

Trade Resilience of Central and Eastern European Countries to the Shock Caused by the Russia-Ukraine War

Joanna Kos-Labedowicz ^{1*}, Sylwia Talar ²

¹ University of Economics in Katowice, Poland
ORCID: 0000-0002-9523-9609
e-mail: joanna.kos@ue.katowice.pl

² University of Economics in Katowice, Poland
ORCID: 0000-0002-4051-6453
e-mail: sylwia.talar@ue.katowice.pl

* Corresponding author: Joanna Kos-Labedowicz, joanna.kos@ue.katowice.pl

Abstract

The instability of the world economy in the 21st century demands that more interest be paid to the nature of emerging disruptions, their effects, and the ways to ensure the appropriate reactions of affected parties. Research on the economic resilience of various kinds is more prominent as a result, with certain exceptions—trade resilience studies are among those that require more attention, both theoretically, methodically, and empirically. Recent trade resilience studies have focused mostly on the effects of the shock caused by the COVID-19 pandemic, either on a global scale or a particular country scale. The goal of our study is to examine how the external shock caused by the Russia-Ukraine war influenced the trade resilience of Central and Eastern European (CEE) countries. The methodology used in our research is an elaboration on and modification of approaches used by previous studies on both economic and trade resilience. On the basis of statistical data from the period 2016–2023, we propose the original Trade Vulnerability Index (TVI), adapted for the shock originating from the Russia-Ukraine war. For the resistance index used for measuring CEE countries' trade resilience, we applied a known but not previously implemented approach. The obtained results showed that all CEE countries' trade was resistant to the disruption caused by the armed conflict in the initial year, with few exceptions (Baltic States and Poland) in the following (2023) period. Even the trade of countries with high TVI scores (Slovakia and Czechia) has proven to be resilient. The main theoretical contribution of this study is the confirmation of the lack of dependence between the vulnerability of trades to disruptions and their resistance to war in the example of war shock and CEE countries. The implications of the obtained results can be helpful in developing nation-specific policies to increase trade resilience and the effectiveness of structural changes.

Key words

trade resilience, trade vulnerability, external shock, Russia-Ukraine War, Central and Eastern European Countries, composite indices.

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Introduction

The instability of the world economy in the 21st century is determined not only by economic factors but also by natural and political shocks. These include, first and foremost, the COVID-19 pandemic, Russia's aggression against Ukraine, and the escalation of political tensions between the world's major powers and the conflict in the Middle East. Figure 1 shows the changes in the World Uncertainty Index in connection with phenomena that contribute to the growth of uncertainty and instability.

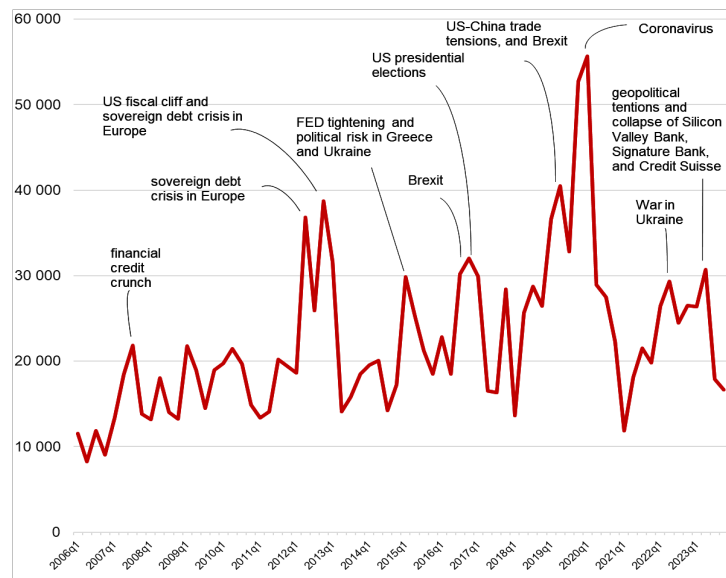


Figure 1. World Uncertainty Index 2006Q1 to 2023Q4.

Source: Ahir et al., 2022.

In turbulent, uncertain times, when rapid changes are taking place and violent shocks are occurring, the interest of both practice and science is focused on issues related to coping with these difficult times and building security and stable development (Atkinson et al., 2022), of which economic resilience is a part. Focusing our research on the nature of emerging shocks, their economic effects, the response of socioeconomic systems to them, and the factors determining their behaviour seems to further this common interest.

The economic shocks caused by the COVID-19 pandemic and the conflict in Ukraine have renewed the debate on the benefits and risks of international trade (Arriola et al., 2024). The situation of uncertainty has implications for international trade, which, under the current high degree of interdependence, is crucial for the development and even the normal functioning of entire national economies. Consequently, the resilience of foreign trade to disturbances has become a subject of particular interest. In the analysis of trade resilience, the main goal is to identify how shocks affect the functioning of trade and what dependencies exist in this process. Owing to the diverse natures (types) and scales of shocks, their impacts may also vary. On the other hand, individual economic systems, including international trade, may react differently to these shocks depending on their type and, for example, may be resilient to some shocks and not to others. Trade resilience studies should therefore consider the specifics of a particular disturbance and the system whose resilience is being analysed. We assume that shocks that cause international trade disruption are diverse in nature and scope. Consequently, their effects, although negative for world trade, will vary depending on the specific type of shock, and individual countries will experience them to different extents.

