest University of Economic Studies – 6 Piata Romana, Bucharest, 010374, E-mail: *andrei.neacsu@fin.ase.ro*
[d]National Bank of Romania, 25, str. Lipscani, Bucharest, 030031, E-mail: *andrei.tanase@bnro.ro*
[e]ESSEC Business School and THEMA, 1 av. Bernarh Hirsch, 95021 Cergy, France. E-mail: *vranceanu@essec.edu*
*Corresponding author

Abstract
This paper investigates the macroeconomic effects from the Russian invasion of Ukraine in February 2022 on the economies of Bulgaria, Czechia, Hungary, Poland and Romania, using a SVAR model based on a similar analytical framework as that described in Bruhin et al. (2023)[3]. The exogenous shock is captured by the geopolitical risk index developed by Caldara and Iacoviello (2022)[4]. Simulations show that, by the end of 2022, the war contributed to a rise in inflation by 0.45-0.85 percentage points and a drop in GDP by 0.79-1.55 percentage points compared to the counterfactual "no-war" scenario. Our findings suggest a generally larger impact on economic activity in CEE countries compared to Western European economies, a result that can be attributed to the structural weaknesses of these economies, and to the geographic proximity to the conflict area, which led to a higher volatility of the series in the CEE region. Regarding inflation, the uncertainty bands suggest that the war's impact could have been larger, potentially reaching up to 3 percentage points.
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DISCLAIMER

The views expressed in this paper represent the views of the authors and not of the institutions to which they are affiliated. Authors declare no conflict of interest with respect to the opinions expressed in this paper.

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1 Introduction

Russia's invasion of Ukraine in February 2022 escalated into a high-intensity, land-based war. As of December 2024, its duration and outcome remain uncertain. For many EU policymakers, the attack was unexpected, rooted in a widespread belief that Europe had entered an era of "peace dividends", where the end of the Cold War fostered prosperity, and better education was thought to guarantee a global order based on values of freedom, democracy and border stability.

The war in Ukraine has inflicted huge human and material losses in Ukraine (Liadze et al. 2023[16]). A report by the World Bank-EU-UN (World Bank 2024)[20] estimates that tens of thousands of Ukrainians, including many civilians, have lost their lives. Ukraine's GDP in 2023 has reached 74 percent of its 2021 level in real terms. Russia's attacks have targeted not only military objectives but also civilian infrastructure, including Ukraine's energy systems, harbours, and river dams, further deepening poverty and forcing many Ukrainians to seek refuge abroad.

Russia has also experienced severe repercussions as a result of the conflict, including substantial military casualties and profound economic challenges. High inflation rates have significantly eroded the purchasing power of households, leading to a decline in living standards. Additionally, the country has faced international sanctions that have disrupted trade, limited access to global financial markets, and constrained economic growth. Western companies largely exited the Russian market, prompting Russia to reorient its trade toward China and other emerging economies. Retaliating, Russia cut off gas and oil supply to the EU in May 2022. This triggered a severe energy shock early in the war, causing significant disruptions before Europe diversified its energy sources, including LNG, from other countries (Gross and Stelzenmüller, 2024[13]). However, energy prices have remained quite elevated, exerting protracted economic strain.

Central and Eastern European (CEE) countries responded swiftly to the humanitarian and military challenges posed by the war. They welcomed large numbers of Ukrainian refugees, supplied weapons and ammunition to Ukraine, and worked within NATO to coordinate logistics and military support. Additionally, frontline countries accelerated rearmament efforts. According to the SIPRI database[1], military spending in constant dollars in Central and Eastern Europe (CEE) increased by a staggering 46 percent in 2022, and by 32 percent in 2023[2]. Despite this, only Poland surpassed NATO's 2 percent of GDP defence spending target, reaching 2.2 percent in 2022 and 3.8 percent in 2023 (see *Appendix* Table 2). The Baltic states followed similar paths, focusing on modernizing armed forces [3] and recruiting additional military and auxiliary personnel. At the EU level, approximately 45 percent of total defence expenditure in 2022 was allocated to 'compensation of employees' [4]. Furthermore, soon after the war started, NATO has reinforced its Eastern flank, establishing four additional multinational battlegroups in Bulgaria, Hungary, Romania and Slovakia to complement the existing ones[5].

[1]See SIPRI: milex.sipri.org/sipri.

[2]By comparison, the Eurostat reports an increase in military spending in 2022, at the EU level by (only) 11%. See ec.europa.eu/eurostat/statistics-explained/index.php?title=Government_expenditure_on_defence

[3]In Poland this procurement essentially favored arms imported from the US (jet fighters, attack helicopters) and South Korean (main battle tanks). Romania invested in US air defense systems and jet fighters. Hungary bought German tanks and Swedish jet fighters. Czechia imports weapons from Sweden, France, Israel. Bulgaria bought US F16 and Stryker transport vehicles.

[4]See ec.europa.eu/eurostat/statistics-explained/index.php?title=Government_expenditure_on_defence

[5]See NATO, "NATO's military presence in the east of the Alliance", July www.nato.int/cps/fr/natohq/topics_136388.htm?selectedLocale=en

Since joining the EU, CEE countries have made significant progress in narrowing the GDP-per-capita[6] gap with Western Europe. Thus, Poland and Romania achieved GDP per capita levels at approximately 80 percent of the EU average in 2023 [7]. However, the Covid-19 pandemic in 2020 left deep economic scars, including large deficits, higher public debts, and sluggish productivity. Although real GDP fell by over 3 percent in 2020, these countries' economies rebounded strongly in 2021.

The war in Ukraine brought a new wave of challenges, with rising energy prices driving up production costs and eroding household purchasing power. These dynamics negatively affected the competitiveness of businesses and curtailed consumer spending. As Western Europe, the primary trading partner for CEE countries, also suffered economic disruptions, export opportunities diminished. In this context, governments implemented aid schemes to populations and firms, further straining public finances, while central banks raised interest rates to address the inflation surge. This combination of fiscal and monetary measures highlighted the significant economic pressures faced by the region amid overlapping crises.

Following a pattern observed throughout in Europe, the war in Ukraine primarily impacted inflation in CEE countries during 2022, with the effects on GDP becoming more pronounced in 2023, when growth rates dropped dramatically. In 2022, inflation across the EU27 reached a 40-year high of 9.2 percent, accompanied by a GDP growth rate of 3.5 percent. By 2023, inflation declined to 6.4 percent, but GDP growth slowed sharply to 0.4 percent.

This paper aims to provide a quantitative assessment of the short-term macroeconomic effects of the war in Ukraine on several CEE countries, focusing on growth and inflation. It examines Bulgaria, Poland and Romania, which experienced common challenges such as refugee inflows, supply chain disruptions, and adverse investor sentiment driven by heightened uncertainty due to their geographical proximity to Ukraine. As a control group, the Czechia and Hungary are included. These countries, while also affected by rising energy prices, were less *directly* impacted by refugee inflows and military activity due to their greater distance from Ukraine. All these countries are members of both NATO and the EU, but none have adopted euro as their currency [8].

To disentangle the impact of the war from the influence of various simultaneous policy adjustments, we employ a standard Structural Vector Autoregression (SVAR) model. Widely used for analysing the macroeconomic dynamics of unexpected shocks (Gottschalk, 2001[12]; Kilian and Lütkepohl, 2017[14]), the SVAR model incorporates time series data to capture exogenous geopolitical shocks affecting those countries. A central variable in our analysis is the Geopolitical Risk (GPR) index, developed by Caldara and Iacoviello (2022)[4], which tracks geopolitical tensions based on the proportion of news articles in prominent newspapers reporting adverse events such as "wars, terrorist attacks, and any tensions among states and political actors that affect the course of international relations". Updated GPR indices are available at global, regional, and national levels, including for Poland, Hungary, Russia, and Ukraine, allowing us to focus on the specific context of the CEE region.

A substantial number of empirical papers used the GPR index in SVAR models to explore the economic effects of major geopolitical shocks, including the Russian invasion of Ukraine. Studies which analysed the Ukrainian war have emphasized its impact on energy prices and

[6] At "purchasing power standards".

[7] See Eurostat: `ec.europa.eu/eurostat/statistics-explained/index.php?title=GDP_per_capita,_consumption_per_capita_and_price_level_indices`

[8] However, Bulgaria, where a currency board was set up more than two decades ago, operates under a fixed exchange rate regime.

inflation (Caldara et al., 2023[6]; Lee et al., 2023[15]; Zhang, 2023[23]; Yang et al., 2023[21]), GDP growth (Caldara et al., 2022[4], Tong, 2024[19]), commodity markets (Aizenmann et al., 2024[1]) and various financial assets (Fang and Shao, 2022[10]; Aliu et al. 2022[2]; Yilmazkudav(2024)[22]). Other studies investigating the impact of the war in Ukraine have employed alternative modelling approaches, such as analysing Google search trends (Lo et al. 2022[17]), two-agent New Keynesian model (Chan et al. 2024[7]) and multiresolution data techniques (Saâdaoui et al., 2022[18]). It goes beyond the purpose of our paper to provide a comprehensive review of such a wide range of analyses. One widely replicated finding, presented by Caldara et al. (2023)[6], is that the war in Ukraine raised global inflation by about 1.2 percentage points and reduced global GDP by around 1 percent.

