Received: 1 February 2023 | Revised: 1 November 2023 | Accepted: 3 November 2023

DOI: 10.1111/jors.12676

RESEARCH ARTICLE

JOURNAL OF REGIONAL SCIENCE WILEY

Socioeconomic impacts of Russian invasion of Ukraine: A multiregional assessment for Europe

Miguel Ángel Almazán-Gómez[1] | Carlos Llano[2] | Julián Pérez[3] | Daniel Rauhut[4]

[1]Departamento de Análisis Económico, Universidad de Zaragoza, Zaragoza, Spain

[2]Departamento de Análisis Económico: Teoría Económica e Historia Económica, Universidad Autónoma de Madrid, Madrid, Spain

[3]Departamento de Economía Aplicada: Econometría e Informática, Universidad Autónoma de Madrid, Madrid, Spain

[4]Centro de Estudos Geograficos, Universidade de Lisboa. R. Branca Edmée Marques, Lisboa, Portugal

Correspondence

Miguel Ángel Almazán-Gómez, Departamento de Análisis Económico. Universidad de Zaragoza, 50005 Zaragoza, Spain.
Email: malmazan@unizar.es

Funding information

Gobierno de Aragón; European Observation Network for Territorial Development and Cohesion; Ministerio de Ciencia, Innovación y Universidades; Comunidad Autónoma de Madrid

Abstract

History shows that wars can be enormously disruptive of economic activity, especially international trade, national income, and global economic welfare. This article analyzes the impact on the European regions the Russian invasion of Ukraine using the largest and most updated multiregional input-output model for Europe. Two shocks, trade and inflation, and four alternative scenarios are simulated. The scenarios are considered regarding the number of countries applying a trade embargo, the exemption of oil and gas, and the potential trade diversions with third countries such as China. We obtained a significant fall in GDP (−1.7%), 3.7 m lost jobs and 3% raise over the prewar inflation rate. For trade shock, large indirect effects are obtained, indicating the high relevance of the sectors and countries exposed to the war and the sanctions. The republics of the former Soviet Union, as well as the satellite countries of the former communism, face the harshest adverse impacts. This work shows the importance of breaking Russia's colonial economic ties to the countries in Eastern Europe.

KEYWORDS

Europe, inflation, multiregional analysis, Russia, socioeconomic impact, trade, Ukraine

1 | INTRODUCTION

Most OECD countries reacted to the recent Russian invasion of Ukraine by imposing powerful economic sanctions, targeting the Russian economy. However, economic history shows that wars can be enormously disruptive of economic activity, especially international trade, national income, and global economic welfare (Glick & Taylor, 2010). These two economies at war account only for around 2% of world's gross domestic product (GDP), but some recent analyses have drawn attention to the fact that the Russian and Ukraine economies have a prominent importance regarding certain strategic goods (Chepeliev et al., 2022; S&P Global Ratings, 2022).

Russia is one of the main suppliers of oil and gas to the European Union, especially in Germany and other Eastern European countries. It is one of the world's leading producers of nickel, an essential input for much of the aluminum, automotive, and other capital goods industries (Kapoor et al., 2022). It is the world's largest supplier of palladium (World Bank, 2022), an essential component in producing sensors, computers, and catalysts for the automotive industry. It is the third largest producer of titanium sponge with 13% of the world production (Gambogi, 2021), a relevant component for the aerospace industry and also used as an input in the manufacture of oil and gas, paper, and packaging processes. Moreover, Russia is a crucial supplier of fertilizers, being the world's leading producer of ammonium, nitrate, urea, nitrogen, phosphorous, and potassium (World Bank, 2022). For its part, Ukraine holds a strong position in the production and export of industrial and agricultural goods: (i) titanium sponge (4th largest producer in the world (Gambogi, 2021), as well as to produce inert gases necessary to produce semiconductors. (ii) Ukraine is the tenth largest exporting economy of agricultural products, highlighting its position in terms of cereal, sunflower oil, pigs, poultry, and butter (World Bank, 2022). It holds an important position as a supplier of food to emerging countries such as China (Chepeliev et al., 2022; S&P Global Ratings, 2022).

The sanctions adopted by most Western countries affect the fields of international trade in goods and services, financial flows, diplomatic relations, and the mobility of people. It is also worth noting the unprecedented sanctions on individual people and companies, trying to exert pressure on the Russian oligarchy and the closest circles to Putin (Mamonov et al., 2021; The International Working Group on Russian Sanctions, 2022).

Studies on the effects of sanctions suggest that up to 1995 sanctions were efficient, but since 1995 their success rate has fallen since then (Felbermayr et al., 2020). However, the sanctions imposed on Russia since 2014 show that strategic firms systemically outperform nonstrategic firms under sanctions, implying a cost of shielding to the regime that adds substantially to the total cost of sanctions (Ahn & Ludema, 2020; Felbermayr et al., 2021). The introduction of new sanctions to Russia significantly lowered firm-level probabilities of serving these sanctioned markets. Firms that depend more on trade finance instruments are more strongly affected, while prior experience in the sanctioned country considerably softens the blow of sanctions. There is also evidence for sanctions avoidance by exporting indirectly via neighboring countries (Crozet et al., 2021; Garfinkel et al., 2020).