Most of the studies related to trade resilience are relatively new and tend to address the disruption caused by the COVID-19 pandemic shock, referring to international trade or the exports and/or imports of individual countries. Despite the growing number of studies on the impact of conflicts in Ukraine on international trade, there are still significant gaps identified by Paryan & Hashfi (2023). This research gap is related to the lack of studies referring to trade resilience and the focus on either Western European states or the participants in the conflict themselves. These two issues are considered in our study. The authors' review of the literature also pointed to existing ambiguities in defining trade resilience and the possibility of measuring it. A critical analysis of the available and hitherto used methods of measuring trade resilience indicated the need to modify existing tools and propose new tools, which has been done and is an additional contribution to our work.

The aim of this study is to assess the resilience of Central and Eastern European (CEE) countries' trade to external disturbances, using the example of a shock caused by Russia's war with Ukraine. The resilience of both the exports and imports of CEE countries will be examined. The countries of the

CEE region, including Bulgaria, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, and Slovakia, were selected for the study because of their location (geographical proximity), historical ties and psychological distance from the countries involved in the conflict. Consequently, the countries analysed are among the most vulnerable to the disruption caused by Russia's war with Ukraine. Moreover, the selected countries share similar economic, political, and historical characteristics. They share a common history of being part of a bloc of socialist states, with the Baltic States being part of the Soviet Union. Today, these countries, despite some differences, are at a similar level of development, are all members of the European Union (EU), share similar institutional characteristics and are relatively similar in size, i.e., belong to the group of small and medium-sized economies.

Our study is preliminary and characterizes the trade responses of CEE countries to disruptions caused by a regional shock of a political nature and the relationship between the ability of these countries to resist and the objective vulnerability of their trade to such a shock. The research questions posed are as follows:

1. What is the trade resilience of CEE countries to a war shock in the region?
2. Is there a relationship between the resilience of trade to disturbances caused by a war shock and the vulnerability of CEE countries to this type of shock?
3. Do CEE countries differ in terms of their vulnerability to a war shock in the region?
4. Do the results of resilience, vulnerability, and the relationship between them differ for exports and imports?

The analysis included statistical data on the value and structure of the foreign merchandise trade of CEE countries from 2016–2023. The study of the resilience of CEE countries' trade to the shock caused by the Russia–Ukraine war includes, in order, the following stages: 1) operationalization and calculation of the composite Trade Vulnerability Index to the war shock, respectively, for exports and imports of the analysed countries; 2) calculation of the Resistance Index also separately for exports and imports of these countries; and 3) examination of the correlation between vulnerability and resistance and testing its statistical significance. The results obtained allow us to determine the vulnerability to trade disturbances and the resilience of CEE countries in the period under study to disturbances caused by the economic shock related to the war in Ukraine.

The paper is structured as follows: Section 1 presents a literature review on economic shocks (1.1) and resilience, with a particular emphasis on problems of definition (1.2). Section 2 is devoted to methodological issues, especially the applied modifications resulting in the development of the trade vulnerability index and the adopted method for measuring trade resilience. Section 3 presents the obtained results, which are discussed in more detail in Section 4. Section 5 summarizes and indicates further directions for research.

1. Literature review

1.1. *Shocks – nature and their effects*

In economic terms, a shock is an unforeseen event that has positive or negative consequences for the economy (Fahad & Abdurrazzaq, 2022). A shock is assumed to be an unforeseen (unplanned) singular or short-term event affecting the environment/economy on a large scale (Fahad & Abdurrazzaq, 2022). Another characteristic attributed to shocks, on which there is no consensus among researchers, is the source of the impulse causing the shock. Two main types of shocks are endogenous (caused within and affecting a particular economic system or sector) or exogenous (caused by factors outside the economic system or sector, such as a natural disaster or armed conflict). An approach linking the two can also be found in the literature, indicating that a shock caused by an exogenous factor (e.g., an armed conflict) triggers adjustment changes to new conditions (e.g., monetary, foreign, trade policy), which are endogenous in nature (Ramey, 2016). Economic shocks, owing to the nature of the impulse/factor causing them, are most often divided into demand, supply, political, financial, or technological shocks (Shevchenko, 2020).

In the contemporary global economy, which is a network of more or less tightly interconnected elements, economic shocks, regardless of their source or nature, tend to spill over to other elements of the interconnected system, with trade being one of the potential transition channels. Research conducted by the OECD (Arriola et al., 2024) indicates which sectors and countries, depending on their location in global value chains (GVCs), show greater resilience to the effects of disruptions originating from foreign shocks. Individual economic shocks can be characterized by their origin, nature, incidence of a disturbance, and scale, nature and duration thereof (Martin & Sunley, 2020; 2015), which allows for the assessment of, among other factors, their intensity, potential duration and aspects of the economy that were most affected by the shock.

An economic shock caused by an armed conflict first affects the actors involved and then spreads to varying degrees to other parties. In either case, it is an exogenous shock of a political nature, triggering the need to adapt to the resulting change in conditions, and can affect supply, demand, finance, etc. There are two strands of research in the literature on the links between economic performance and conflict (including armed conflict), most often examining how a conflict situation affects the economy of an area or the potential for spillover effects on neighbouring states/regions and how economic performance can lead to a conflict situation (Leepipatpiboon et al., 2023).