Our analysis builds upon and expands the study by Bruhin et al. (2023)[3], which employed the GPR index in a SVAR framework to examine the effects of geopolitical shocks on the economies of "large" Western European countries (Germany, France, Italy, and the UK) as well as Switzerland. Three of them are members of the European Union and share the same currency, while the UK and Switzerland although connected to the EU through free trade agreements, maintain their own currency. Using time series data from the 1970s (including several major conflicts such as the Gulf war, the Iraq war and the Ukraine War), Bruhin et al. (2023)[3] find that the Ukraine war has a significant negative impact on GDP and a positive, less persistent, but immediate effect on inflation. For instance, Germany's GDP was found to be 3.2 percent lower two years after the shock, while CPI inflation rose by 2 percentage points on impact before gradually subsiding.

In our study, we adopt a similar block structure as in Bruhin et al. (2023)[3] including global variables (GPR index, oil prices, US GDP and US CPI), and country-specific variables (GDP growth, HICP inflation, Economic Sentiment Indicator, Real Effective Exchange Rate and 3-month interbank interest rate), respectively. By contrast, we also include the gas price in the global variables, which provided for an important channel of shock transmission in the CEE. However, our analysis is constrained by the shorter time series available for CEE countries, given their transition to market economies in the early 1990s and their establishment as "functional market economies" around 2000[9]. The EU's expansion into Central Europe in 2004, followed by Romania and Bulgaria's accession in 2007, marked the completion of this transition, rendering pre-2000 data unsuitable for this analysis.

The relatively short data interval prompted us to opt for a parsimonious estimation approach – i.e., a constant-parameter Bayesian VAR model, implemented using the BEAR toolbox (Dieppe et al., 2016[9])[10].

Due to a rather limited number of war episodes included in our sample (Iraq war of 2003, Crimea annexation in 2014, Ukraine invasion in 2022), we were unable to apply the narrative restrictions as in Bruhin et al. (2023)[3] and relied solely on sign restrictions.

Our results reveal a similar pattern of effects of the war in Ukraine on the CEE economies: higher energy prices, deteriorating export opportunities, lower consumer and business confidence all took a toll on GDP growth. Inflation across the region, which was already high, increased sharply, primarily due to higher energy prices. In response, central banks raised interest rates, while some central banks intervened in currency markets to stabilize exchange

[9]The Copenhagen criteria established in 2016, to be fulfilled by a country to access the EU include among the three essential criteria "a functioning market economy and the ability to cope with competitive pressure and market forces within the EU". See https://eur-lex.europa.eu/EN/legal-content/glossary/accession-criteria-copenhagen-criteria.html

[10]It might be interesting in further research, using more abundant data, to analyze whether the main results hold using a time-varying parameter SVAR as in Yang et al. (2023)[21]. This model may be suited for addressing certain irregularities associated with geopolitical shocks, potentially providing additional robustness in such contexts.

rates and, albeit subtly, in bond markets to maintain financial stability and promote the smooth transmission of monetary policy. As the war had a contractionary effect across the region, governments implemented fiscal support measures such as energy subsidies, price caps, and targeted assistance for vulnerable sectors, including energy-intensive industries and SMEs, to prevent bankruptcies and preserve jobs. However, the increased public spending aimed at cushioning the social consequences of the shock has also contributed to inflationary pressures, compounding the effects of high-energy costs. In the new context in which NATO aimed to strengthen the eastern flank, some of the additional military expenses boosted imports, while another part contributed to increased domestic demand.

In general, the CEE countries adopted diverse governmental policies to mitigate the impact on their economies and populations. These policy variations, and consequently their differing economic effects, reflected differences in fiscal capacity, energy market structures, and national economic priorities. Therefore, given the substantial magnitude of the geopolitical shock and the multiple channels through which it has impacted CEE economies, our findings should be interpreted with caution. Our analysis focuses on the observable spectrum of the macroeconomy, emphasizing key transmission mechanisms: the aggregate demand and supply channel, a price equation capturing the effects of energy price fluctuations and the output gap, and the responses of central banks and governments to the shock. The results of any SVAR model are influenced by the number of lags and restrictions applied, which build on logical assumptions and empirical observations.

The analysis focuses on the short-term effects of the shock (in 2022), and, as such, does not allow us to draw conclusions about the structural changes that the war may have brought about. Within the realm of potential structural changes that remain undiscussed, one might consider heightened investment uncertainty in countries near the conflict zone, the persistently higher relative price of energy affecting resource allocation, a worsening of social cohesion, economic decoupling from Russia and reorientation of trade flows toward other countries, and the challenges of managing increased public debt and budget deficits.

On a general note, the surge in energy prices following the war in Ukraine has disproportionately impacted consumers and firms, with energy-intensive companies facing higher operational costs, reduced equity returns, and increased credit risks. Lower-income households have been most affected, experiencing a significant rise in energy poverty due to the regressive nature of energy price increases. However, this paper does not specifically address these distributional effects, focusing instead on broader macroeconomic implications.

Conversely, the war may present some positive opportunities for CEE economies. These include the relocation of Western firms previously operating in Ukraine or Russia to the region, increased investment in the defence sector, which could boost short-term economic growth (though budget constraints may impair resource allocation to civilian sectors), and the advancement of strategic projects under strengthened NATO cooperation.

The paper is organized as follows. In Section 2 we will present the data and the methodology. The results are presented in Section 3. Section 4 is our conclusion.

2 Data and Methodology

The SVAR model is estimated individually for each country (Bulgaria, Czechia, Hungary, Poland and Romania) using a quarterly balanced dataset that contains both global and domestic variables. The sample covered the period from 2000Q1 to 2024Q2 for all countries[11].

[11]Sources: Eurostat, Federal Reserve Economic Data, Energy Information Administration and Bloomberg.

The global variables include the Geopolitical Risk (GPR) Index, oil and gas commodity prices – primarily influenced by the outbreak of the war in Ukraine – and a selection of foreign variables representative for the global macroeconomic environment, specifically US GDP and US CPI. For each country, the dataset comprises key domestic macroeconomic variables: GDP growth, HICP inflation, the Economic Sentiment Indicator[12](ESI), the Real Effective Exchange Rate (REER) and the 3-month interbank interest rate. Robustness checks were conducted by adding the government budget or substituting HICP with HICP food. To ensure stationarity, all variables were transformed into quarter-on-quarter rates of change, except for the interest rate and ESI, for which we used the first difference. Figure 1 illustrates the Global GPR index alongside two country-specific GPR indices for

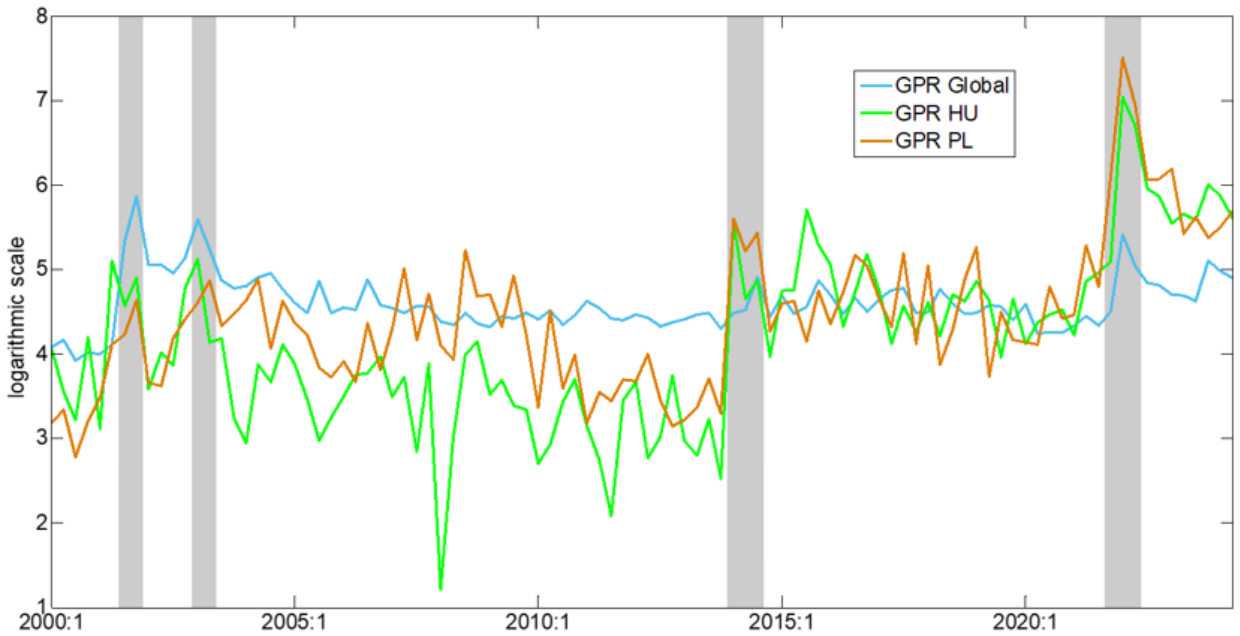

Figure 1: GPR indexes.