Russia's attack on Ukraine in February 2022 came as a shock to the global economy and prompted an immediate (March 2, 2022) response from the United Nations in the form of a declaration demanding the cessation of aggression (confirmed by a later declaration on October 12, 2022). Condemnation in the international public forum was quickly backed by the implementation of a series of economic sanctions on Russia by most OECD and EU countries (Darvas & Martins, 2022). On 24 June 2024, the EU adopted a 14th package of sanctions on Russia supplementing and tightening earlier measures (European Commission, 2024). The trade-related sanctions significantly restrict both Russia's access to specific groups of goods (especially products, technologies and services that may have military applications) and its ability to export to reduce its ability to finance the conduct of further military operations (European Council, 2024).

The shock of Russia's war with Ukraine, unlike the COVID-19 pandemic, is more long-lasting in nature. Since the outbreak of the war in February 2022, it has extended to at least 2023. Studies conducted on its impact on the global economy indicate, among other things, a deterioration of macroeconomic conditions and global financial stability (Tong, 2024), international food production and availability (Laber et al., 2023), commodity markets and energy commodity prices (Aizenman et al., 2023; Ozili, 2024), stock markets (Czech et al., 2023) and many others. The sheer number of studies on the impact of Russian military action in Ukraine on international trade is so large that systematic literature reviews in this area are already available, pointing to existing research gaps. An important research gap is the focus on specific sectors or product groups and individual countries and the lack of a more systematic approach to studying changes and adjustments in trade flows in response to the shock of military action in Ukraine (Paryan & Hashfi, 2023). Our study on the trade resilience of the CEE region to the shock of armed conflict aims to address this research gap, as it focuses on a certain region and potential changes in trade flows.

1.2. Resilience—the interpretation and dimensions of resilience

In the context of emerging shocks, disruptions or disturbances, interruptions and perturbances, resilience is one of the main categories used to describe the characteristics of systems or organisms affected by them. The concept of resilience is used in different scientific fields and has no uniform interpretation. Martin & Sunley (2020; 2015), Rose (2017) and Pendall et al. (2009) explore concepts of resilience, including engineering, ecological, extended ecological, psychological, geographic, disaster, political, social (human communities), organisational and planning approaches. They also pointed to changes in the meaning of the concept over time and the uncertainties that are associated with the interpretation of some of the definitions used. As Fisher (2015) noted, there are at least 70 different approaches to understanding resilience.

In a general sense, resilience means the ability to resist shock or disturbances. There are also many notions that can be used interchangeably or are closely synonymous with resilience, such as resistance, robustness, responsiveness, and volatility, and there is often a lack of clear delineation between them. For example, in complex adaptive system (CAS) theory, the concept of resilience does not appear at all, and the primary term is robust. However, resilience is the most popular concept used in the literature, and it was also adopted in our study. In economics, the interpretation of a notion of resilience draws from virtually all previously indicated scientific fields and is considered from both a macroeconomic and a microeconomic perspective, as well as combining both. In this area, too, there is 'no universally agreed' (Martin & Sunley, 2015) or 'commonly accepted' (Montrimas et al. 2023) definition of resilience. Economic resilience research is most often undertaken in the fields of economic geography and regional studies. It concerns the entire socioeconomic system in a specific spatial dimension. Given the multifaceted nature of the concept of resilience, the key issue is to provide a precise interpretation of this notion. Trade resilience is very rarely the subject of conceptual elaboration and empirical research compared with, for example, economic resilience, as is clearly pointed out by Mena et al. (2022) and Shahnazi et al. (2023). Therefore, our work has also contributed to the conceptualization of this notion and its operationalization.

Mena et al. (2022), examining the impact of the COVID-19 pandemic on international trade, define a country's trade resilience as 'a country's ability to both resist disruptions to international trade and recover from disruptions', adopting the concept proposed by Melna et al. (2022) for studying supply chain resilience. In this approach, two distinctive but complementary aspects of resilience are included. The first, called robustness (Mena et al., 2022) or resistance (Melnyk et al., 2014), means the ability to resist a disruption and minimize the impact of a shock, and the second, called responsiveness (Mena et al., 2022) or recovery (Melnyk et al., 2014), is understood as the ability to recover after a shock and return to functionality. In this approach, the impact of the shock is divided into two phases, where the first (initial) covers the period of impact (duration) of the shock and the second the period after its disappearance (after disruption). A study by Mena et al. (2022) covered the impact of macroeconomic factors on trade dynamics during the COVID-19 pandemic. A more comprehensive definition of trade resilience, which is based on Martin & Sunley's (2020) approach, is employed in the analysis of Polish export resilience against noneconomic external shocks (Talar, 2023). In this study, four dimensions of resilience are taken into account, i.e., resistance, responsiveness, adaptability and transformation. The first three types of resilience were subjected to empirical analysis on the basis of export dynamics, similar to the study by Melnyk et al. (2014).