Hungary and Poland, that are representative for the CEE region. The graph highlights key geopolitical events, including the 9/11 terrorist attack in 2001, the Iraq war in 2003, the annexation of Crimea in 2014, and the outbreak of the war in Ukraine in 2022. The first two events had a more pronounced impact on the global index compared to the regional ones, whereas the Russian invasion of Ukraine had a significantly stronger impact on the regional indexes. To better capture the response of key country-specific variables to a GPR shock, a regional GPR index was employed for the analysis. Specifically, for Hungary and Poland, their respective country-specific indices were used, while for Czechia, Bulgaria and Romania, for which country-specific indices are not available, the Polish GPR index was used as a proxy due to its heightened sensitivity to adverse events linked to the war and its geographical proximity to Ukraine. The generalized form of the VAR (2) model that we use in our empirical analysis, for each country, is the following:

$$y_t = \Pi_0 + \Pi_1 y_{t-1} + \Pi_2 y_{t-2} + \varepsilon_t, \quad \varepsilon_t \sim N(0, \Sigma_t) \tag{1}$$

[12]ESI is a confidence composite indicator developed and updated since 1985 by the European Commission within its monthly business and consumer surveys. ESI combines judgements and attitudes of producers and consumers by means of a weighted aggregation of standardized input series, thus it can be viewed as a summary of five sector-specific confidence indicators with specific weights, as follows: Industrial (40%), Services (30%), Consumer (20%), Retail trade (5%) and Construction (5%).

In our case, y_t encompasses a set of global and domestic variables. The model is therefore expressed in the following form:

$$\begin{pmatrix} g_t \\ d_t \end{pmatrix} = \begin{pmatrix} \beta_{0,g} \\ \beta_{0,d} \end{pmatrix} + \begin{pmatrix} \beta_{1,gg} & 0 \\ \beta_{1,dg} & \beta_{1,dd} \end{pmatrix} \begin{pmatrix} g_{t-1} \\ d_{t-1} \end{pmatrix} + \begin{pmatrix} \beta_{2,gg} & 0 \\ \beta_{2,dg} & \beta_{2,dd} \end{pmatrix} \begin{pmatrix} g_{t-2} \\ d_{t-2} \end{pmatrix} + \begin{pmatrix} \varepsilon_{g,t} \\ \varepsilon_{d,t} \end{pmatrix} \tag{2}$$

where g_t represents global variables while d_t denotes the vector of country-specific variables. The β's represent the model parameters, and the ε's are the residuals. Following Bruhin et al. (2023)[3], global variables are grouped into a block of exogeneity relations (see Table 1) to map their unidirectional impact on domestic variables. This grouping assumes that global factors, such as geopolitical risks, energy prices, and foreign economic indicators, impact domestic economies without being significantly influenced in return. By structuring the model in this way, the analysis isolates the external shocks' direct effects on domestic macroeconomic conditions, ensuring a clearer interpretation of how these global forces propagate through local economic channels.

The VAR model was estimated using Bayesian techniques, where the prior parameters were fine-tuned through a grid search procedure, following the methodology described in Giannone et al. (2015)[11]. This approach allows for the incorporation of prior information, enhancing the model's robustness, especially in cases with relatively short time series.

Given the limited number of war episodes included in the sample (Crimea's annexation in 2014 and the invasion of Ukraine in 2022), we did not impose any narrative restriction. Furthermore, sign restrictions were applied only contemporaneously (same-quarter effect of the GPR shock) without extending to subsequent quarters. This allows for a much reasonable computational burden, which would otherwise have become problematic given that the models were estimated independently on five countries. For each country, the analysis involved 15.000 iterations, with 30% of them being discarded during the burn-in phase. The VAR models are estimated using the BEAR toolbox (see Dieppe et al. (2016)[9] for further details).

3 Results

3.1 Impulse Response Functions

Following Caldara et al. (2022)[4], our initial identification strategy for analysing the response of variables to a GPR shock was based on a Cholesky decomposition. The variable ordering is the following [GPR, oil price, gas price, US GDP, US CPI, country REER, country RIR, country ESI, country GDP, country CPI] for all five countries**.** Under this approach, a GPR shock first impacts the oil price, which subsequently influences gas price. This cascade effect then extends to the US economy. For domestic variables, the assumed sequence of responses begins with financial variables (interest rate), followed by confidence indices, GDP, and lastly, inflation. However, the impulse functions for Romania, shown in the Appendix (Figure A1) and derived using a simple Cholesky identification scheme, do not reveal significant reactions of commodity prices, particularly gas; furthermore, the responses for GDP and ESI were counterintuitive, notably showing positive effects. Only in the case of inflation does the response have the expected sign.

These counterintuitive results call for a more sophisticated identification strategy aiming at better capturing the war shock. As a result, we applied a series of sign restrictions to capture the expected directional impacts of specific variables linked to the onset of the war - namely, the GPR index, oil prices, and gas prices - as well as those related to economic

Table 1: Block of exogeneity

	gpr	oil	gas	gdp_us	cpi_us	reer	interest	esi	gdp	hicp
gpr		1	1	1	1	1	1	1	1	1
oil				1	1	1	1	1	1	1
gas				1	1	1	1	1	1	1
gdp_us						1	1	1	1	1
cpi_us						1	1	1	1	1
reer										
interest										
esi										
gdp										
hicp										

Note: The value of 1 in row i, column j indicates that variable j does not affect variable i. (e.g., gdp does not affect gpr, oil, gas, gdp_us, cpi_us).

growth, consistent with the approach outlined by Bruhin et al. (2023)[3].

These sign restrictions aim to reflect the theoretical and empirical understanding of how such shocks propagate through the economy. For instance, variables such as GPR, oil, and gas are assigned positive signs (+), indicating that an increase in these factors is expected to exert upward pressure on costs and inflation. Conversely, economic indicators like GDP are assigned negative signs (-), reflecting the contractionary effects typically associated with heightened geopolitical risks and commodity price spikes:

Table 2: Sign restrictions

Global block variables		**Country-specific variables**	
GPR	+	**REER**	
Oil	+	**Interest rate**	
Gas	+	**ESI**	
US_GDP	-	**GDP**	-
US_CPI		**HICP**	

We estimate this SVAR model for all five CEE countries. To maintain clarity and conciseness, we focus on presenting the results for Romania in greater detail and subsequently compare the findings for the other countries against this baseline. Figure 2 illustrates the Impulse Response Functions (IRFs) for Romania, corresponding to a GPR shock equivalent to one standard deviation (0.8 points). This magnitude represents approximately half of the cumulative increase in the index observed between 2021Q4 and 2022Q2. The median of each distribution is considered as the Bayesian estimator; furthermore, the 16^{th} and 84^{th}

quantiles of distributions are used to construct the 68% credible sets, following the standard approach in the Bayesian literature.

In response to this shock, commodity prices rose significantly, with oil price increasing by 18.3 percentage points and gas price by 34.2 percentage points. As expected, the response of gas prices is larger, reflecting the war in Ukraine's more pronounced impact on gas markets compared to oil markets (see Figure A2 and Figure A3 in the Appendix). Under the imposed sign restrictions, GDP declines in both the US and Romania, with the contraction being more severe in Romania. The Romanian GDP falls by nearly 4 percentage points, while the US experiences a smaller decrease of around 1.6 percentage points[13]. Among the unrestricted variables, the most significant change is observed in the ESI, which declines by almost 9 percentage points, as heightened geopolitical risks lead to increased investors caution. The war outbreak also directly impacts inflation, primarily through the raw materials channel. US inflation shows a significant response, with quarterly inflation rising by 1.1 percentage points following a GPR shock. Romanian HICP inflation exhibits a similar magnitude of response; however, the confidence intervals for the IRF are wider, indicating a higher degree of uncertainty. Using the same sign restrictions identification scheme described earlier,

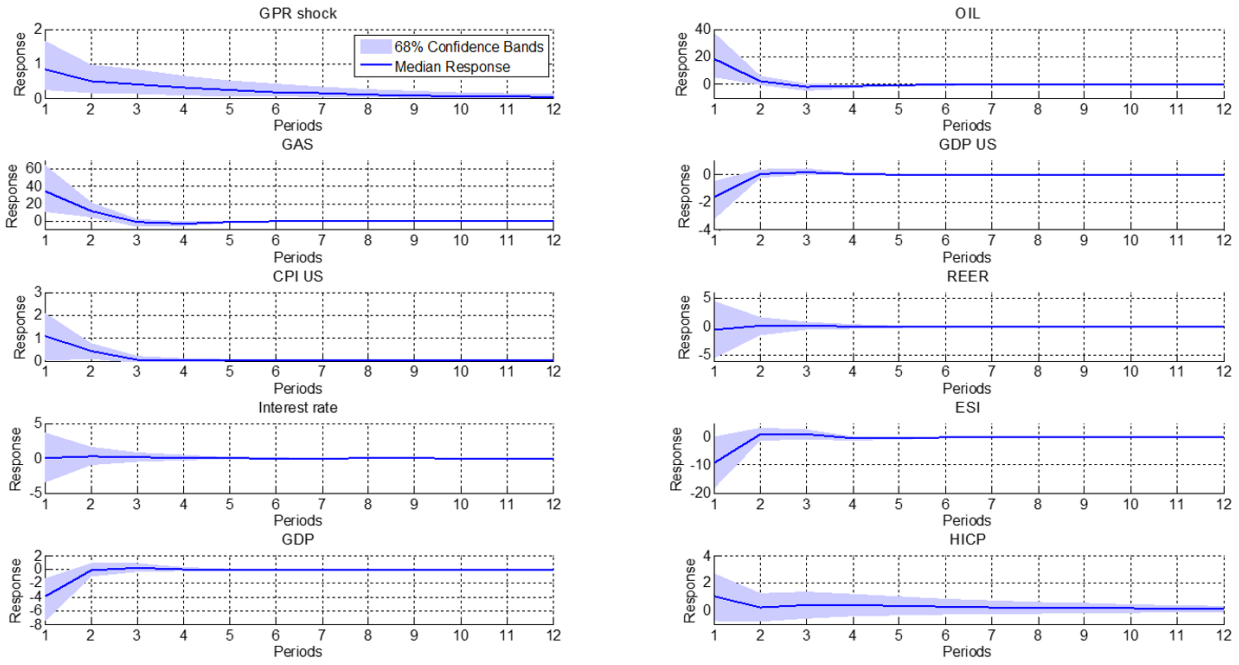

Figure 2: Impulse responses to a geopolitical conflict shock (Romania - sign restrictions)

we estimated the model individually for the other four CEE countries to gain a better understanding of the regional adverse impact of the war.

For Czechia, the outcome of block exogenous variables is quite similar to those of Romania (see Appendix, Figure A4). However, some differences are notable: the HICP inflation response is only slightly positive and largely insignificant, as indicated by the wide uncertainty bands. As expected, GDP and ESI responses are negative, but their magnitudes are almost half of those in Romania.

Results for Hungary (Appendix, Figure A5) are broadly similar to those for Czechia. In contrast, Poland's outcomes (Appendix, Figure A6) align more closely with Romania's, except for the response of GDP, where the magnitude of the impact is smaller. For Bulgaria

[13]This figure is not far from the 1.8 percent US GDP reduction as estimated by Bruhin et al. (2023)[3] in their analysis for the large Western European countries.

(Appendix, Figure A7), the IRFs show largely insignificant responses for both ESI and HICP inflation, while GDP exhibits a negative response, albeit of a smaller magnitude compared to Romania and Poland.

It is worth noting that, across all countries, the median response of HICP inflation displays the expected positive sign, but the confidence bands are relatively wide. However, for Romania and Poland, confidence bands barely include the null value, making the responses relatively more significant than in the case of the other three countries.

3.2 Counterfactual Analysis

For each variable of interest - namely GDP, the ESI confidence index, and prices (both in levels and annual inflation) - we constructed a set of counterfactual series by taking out the contributions of the GPR shocks from the historical decomposition of the respective variable over the period from 2021Q4 to 2022Q2. This approach allows us to isolate the specific impact of geopolitical risk shocks on these key economic indicators, providing a clearer understanding of how the war in Ukraine influenced economic dynamics. By comparing the actual series with the counterfactuals, we can better assess the extent to which these shocks contributed to deviations from expected economic trends, offering valuable insights into their short-term macroeconomic implications. Results are illustrated in Figure 3 for Romania and Figures A8 – A11 in the Appendix for all other countries.

It turns out that for Romania, the GDP in 2022 would have been 1.6 percentage points higher in the absence of the war in Ukraine. Due to the construction of the counterfactual (removing three shocks from the actual/observed variable), this gap is considered permanent.

Regarding inflation, prices would have increased by nearly 1 percentage points less than observed. Notably, the uncertainty bands are right-skewed, indicating that the war's impact could have been larger, potentially reaching a level lower by up to 3 percentage points than the values observed. In terms of the economic sentiment, had the war not occurred, the ESI would not have fallen below 100, its long-term average.

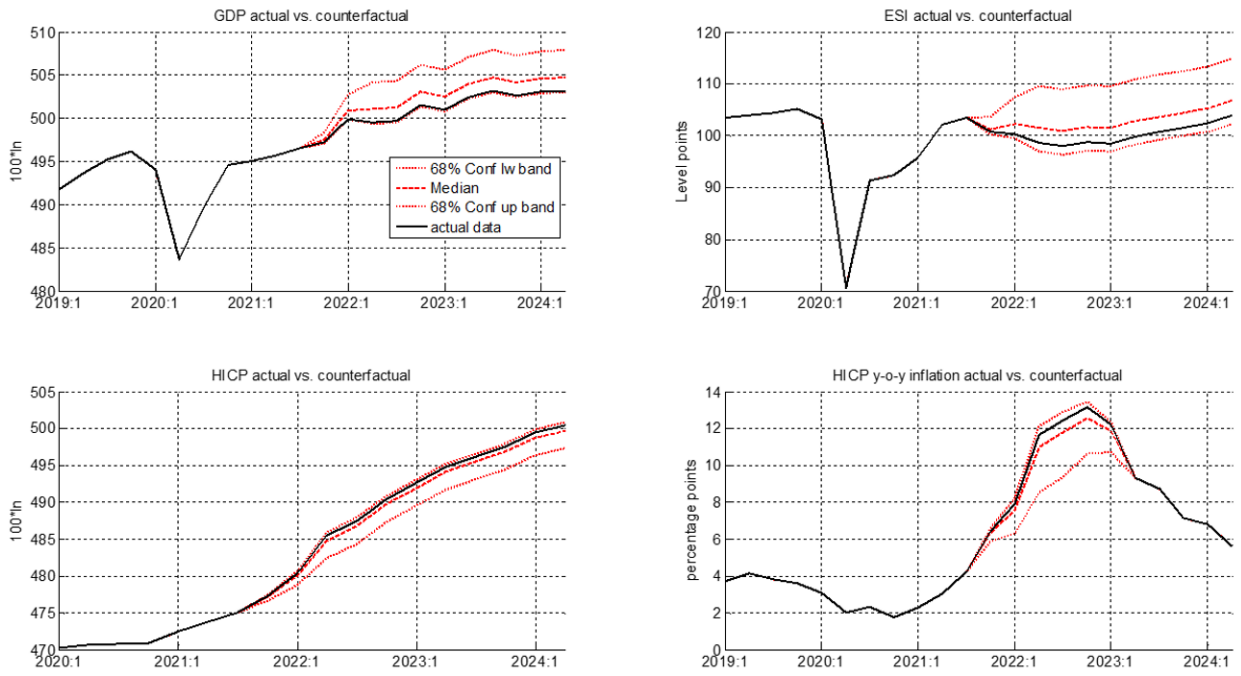

Figure 3: Counterfactual series if Russia had not invaded Ukraine

Table 3 provides an alternative way of presenting the counterfactual results (

Table 3: Median percentage difference to no-war counterfactual by 2022Q4. 68% confidence bands in brackets

Countries	**HICP**	**GDP**
BG	-0.45%	0.84%
	[-2.69%, 0.73%]	[-0.16%, 2.51%]
CZ	-0.85%	0.83%
	[-3.27%, 0.46%]	[-0.43%, 3.08%]
HU	-0.59%	0.79%
	[-2.69%, 0.48%]	[-0.62%, 2.83%]
PL	-0.71%	0.87%
	[-2.83%, 0.12%]	[-0.29%, 2.76%]
RO	-0.67%	1.55%
	[-3.10%, 0.47%]	[-0.17%, 4.68%]

For HICP, there is noticeable heterogeneity in the median impact. Bulgaria shows the smallest impact (-0.45 p.p.), while Czechia registers the largest (-0.85 p.p.). For Hungary, Poland and Romania, the differences are approximately -0.7 p.p. The lower bounds of the confidence interval are similar across all countries (around -3 p.p., with the highest absolute values for Czechia and Romania).

Regarding GDP, Romania stands out with the largest median impact (1.55%) and the highest upper bound (4.7%). For the other countries, the median GDP impact is around 0.8%. The asymmetry of the confidence intervals for both HICP and GDP highlights the significant impact of the war.

Although our results are not directly comparable to those of Bruhin et al. (2023)[3] due to differences in methodology and sample size, our findings suggest a generally larger impact on both inflation and economic growth in CEE countries compared to wealthier Western European economies. The stronger GDP impact in CEE countries, particularly in Romania, is partly attributed to the higher volatility of the series in this region also on account of structural weaknesses of these economies. In relative terms - measured by dividing the median GPR shock impact by the standard deviation of quarterly GDP growth [14] - the effect on GDP in CEE countries is comparable to, and only slightly higher than, that estimated for Germany, with the notable exception of Hungary, where the relative effect is slightly lower.

3.3 Robustness checks

This section presents some robustness checks for our results. For the sake of simplicity, they are tested herein only for Romania, but similar conclusions should be reached for other countries, too.

The invasion of Ukraine caused a rise not only in energy prices but also in other raw material and crop prices, contributing to inflation via the food inflation channel. The first robustness check simply replaces HICP inflation with HICP food inflation (Figure 4). Overall, the responses closely align with the baseline results. However, due to the larger historical

[14]The standard deviation of quarterly GDP growth between 2000Q1 and 2024Q2 is 1.5 in Bulgaria, Czechia and Polands 2.2 for Hungary; and 2.5 for Romania, while Germany's corresponding value is 1.5.

volatility of the food inflation series, the response to a GPR shock exhibits wider uncertainty bands.