In an even more holistic approach presented by Martin & Sunley (2020; 2015), resilience is treated as a process consisting of the following elements: vulnerability, shocks, resistance, robustness, and recoverability. Vulnerability, understood as the sensitivity or propensity of a system to a shock (Martin & Sunley, 2015), undoubtedly has a significant effect on resilience. Resistance in this process approach concerns the scale of the system's response to shock and has a quantitative dimension. Robustness, on the other hand, refers to the extent of adaptive change, particularly structural change that occurs over a somewhat longer period of time. Recoverability refers to a return to the preshock or the new reference state and is identifiable over a longer period of time after the disturbance has ceased. As Martin & Sunley (2020) noted, with the prolonged duration of the disturbance caused by the shock but also depending on the intensity of the shock, conditions are created for adaptive actions to occur in the direction of system readjustment. These changes aim at a flexible adaptation of the system to the new conditions created by the shock and have the characteristic of adaptive changes. This interpretation of resilience is referred to as 'adaptive resilience' in the literature and is found, among others, in behavioural psychology (Wright et al., 2013) and is part of the complex adaptive systems (CAS) theory applied to different types of systems (Jen, 2023). Rose & Krausmann (2013) propose a similar definition of economic resilience, but they introduce the term 'static resilience' as the ability of systems to maintain their functions during shock and 'dynamic resilience' in reference to the efficient allocation of resources for repair and recovery following disruption.

Economic vulnerability to shock refers to the exposure of a country to external shock arising from intrinsic inherent, permanent, or quasipermanent features of the economy (Briguglio, 2016; Briguglio & Galea, 2003). The heterogeneity of individual economies means that they are sensitive to emerging disturbances to varying degrees. There is an assumption that economies that are less vulnerable are more resilient (Fingleton et al., 2012), yet research by Briguglio (2016) indicates that even with high levels of vulnerability, economies can, through the pursuit of appropriate policies, also be resilient to disturbances. Vulnerability, however, increases the risk of disturbances in the economy caused by external shocks but does not determine resilience, which also depends on the nature of the implemented policy (policy-induced) (Briguglio & Galea, 2003).

2. Methodology

In our study of trade resilience to the shock of Russia's war with Ukraine, we adopt the approach of Martin & Sunley (2020; 2015). As only data up to 2023 can be included and we are still in the midst of the disruption induced by the still ongoing hostilities and the introduction of further trade sanctions, we cannot include an element of robustness and recovery after the shock in our study. We therefore interpret trade resilience as vulnerability to shock and resistance against it, i.e., as the ability of a country to maintain its performance of exporting and importing against disruption (so-called 'absorptive resilience').

In studies of the vulnerability of the economy to external shocks, Briguglio (2016) and Briguglio et al. (2009) constructed a composite index of "economic vulnerability". This index consists of four components: trade openness, export concentration, dependence on strategic imports and proneness to natural disasters. Owing to the occurrence of shocks of different natures and magnitudes, the vulnerability of a system to a given type of shock may be influenced by different factors. Moreover, the determinants of vulnerability depend on the specifics of the system under analysis (Ram et al., 2019). In the analysis of the economic resilience of CEE and Black Sea countries from a defence perspective, variables such as trade partner concentration, the share of selected partners in trade, the trade balance, and, in the area of 'trade dependence', indicators characterizing the product structure of trade and, in particular, reliance on strategic goods in foreign trade are mentioned as determinants of foreign trade vulnerabilities (Constantinescu, 2023).

When examining the trade vulnerability of countries to war shocks, we have to adjust the components (variables) of the index according to this specific case. For the purpose of constructing our composite trade vulnerability index (TVI), we adopted methods and procedures described by the OECD (2008), Mazziotta & Pareto (2013) and Guillaumont (2009). In the first step, we identify and select quantitative variables appropriate for describing trade vulnerability against war shocks. We then normalize the selected variables while taking into account the direction of their influence on the created index. In the next step, we assign weighting coefficients to the adopted variables. The procedure ends with the aggregation and calculation of composite indices for each country.

The TVI is calculated separately for exports (ExVI) and imports (ImVI). On the basis of the literature review, we selected the following four variables as determinants of CEE countries' trade vulnerability to the shock of Russia's war against Ukraine:

- 1) exports and imports to/from Russia and Belarus as percentages of total exports ($R+B_{ex}$) and imports ($R+B_{im}$) of reported countries, respectively
- 2) trade partner concentration ratio ($CR3_c$), i.e., three main leading markets for exports ($CR3_{c_{ex}}$) and imports ($CR3_{c_{im}}$) as shares of total reporting countries' exports and imports, respectively
- 3) concentration ratio for the product structure of trade ($CR3_p$), which is calculated as the share of the three largest commodity groups in the total reporting country's exports ($CR3_{p_{ex}}$) and imports ($CR3_{p_{im}}$) (i.e., sectoral specialization).
- 4) product complexity, estimated via the product complexity index (PCI) for $CR3_p$ for imports (PCI_{im}) and the economic complexity index for exports (based on a country's export basket)

(PCI_{ex}) on the basis of data and methodology developed by Harvard Growth Lab (Hausmann, 2013; Growth, 2024).

The inclusion of the shares of Russia and Belarus in the trade of the analysed countries as components of the TVI results directly from the specificity of the studied shock. As a result of Russia's attack on Ukraine and the continuation of military operations against that country and the emergence of a kind of alliance between Russia and Belarus, these two countries became sources of regional shock or even geopolitical disturbances. As a result, Russia and Belarus are subject to trade sanctions by most countries, particularly the European Union and the USA (Darvas & Martins 2022). Therefore, their share in the reporting trade of CEE countries is highly important for their vulnerability to this shock.

The next variables selected for the TVI are concentration ratios, which are related to the dependency of a country on a few major partners and products and are commonly used in vulnerability analyses. This approach is also based on research confirming the importance of concentration for resilience as a result of the emergence of high dependence on trade with a limited number of trading partners as well as trade with a limited number of products (Briguglio & Galea, 2003; Haddad et al., 2013; Rodrik, 1998; Caselli et al., 2020).