The second robustness check involves incorporating the general government balance as a country-specific variable. For this variable, the response to a GPR shock is only slightly negative (Figure 5), but remains largely insignificant due to the wide uncertainty bands.

One additional issue is the potential impact of high series volatility during the pandemic year 2020 on the results. While this is a major concern for forecasting applications - where regime switches can cause significant errors - our study focuses on disentangling the contribution of specific shocks (particularly GPR) in the historical decomposition of observed series. Nonetheless, we conducted an additional robustness check by addressing outliers from the 2020 data. Prior to re-estimating the model, the 2020 observations were adjusted by trimming values to fall within the 10^{th} and 90^{th} percentiles[15]. For instance, oil price fluctuations of -50% and 40% in Q2 and Q3 2020 were adjusted to -15% and 17%, respectively, while Romanian GDP changes of approximately -10% and 6% were trimmed to -0.9% and 3.5%. Comparing the updated results with the baseline estimates (Figure 3), we find that the median responses for ESI and US GDP decreased in magnitude, while the response for Romania's GDP remained largely unchanged (Figure 6). For HICP inflation, the responses are nearly identical to the baseline, as no outliers were present in HICP observations during 2020.

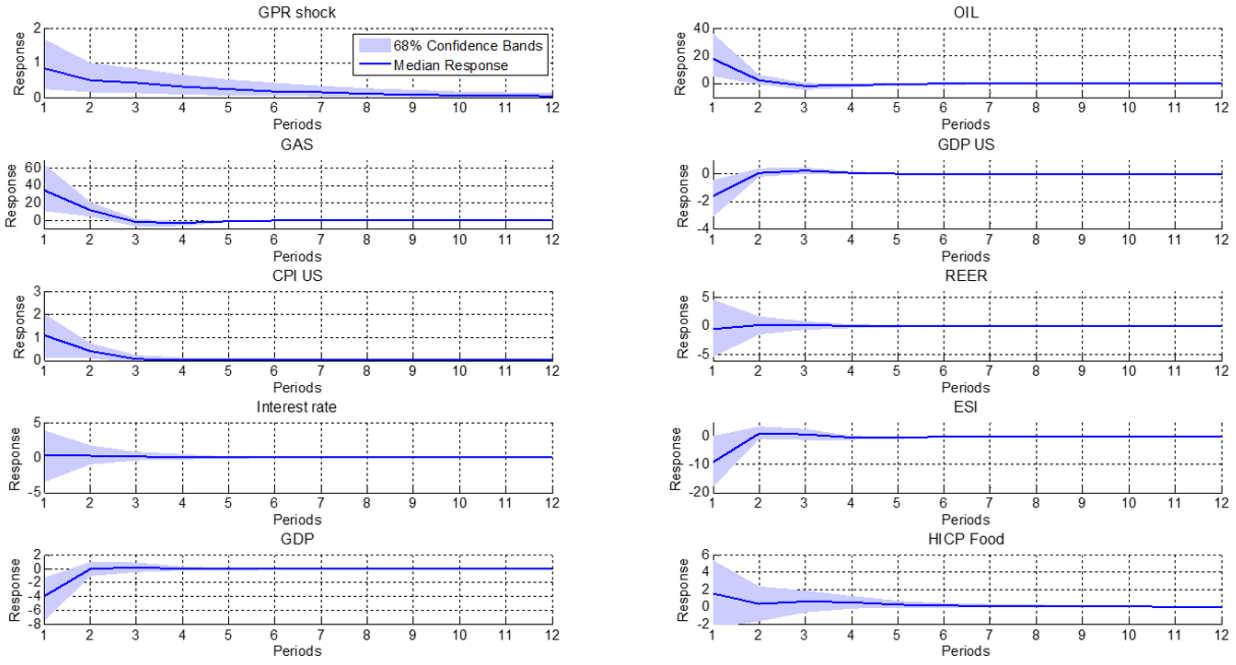

Figure 4: Romania: Impulse responses to a geopolitical conflict shock (Romania – hicp food)

We also estimated a model including the euro area short-term interest rate, along the lines of the analysis by Aizenman and Saadaoui (2024). This variable does not appear to play a significant role in the dynamics of inflation and GDP growth.

As another robustness check, we also estimate the model using 5 lags instead of 2. The results, summarized in Table A12 in the Appendix, are close to the results displayed in Table

[15]Trimming data before estimating a model can be a useful tool for ensuring the robustness of estimates, although it may induce bias. A list of references (both theoretical and practical) regarding robust vector autoregressive models can be found in Chang and Shi (2022)[8], albeit they are discussed mainly for financial markets applications.

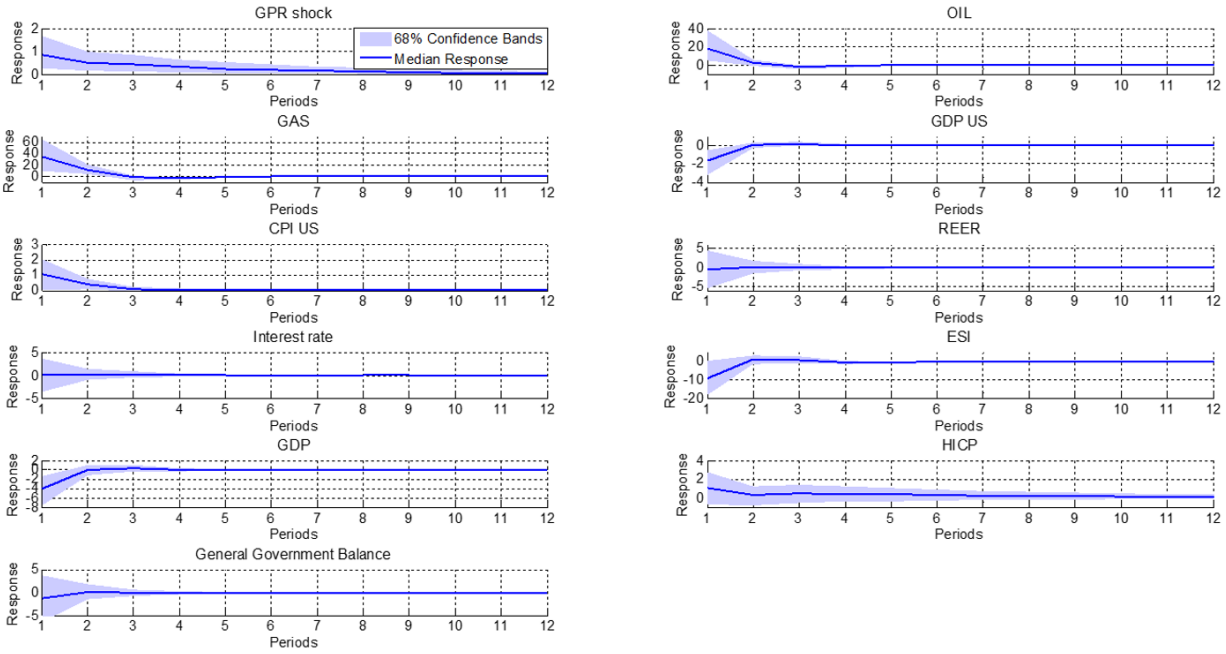

Figure 5: Impulse responses to a geopolitical conflict shock (Romania – government balance)

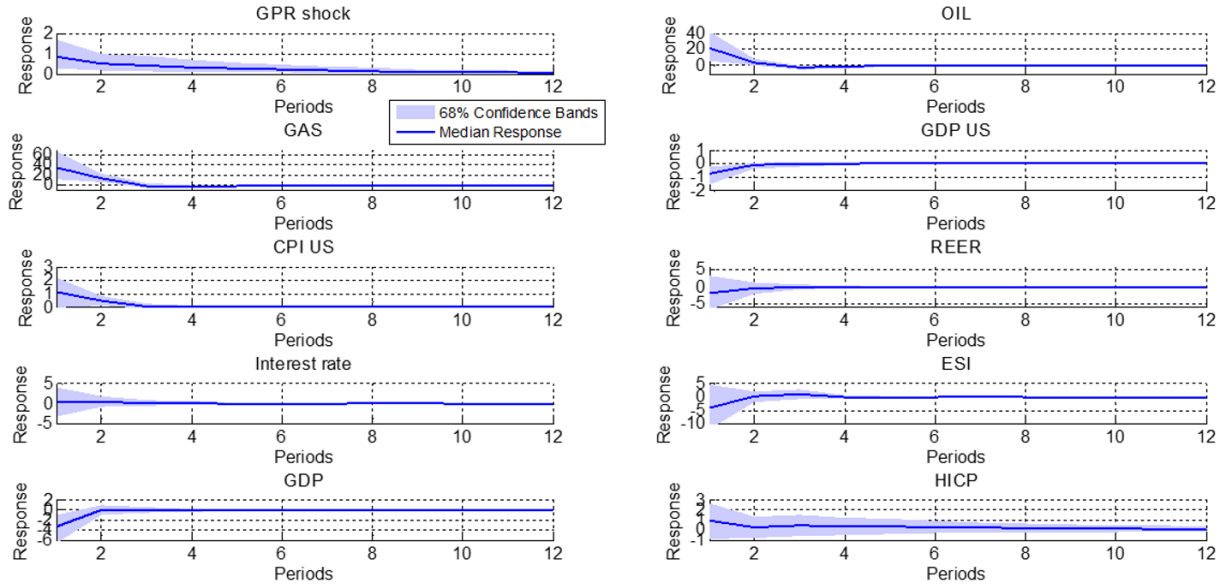

Figure 6: Impulse responses to a geopolitical conflict shock (Romania – trimming outliers for 2020)

3. In the 5-lag specification, the impact of the war on inflation is slightly higher, while its effect on GDP is merely marginally lower.

4 Conclusion

To the best of our knowledge, this is likely the first paper to date which use a SVAR model inspired by the analysis of Bruhin et al. (2023)[3], to analyse the effect of the war in Ukraine on countries significantly exposed to this geopolitical, owing to their geographic proximity to the conflict zones and their membership in both NATO and the EU.

In contrast to the model in Bruhin et al. (2023)[3], gas prices were included as a key variable, given their substantial increase relative to oil prices in the context of the Russian invasion and their role as a significant channel for shock transmission for the CEE. Additionally, we performed three robustness checks: incorporating food inflation and government balance as variables, and trimming outlier observations from the pandemic period.

Results show that the war in Ukraine had an immediate and substantial adverse macroeconomic impact on the CEE economies. Counterfactual exercise suggests that if Russia had not invaded Ukraine, the real GDP of the countries would have been 0.79 to 1.55 percentage points higher. Our findings highlight that the contractionary effects on GDP were notably stronger in CEE economies than in Western Europe, reflecting a higher economic vulnerability owing to geopolitical proximity and structural economic fragility, particularly in Romania and Poland. At the same time, the sizable confidence bands point out that the war's impact could have been larger, reflecting the significant uncertainty surrounding the economic effects and the potential for more severe outcomes of this geopolitical event.

In 2022 inflation rates in these countries ranged from 12 percent (in Romania) to 15.3 percent (in Hungary), from rates that did not exceed 4 percent in any of these countries in 2021 (Table A1). According to our model results, almost $\frac{1}{4}$ of this increase can be attributed to the effects of Russia's invasion of Ukraine, significantly complicating the tasks faced by national central banks. In response, they all raised interest rates, despite the challenging context of declining economic activity, which exacerbated the direct impact of the war on economic activity.

These results identify the initial impact of the shock on economic activity as definitely unfavourable, but over time it was gradually mitigated by a recovery in domestic demand, at the expense however, of higher deficits and public debt. In turn, higher deficits, coupled with a worsening of the terms of trade that peaked during the energy crisis, led to a significant deterioration in the external position of these countries.

However, the study employs a homoskedastic VAR model, which, while a widely used and established approach, requires careful specification to ensure robust and reliable results. These economies have a relatively short history as functional market economies and EU members, limiting the times series to the period of structural stability after 2000. This constraint restricted our methodological approach to a fixed-parameter Bayesian SVAR model. While the restrictions imposed on the main variables are based on logical considerations, alternative specifications could potentially yield different results. Nevertheless, our robustness checks confirm that the key findings remain consistent even when additional variables are included in the analysis. The study does not take into account the longer-term effects of the war, which is driving a major reconfiguration of trade and investment links between the EU and Ukraine, as well as Russia. The decoupling of Russia from the EU, accompanied by its pivot toward China and the BRICS nations, has significant implications for both Russia and the EU. Furthermore, the EU's decision to open its agricultural market to Ukrainian commodity exports introduces important structural changes, particularly for the CEE EU member countries.

Another critical structural dimension involves the significant defence efforts being undertaken by CEE countries to meet NATO standards and address emerging threats. These

efforts entail increased public spending and substantial investment in military infrastructure and the defence-industrial base, which will have a lasting effect on the region.

Despite these limitations, our analysis offers a rigorous estimation of the economic losses imposed by this major shock on the CEE member states. These countries are particularly vulnerable to the effects of the war because of their geographic proximity to the conflict zones. Additionally, they face compounded challenges stemming from their relatively weaker economies compared to their Western counterparts. These challenges include less diversified industrial bases, higher dependency on energy imports, and limited fiscal buffers, all of which constrain their ability to absorb shocks. This combination of geographic and structural vulnerabilities underscores the disproportionate burden borne by these nations in the wake of the crisis.

From a policy perspective, our findings underscore the critical role of effectively absorbing EU funds, particularly those allocated under the Next Generation EU programs, in mitigating the persistent negative effects of the Russian invasion of Ukraine. These funds can provide much-needed support for economic recovery by financing key investments in infrastructure, green energy, and digitalization, which not only stimulate growth but also enhance long-term resilience.

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Appendix

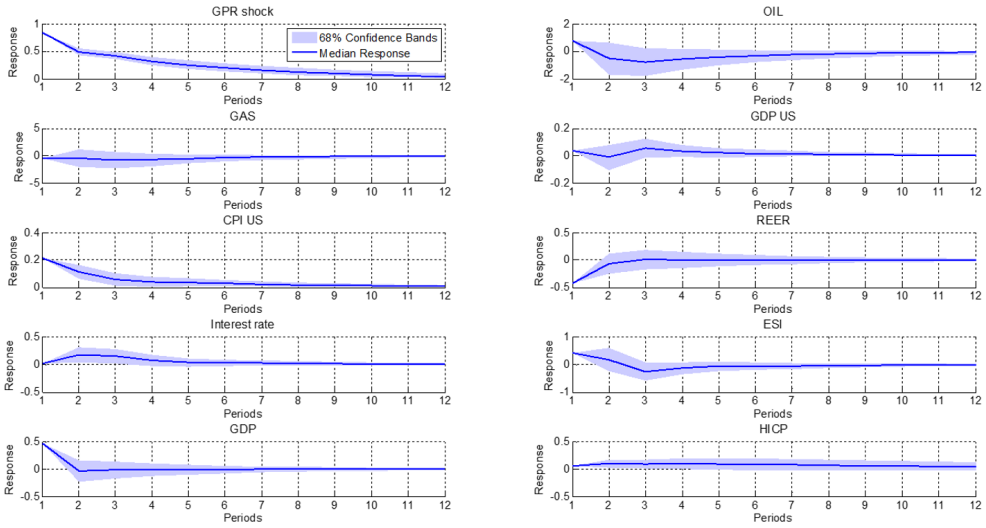

Figure A1: Simple VAR – impulse function for Romania, using Choleski decomposition

Table A1: Statistics

	GDP / capita (PPP)		Growth rate		Inflation rate (HICP)		Unemployment rate	
	2019	**2022**	**2019**	**2022**	**2019**	**2022**	**2019**	**2022**
EU-27	31300	35400	1.9	3.5	1.4	9.2	6.8	6.2
Bulgaria	16600	24200	3.8	4.0	2.5	13.0	5.2	4.2
Czech Republic	29200	32000	3.6	2.8	2.6	14.8	2.0	2.2
Hungary	22900	26900	5.1	4.3	3.4	15.3	3.3	3.6
Poland	22800	28200	4.6	5.3	2.1	13.2	3.3	2.9
Romania	21800	26700	3.9	4.0	3.9	12.0	4.9	5.6
	Public Deficit (%)		**Public Debt (%)**		**Military Spending Current mil.$***		**Military Spending Percent of GDP***	
	2019	**2022**	**2019**	**2022**	**2019**	**2022**	**2019**	**2022**
EU-27	-0.5	-3.2	77.4	82.5				
Bulgaria	2.2	-2.9	20.1	22.5	2158	1436	3.13	1.59
Czech Republic	0.3	-3.1	29.6	42.5	2910	4005	1.15	1.38
Hungary	-2.0	-6.2	65.0	73.8	2190	3256	1.34	1.84
Poland	-0.7	-3.4	45.2	48.8	11786	15341	1.98	2.23
Romania	-4.3	-6.4	35.0	47.9	4613	5188	1.84	1.72

*Military spending is SIPRI Data, consistent with NATO Methdology. Eurostat is publishing some more "conservative" statistics `https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Government_expenditure_on_defencehttps://ec.europa.eu/eurostat/statistics-explained/index.php`