The inclusion of the product complexity variable in the construction of the TVI results from relatively new research confirming the importance of economic complexity in reducing vulnerability by reducing dependence on a narrow range of products, in conjunction with the ability to introduce new products affecting the diversification of the conducted activity (Balland et al., 2023; Hausmann et al., 2021). The product complexity index we adopted is based on the number of countries that produce a given product and their economic complexity. A high level of this indicator indicates that only a few highly complex countries produce a given product. In exports, this will reduce vulnerability, whereas in imports, it will increase exposure to disturbances in trade.

The selected TVI component variables were then normalized via the Max-Min method, which is often used in the construction of these types of indices (e.g., Briguglio, 2016). All the variables after this normalization take an identical range of values between 0 and 1. We use a popular formula for this transformation, which is for stimulants:

$$z_{ij} = (x_{ij} - \text{Min}x_j) / (\text{Max}x_j - \text{Min}x_j) \quad (1)$$

and for destimulants:

$$z_{ij} = (\text{Max}x_j - x_{ij}) / (\text{Max}x_j - \text{Min}x_j) \quad (2)$$

where z_{ij} is the normalized value, x_{ij} is the current input value (observed variable) for country i and component j , and Min , Max are the minimum and maximum values among the analysed observations (Zeliaś, 2002).

To weight the importance of the four selected variables, we choose the most commonly used technique, equal weighting (OECD, 2008). To calculate the TVI value, we use a linear aggregation procedure and arithmetic averaging.

The TVI is calculated for 2021 as the year before the shock. Data for all component variables are taken from The Atlas database (The Growth, 2024). The variable CR3p was calculated for commodity groups at the level 4 digit HS product classification (the Harmonized Commodity Description and Coding System referred to as the 'Harmonized System'). The correlation between the TVI components was examined to verify the validity of their selection; the lack of statistically significant high-strength relationships between the ExVI and ImVI components (Table 1) confirms the validity of their selection.

Table 1. Correlation of the TVI component variables.

	(R+Bex)	CR3c_ex	CR3p_ex	PCl _{ex}	(R+Bim)	CR3c_im	CR3p_im	PCl _{im}
(R+Bex)	1	-0.688	-0.291	-0.476	0.825	-0.096	0.440	-0.569
CR3c_ex		1	0.309	0.648	-0.600	0.675	-0.254	0.712
CR3p_ex			1	0.626	-0.274	0.532	0.436	0.705
PCl _{ex}				1	-0.669	0.715	0.004	0.871
(R+Bim)					1	-0.310	0.604	-0.549
CR3c_im						1	0.056	0.666
CR3p_im							1	-0
PCl _{im}								1

Source: Own elaboration on the basis of WTO (2024), The Growth (2024).

To measure resistance, a reference state (or reference position) is needed, understood as a certain level or trend of changes in the variable describing the behaviour of the system under study. We operationalize the concept of resistance on the basis of the absolute effects of the shock. This is an alternative and oppositional approach to the comparative or relative measure of resilience, which is estimated by comparing the performance of the system under study to a selected average (particular system-wide shock, e.g., nationwide shock) or the performance of other systems. Here, the reference position is often the national benchmark. These relative measures are often used in regional studies for both economic resilience (e.g., Martin et al., 2016; Martin & Gardiner, 2019) and trade resilience (Li et al., 2024; Arbolino et al., 2023). Among the few trade resilience studies, attention should be given to the analysis by Luo et al. (2023), which uses an absolute measure of ‘absorptive resilience’ (although it is defined as robustness rather than resistance) and calculates the resilience indices for exports and imports separately. In this study, the average trade growth rate of the two years preceding the shock was used as the reference position. We used a different approach, which is based on the trend of changes in the value of trade turnover.

To assess absolute trade resilience, we construct the resistance index (RESIS) as a singular measure and rely on the methods of Martin & Sunley (2015). The reference position in this index is a hypothetical trade value forecasted via an autoregressive time series model of the preshock growth path. The RESIS index represents the ratio of the value of trade (exports or imports) achieved by a given economy during a shock or disturbance to the value of the reference position at the same time. We construct the RESIS index separately for exports and imports. To the best of our knowledge, this is the first study of trade resilience in absolute terms using a preshock growth path as a reference position. The formula of trade resistance for exports is as follows:

$$RESIS_c^{Ex} = \frac{Ex_c^{ts}}{Ex_c^e} \quad (3)$$

and correspondingly for imports:

$$RESIS_c^{Im} = \frac{Im_c^{ts}}{Im_c^e} \quad (4)$$

where Ex_c^{ts} and Im_c^{ts} refer to the export and import values of country c , respectively, at time t during shock s , whereas Ex_c^e, Im_c^e represents the expected value of exports and imports at time t_s , which is estimated on the basis of the preshock path growth of exports and imports. A RESIS index value is centered at approximately 1 and, if it is equal to or greater than 1, indicates resistance (resilience) of the exports or imports of a country in the face of a shock; if it is less than 1, it indicates that it is not resistant, i.e., the export or import value in the year during a shock is lower than expected according to the preshock trend line.

The advantage of this approach to resistance testing is that it is an appropriate benchmark for each economy on the basis of differential trends in foreign trade development compared with relative estimates on the basis of a ratio to the average of, for example, a selected group of countries. The

results of this index are influenced by the choice of preshock period of study, but this is a limitation that also occurs in all relative measures. We used international trade time series data covering the 2016–2023 period to calculate the *RESIS* index. The export and import value data include only goods (merchandise trade) and come from the WTO database (WTO, 2024). To estimate the preshock growth path via the autoregressive time series model, we chose the period from 2016–2021. Although there was a shock from the COVID-19 pandemic during this period and therefore a decline in international trade in 2020, in 2021, this decline was compensated for by an increase in world trade, and this shock can be treated as some eventually balanced disturbance in the growth path. In turn, 2016, as the beginning of the period, was chosen because of the decline in the value of trade in 2015 and is the year in which the trend changed; therefore, it can be considered to mark the beginning of a new trend in trade growth after the disturbances in 2015–2016.

3. Research results

The calculations of the export and import vulnerability indices for the CEE countries and their *RESIS* indices are presented in Table 2, while Table 3 contains descriptive statistics of both the vulnerability variables and the *RESIS* index.

Table 2. Trade resilience of CEE in terms of vulnerability (ExVI, ImVI) and resistance index (*RESIS*) for exports and imports.

Country	ExVI	ImVI	<i>RESIS</i> _c ^{Ex}		<i>RESIS</i> _c ^{Im}		Trade <i>RESIS</i> ¹	
	2021		2022	2023	2022	2023	2022	2023
Bulgaria	0.35	0.15	1.15	1.05	1.19	1.04	1.17	1.05
Czechia	0.37	0.59	1.02	1.04	1.06	0.99	1.04	1.01
Estonia	0.45	0.71	0.98	0.81	1.06	0.88	1.02	0.85
Hungary	0.27	0.41	1.02	1.04	1.10	0.98	1.06	1.01
Latvia	0.54	0.62	1.08	0.95	1.14	0.99	1.11	0.97
Lithuania	0.48	0.50	1.08	0.93	1.17	0.98	1.12	0.96
Poland	0.39	0.35	0.99	0.99	1.05	0.96	1.02	0.97
Romania	0.33	0.35	1.07	1.07	1.08	1.02	1.07	1.05
Slovakia	0.49	0.72	1.00	1.05	1.04	1.01	1.02	1.03

Note: ¹ trade *RESIS* is the simple average of *RESIS*_c^{Ex} and *RESIS*_c^{Im}.

Source: Own elaboration on the basis of WTO (2024), The Growth (2024).

The *RESIS* results indicate that both export and import resistance were lower on average in 2023 than in 2022 (Table 3).

Table 3. Descriptive statistics of the variables of vulnerability (ExVI, ImVI) and resistance (*RESIS*).

Indices	Mean	Std.Dev.	Min	Max
ExVI	0.41	0.08	0.27	0.54
ImVI	0.49	0.18	0.15	0.72
<i>RESIS</i> _c ^{Ex} 2022	1.04	0.05	0.98	1.15
<i>RESIS</i> _c ^{Ex} 2023	0.99	0.08	0.81	1.07
<i>RESIS</i> _c ^{Im} 2022	1.10	0.05	1.04	1.19
<i>RESIS</i> _c ^{Im} 2023	0.98	0.04	0.88	1.04

Source: Own elaboration on the basis of WTO (2024), The Growth (2024).

The averaged indices also show that only in 2023 did CEE countries show a lack of resistance, and in 2022, only Estonian and Polish exports were not resistant (Table 2 – a *RESIS* index value below 1, marked in red, indicates a lack of resistance). Compared with exports, imports had lower resistance in 2023. In terms of shock vulnerability, significantly greater volatility among CEE countries occurs with respect to imports than with respect to exports (Table 3).

In exports, above-average vulnerability was shown primarily by the Baltic countries, with Slovakia additionally in this group (Figure 1 and Table 2). Despite the relatively high vulnerability of Slovakia's exports to war shocks, it has also shown high absorption resistance to these disturbances (Table 2).

Slovakia is therefore a country that stands out in this respect. Poland, on the other hand, is the only country with a lack of export resistance (Table 2) among countries with below-average vulnerability (Table 3).

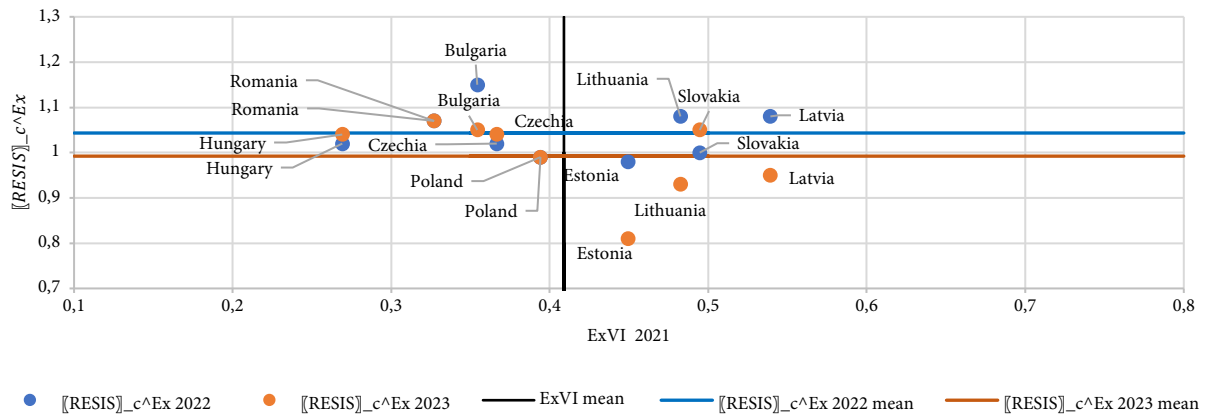


Figure 1. $RESIS_c^{Ex}$ and ExVI for CEE countries.