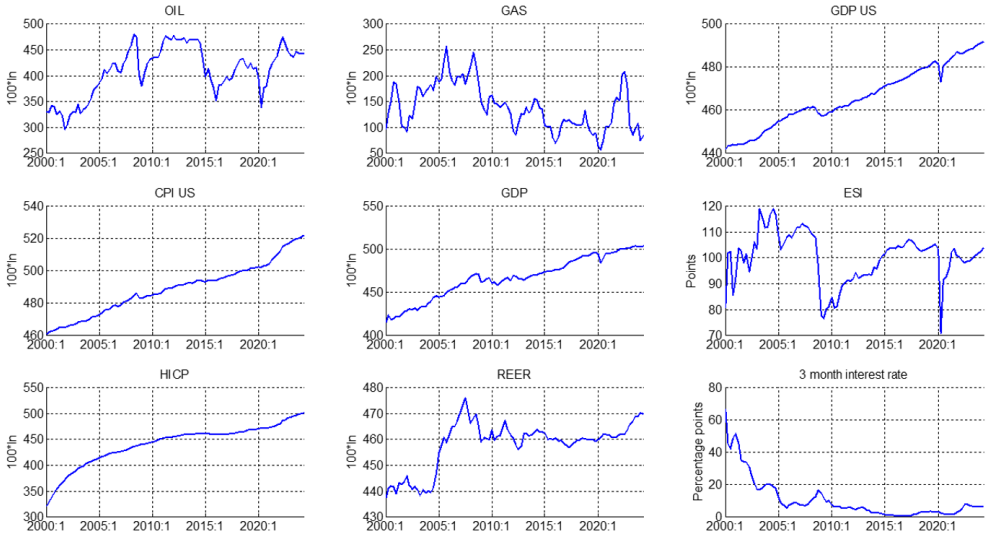

Figure A2: Romania: raw data

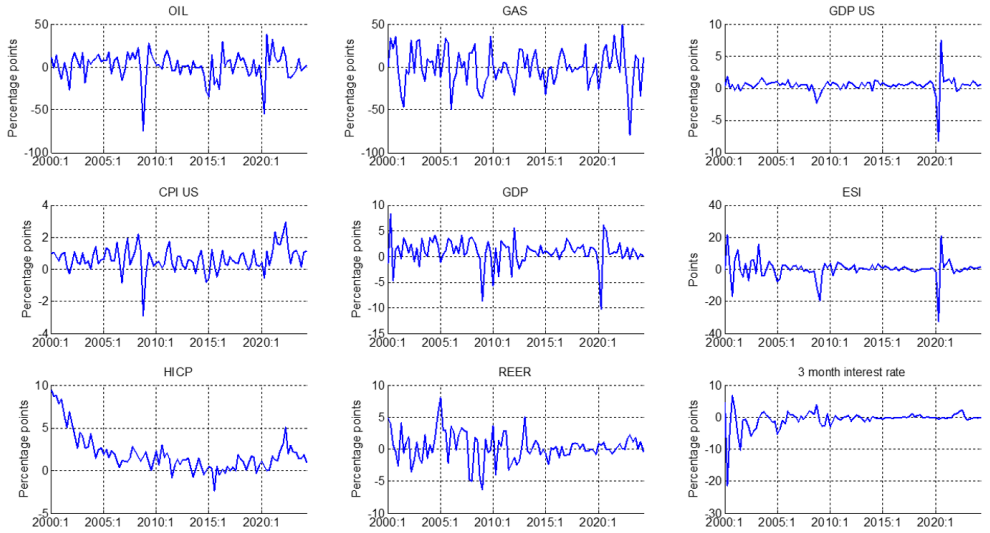

Figure A3: Romania: transformed data

Table A2: Median percentage difference to no-war counterfactual by 2022Q4 obtained with the 5-lag model. 68% confidence bands in brackets

Countries	**HICP**	**GDP**
BG	-0.64%	0.59%
	[-2.58%, 0.31%]	[-0.34%, 2.13%]
CZ	-1.10%	0.85%
	[-3.50%, 0.12%]	[-0.40%, 3.02%]
HU	-0.63%	0.80%
	[-2.72%, 0.53%]	[-0.50%, 2.83%]
PL	-0.54%	0.76%
	[-2.45%, 0.18%]	[-0.41%, 2.63%]
RO	-0.88%	1.36%
	[-3.10%, 0.16%]	[-0.42%, 4.39%]

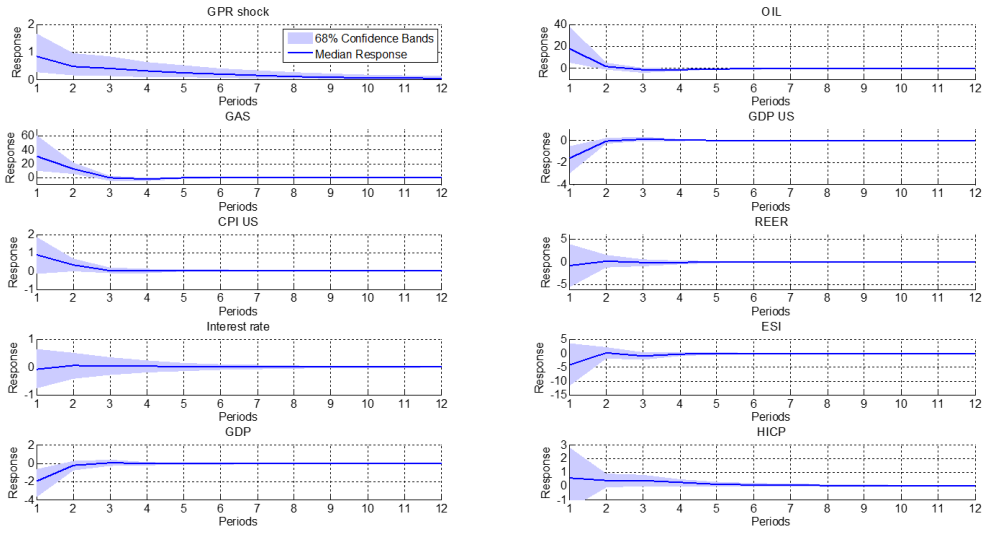

Figure A4: Impulse responses to a geopolitical conflict shock (Czech Republic - sign restrictions)

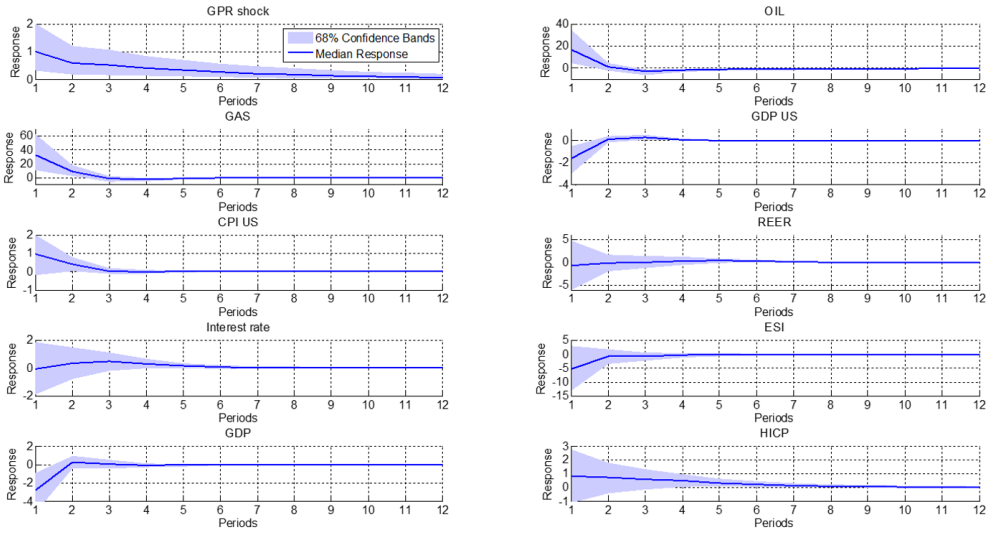

Figure A5: Impulse responses to a geopolitical conflict shock (Hungary - sign restrictions)

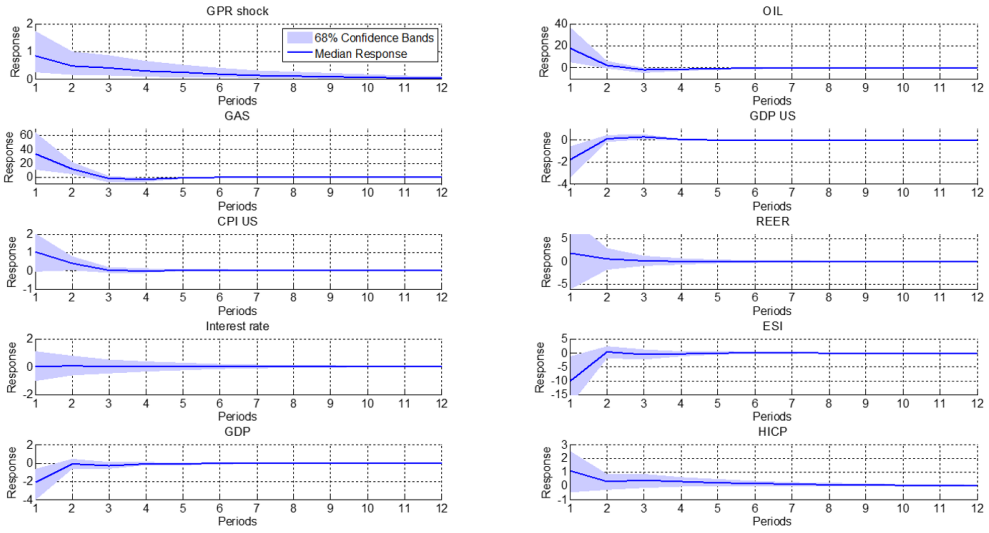

Figure A6: Impulse responses to a geopolitical conflict shock (Poland - sign restrictions)