Source: Own elaboration on the basis of WTO (2024), The Growth (2024).

Countries with above-average import vulnerability included the Baltic States, Slovakia and, additionally, Czechia (Figure 2). In 2023, the imports of these countries, with the exception of Slovakia, also showed a lack of resistance. From the group of economies with lower vulnerability to the impact of war shocks on imports, Poland again showed a lack of resistance but was joined in this case by Hungary. In imports, the best vulnerability and resistance results were achieved by Bulgaria (Table 2).

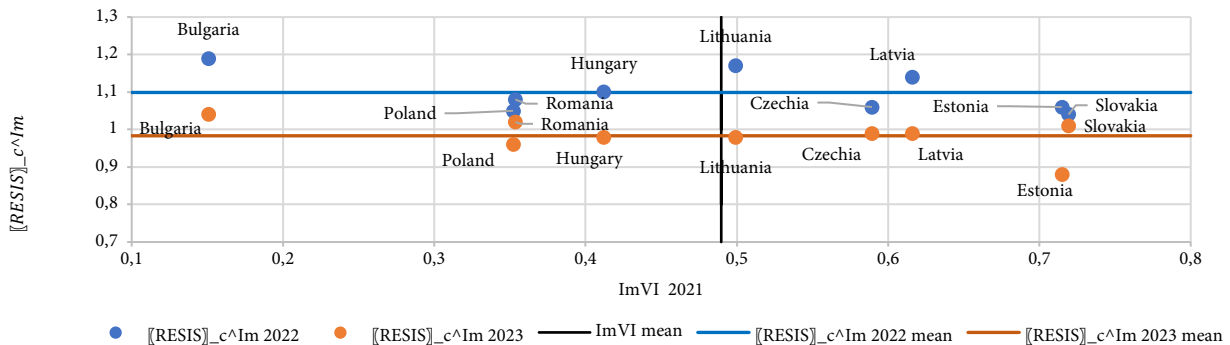


Figure 2. $RESIS_c^{Im}$ and ImVI for CEE countries.

Source: Own elaboration on the basis of WTO (2024), The Growth (2024).

In summary, several characteristic and distinctive groups can be identified among the CEE countries:

- the Baltic countries, which are both highly exposed to the impact of the war shock on their trade and do not have sufficient ability to rebound from this shock, especially in exports;
- Slovakia and Czechia, which are characterized by high vulnerability but also high resistance;
- Poland and partly Hungary (in particular in imports), which are not so exposed to shock, but their resistance results, especially those of Poland, are weak;
- Bulgaria and Romania stand out in terms of both low vulnerability and resistance. This grouping, as it turns out, largely corresponds to the division of these countries on the basis of geographical–political–historical factors. However, this relationship needs to be examined to determine whether it is merely coincidental.

To test the potential links between vulnerability indicators and import and export resistance, a Pearson's coefficient correlation analysis was conducted for two different levels of significance, and the results are presented in Table 4.

Table 4. Pearson coefficient across CEE countries between resistance (RESIS) and vulnerability (TVI) for exports and imports

	ExVI	ImVI	RESIS ^{Ex} _c _2022	RESIS ^{Ex} _c _2023	RESIS ^{Im} _c _2022	RESIS ^{Im} _c _2023
ExVI	1.000	0.648	- 0.050	- 0.524	0.064	- 0.220
ImVI		1.000	- 0.613	- 0.488	- 0.495	- 0.519
RESIS ^{Ex} _c _2022			1.000	0.305	0.893**	0.678*
RESIS ^{Ex} _c _2023				1.000	- 0.010	0.872**
RESIS ^{Im} _c _2022					1.000	0.390
RESIS ^{Im} _c _2023						1.000

Note: * = significant at $\alpha=0.05$ (bilateral), ** = significant at $\alpha=0.01$ (bilateral),

Source: Own elaboration on the basis of WTO (2024), The Growth (2024).

The results of the correlation analysis of the vulnerability and resistance measures used and the testing of their statistical significance (Table 4) indicate the following:

- fairly strong and statistically significant (at the $\alpha=0.01$ level) relationships between export and import resistance in 2022 and 2023 and moderate and statistically significant (at the $\alpha=0.05$ level) relationships between export resistance in 2022 and import resistance in 2023;
- no statistically significant relationship between export resistance in 2022 and 2023 and, similarly, for imports;
- no statistically significant relationship between export and import vulnerability;
- there is no statistically significant relationship between resistance and objective vulnerability for exports in both years studied, and there is a similar relationship for imports.

4. Discussion

The correlation analysis of the RESIS and TVI indices revealed no statistically significant correlation between the export resistance of CEE countries and the exposure of their exports to the shock caused by the war between Russia and Ukraine, as well as their imports in both years studied, which is consistent with the results obtained by Steinbach (2023) regarding the impact of this conflict on the relocation of global trade flows, which mainly affected the parties directly involved in the conflict and, to a limited extent, other countries. The results indicate that there is no correlation between resistance and vulnerability, which can be considered to be in line with the results of Briguglio's (2016) study on economic resilience, which indicated that despite high vulnerability, countries can be characterized by high resilience as 'a result of resilient-conditional policies'. Thus, trade resilience, understood as absorptive resilience and the ability to maintain trade performance, is influenced by the internal conditions of individual countries, including macroeconomic factors and actions taken at the firm level. We assume, therefore, that the achievement of higher-than-average resistance scores with a higher objective vulnerability to disruption is the result of endogenous actions occurring simultaneously with disruption to reduce negative effects, which may relate primarily to the redirection of trade to other geographic markets, including not only diversification but also trade concentration, particularly when we increase sales in markets where we are already present and where there is high demand or supply. Slovakia's high vulnerability to trade distortions is due to its economy's high dependence on trade links with Germany (Baláž & Hamara, 2016), but it did not translate into the lack of trade resilience of this country.

All CEE countries showed trade resilience in 2022; in a few cases (Baltic States and Poland), the decrease in resilience did not occur until 2023. The results obtained can be justified in several ways. First, the (regional) war shock was not strong enough, especially in 2022, to disrupt the trade turnover of the countries in the region, and given the 12.2% increase in the value of world exports in 2022

(WTO, 2024), it should also be assumed that it did not significantly affect the other partner countries of CEE countries. It was only in 2023 that there was a decline in world trade turnover, which could have translated into the observed decrease in resilience for several CEE countries. Second, the trade effects of external shocks and disturbances are heterogeneous in nature, and many other factors also influence the reactions of the trading system. This means that sectoral and geographic concentration does not necessarily imply greater vulnerability to external disturbances, which, with respect to the impact of these structural factors on a country's income volatility, was confirmed by Caselli et al. (2020) in their research regarding the impact of these structural factors on a country's income volatility, thus justifying the often diverse results of empirical research in this area in the literature. The lack of a statistically significant relationship between indicators of product and partnership (geographic) structure diversification and production volatility and sales stability at the firm level in CEE countries during the 2009–2012 crisis was also shown by Čede et al. (2016) in their study.

The observed effects in the CEE trade regime under war shock conditions may also not match expectations because of the ineffectiveness of trade sanctions and the varying extent to which they are circumvented by individual countries, as indicated by both Steinbach (2023) for the current situation and the earlier sanctions imposed on Russia, which did not affect Czech exports (Coufalová, 2020). For the Baltic states, the observed lack of trade resilience in 2023 is in line with the trend observed by Veebel & Markus (2018) related to changes in their trade flows in earlier cases of Western countries imposing sanctions on Russia. The disruptions caused by the war shock are also compounded by other processes and phenomena causing instability that have been present in the global economy for a long time (such as, for example, the uncertainty of the political situation or increasing digitalization (Zhu & Ye, 2024)), affecting different actors in the global economy to varying degrees (Gorynia et al., 2024).

Conclusions

Like economic or regional resilience, trade resilience is a very complex concept influenced by many different factors (Martin et al., 2016, Martin & Sunlay, 2015; Mena et al., 2022). The obtained results allowed us to address the adopted research questions, indicating that regional wars may not have a significant effect on disturbances in the trade exchange of the countries of the region, regardless of whether they are strongly or weakly exposed to disturbances due to their product and partner concentration or/and the product complexity of traded goods. The shock of war caused an abrupt change in the situation, but in addition to the necessity of severing trade links with some countries, it also brought many opportunities and created possibilities for boosting exchanges with friendly countries that were also looking for new trade partners. Their flexibility, adaptability, and effectiveness may determine trade performance to the greatest extent and, therefore, the resilience of trade to this type of disruption. The impact of political shocks, especially regional shocks, may therefore differ significantly from the impact of economic shocks on trade.

The conducted study, in addition to answering the research questions regarding the resilience of the trade of CEE countries to disruptions resulting from the conflict in Ukraine, allowed the authors' innovative approach to measuring the resilience of trade to disruptions caused by an external shock of the Russia–Ukraine war to be tested. We used a methodological approach including two separate and original indicators (ExVI and ImVI) of trade vulnerability adapted to a specific shock for the selected region. Owing to the lack of such studies, our work has also contributed to the conceptualization of this notion and its operationalization. An additional adopted methodical modification is the use of an approach based on the trend of changes in the value of trade turnover as a reference position when examining the resilience of CEE trade. To the best of our knowledge, this is the first study of trade resilience in absolute terms using the preshock growth path as a reference position. The advantage of this approach to resilience studies is that a reference point is appropriate for each economy on the basis of differential trends in the development of foreign trade compared with relative estimates on the basis of the ratio to the average of, for example, a selected group of

countries. A thorough description of the adopted methodology allows it to be further modified and used for studies of other types of shocks or other regions, which can be helpful in developing nation-specific policies to increase economic resilience and structural reform effectiveness.

The limitation of the conducted study is the components adopted for the trade vulnerability index typical for this shock—they will need to be modified for other shocks. Another limitation is the short time adopted, which did not allow the study to include elements related to recovery after the shock and the focus on a small group of countries (only that particular region). Other limitations are the relatively large discrepancies in the product structure data (from several to a dozen or so per cent of the share of unclassified products and with differences in data), which may distort the structural data for the developed sensitivity indicators, and the inclusion of only the merchandise trade.

As a preliminary study, it opens the way for further considerations, including for example, studies involving more countries and comparisons for more shocks or different types of shocks. It is also worth considering changes to the methodology by including additional variables, for example, the product structure in the longer term or considering political and regulatory factors.

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