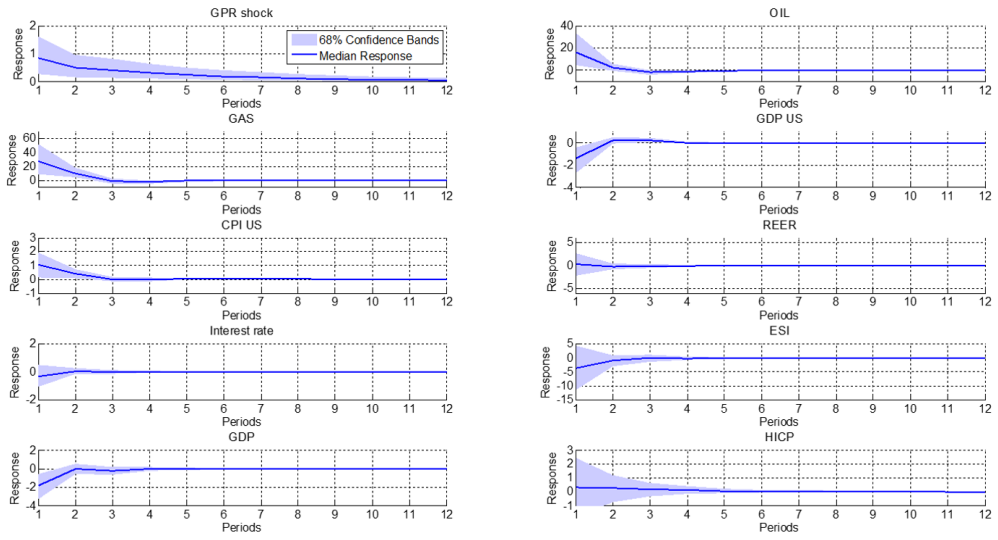

Figure A7: Impulse responses to a geopolitical conflict shock (Bulgaria - sign restrictions)

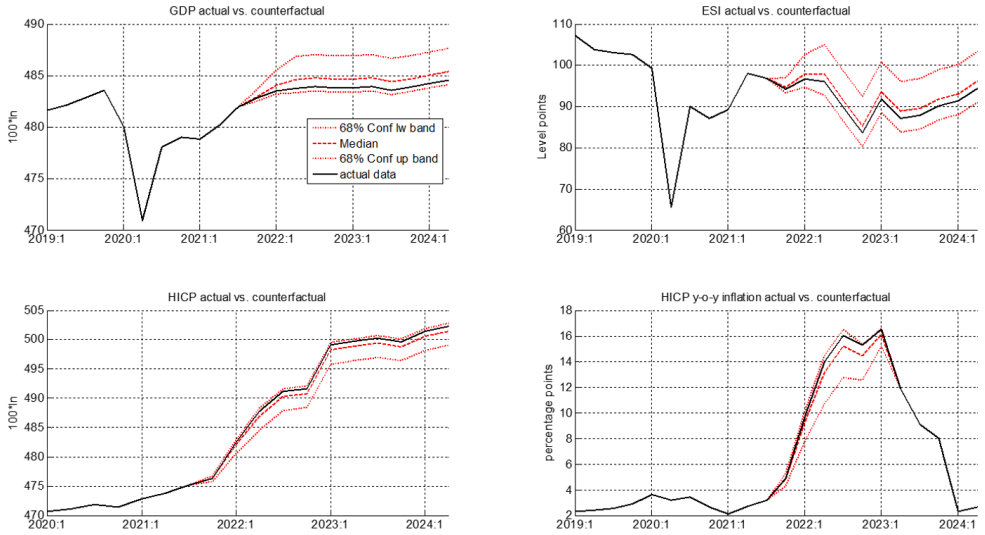

Figure A8: Czech Republic: Counterfactual series if Russia had not invaded Ukraine

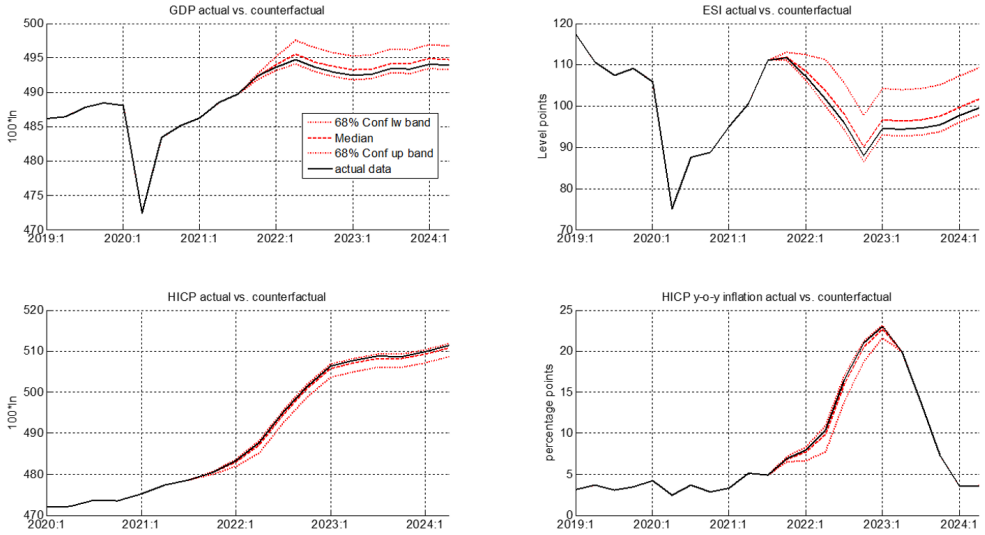

Figure A9: Hungary: Counterfactual series if Russia had not invaded Ukraine

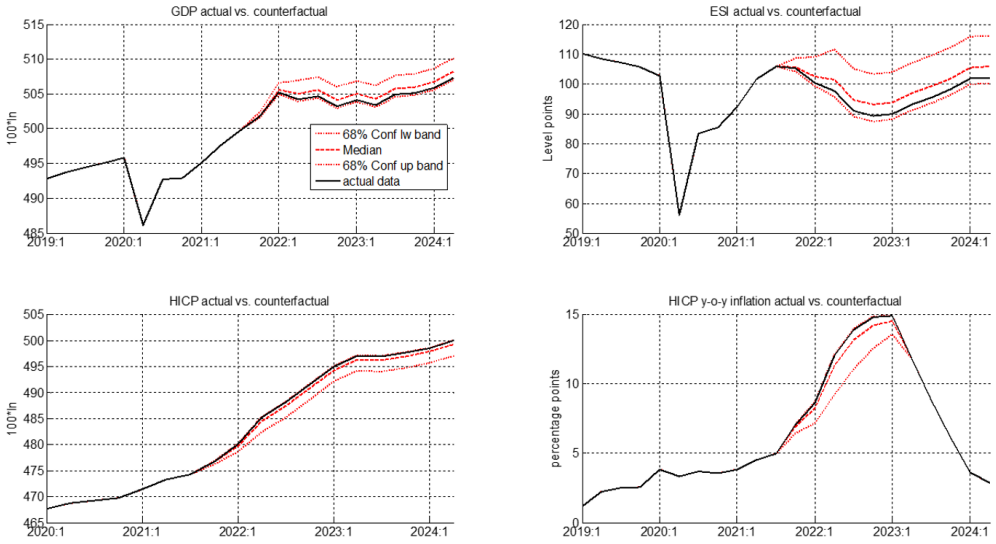

Figure A10: Poland: Counterfactual series if Russia had not invaded Ukraine

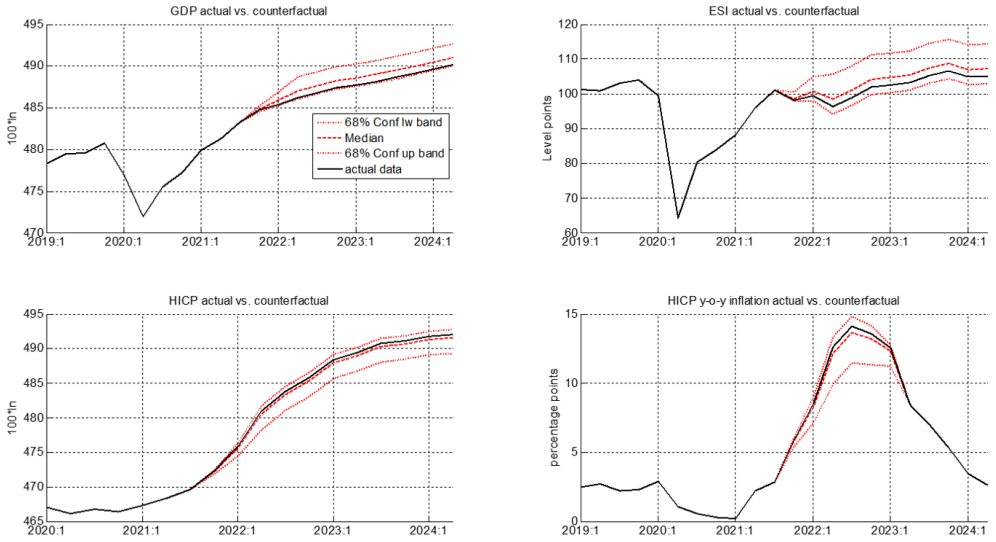

Figure A11: Bulgaria: Counterfactual series if Russia had not invaded Ukraine