From a macroeconomic point of view, we consider the possible economic impact of the invasion of Ukraine and the economic sanctions against Russia as two simultaneous shocks, operating through two different channels: prices and trade. Both are expected to have an impact on the economic activity of each country and region in Europe. Two possible short-term impacts should be noted: first, the drop in production and export activity in both countries related to the war and sanctions, will produce shortages in the markets where both economies are essential, especially those related to energy (oil and gas) and food products, generating immediate tensions in prices (reinforced by the corresponding speculative effect), with its derived effects on the rise in production costs and its corresponding translation to the general price indices of most countries and regions. Such raise in prices is expected to generate additional effects on the demand side, by reducing the consumer behavior of households and firms (Camagni et al., 2022). Likewise, it is possible to expect supply problems in essential parts and components for certain industries, which will again result in interruptions in normal production processes. Second, the military conflict and the restrictions imposed by NATO countries as well as by Russia itself, will reduce trade with Russia and Ukraine. The reduction of such transactions will also decrease the GDP and employment in the source countries. And the intensity of such effect will be conditioned by the degree of previous trade relations vis a vis.

This paper discusses the effects in Europe of the Russian invasion of Ukraine and the sanctions proposed on international trade in goods and services. More concretely, this work measures the impacts on value-added (VA) and employment, at the NUTS-2 level, along 32 European countries (EU27, United Kingdom, Norway, Iceland, Switzerland, and Liechtenstein).

The advantages of using a multiregional input-output (MRIO) framework at the NUTS-2 level, beyond the ones of the national input-output (IO) tables that embed them, are main fold.

First, as reported in the literature, the level of territorial and sectoral aggregation matters in all kinds of IO analysis (Lenzen, 2011; Miller & Blair, 2009; Lenzen, 2011; Su & Ang, 2010; Su et al., 2021). To this regard, the use of MRIO tables is superior to more aggregated frameworks, providing a finer view of the flow of goods and services connecting the countries.

Second, by using MRIO tables, it is possible to identify the most interconnected industries and regions, offering a greater granularity in terms of their exposure to the shock under consideration. This helps to better tailor the required policies to compensate the unwanted socioeconomic negative effects or distribute the corresponding positive spillovers.

Moreover, the use of an MRIO framework such as the one used in this article is of additional relevance in Europe. On the one hand, it is important to address the spatial heterogeneity of the shocks, within and between countries in the EU27, and to consider the discontinuities imposed by different kinds of borders (national and regional) within the Union. This is especially important in the border regions between countries, whose attract a major attention of EU policy. In addition, our EUREGIO framework also considers the interregional connections between EU27 and non-EU members, such as the United Kingdom, Switzerland, Norway, Lichtenstein, or Iceland. To this regard, it is important to remark that a shock that is not of special relevance at the national level (i.e., France–Switzerland), can be critical for a given pair of border regions (i.e., Rhône-Alpes/Lake Geneva region). Previous shocks such as the Brexit or the COVID-19 have taught us that these interregional small linkages can play an important role in the transmission of the shocks (Capello & Caragliu, 2021; Chen et al., 2018; McCann, 2018; Thissen et al., 2020). Moreover, this territorial dimension is of great interest when considering the growing share of socioeconomic policies defined and managed at the regional level in Europe, being the Cohesion funds or the most recent NGEU, two relevant examples (Barbero et al., 2022).

Finally, we want to remark that the explicit consideration of the interregional links for the whole of Europe within the EUREGIO-2017 framework, and the results obtained in the simulations, reinforce the recent evidence about the existing interconnections at the subnational level in Europe (Barbero et al., 2021; Bolea et al., 2022; Capello & Caragliu, 2021). Moreover, the heterogeneous results obtained at the regional and national level for the whole Europe, can also be connected with other strands of the literature, such as the one discussing the link between trade and sanctions (Crozet et al., 2021; Felbermayr et al., 2020; Garfinkel et al., 2020), trade and inequality (Ezcurra & Rodríguez-Pose, 2014; Rodríguez-Pose, 2012) and trade and the quality of institutions (Barbero et al., 2021).

The rest of the article is structured as follows: first, we provide a theoretical framework for analyzing the adverse supply shocks caused by the war by extending the adverse supply shock theory to include simultaneous multiple supply shocks. Then we describe the methodology applied. Next, we review the results obtained, starting with a descriptive analysis on the degree of exposure of the European economies to the Russian economy, followed by a detailed analysis of the results obtained in our simulation, starting with the trade effect, then the price effect, and then the overall impact obtained. The last section presents conclusions and policy implications.

2 | STATE OF THE ART

An adverse supply shock is an unexpected reduction in the trade supplied for a commodity for any given price. Such situation could result from natural disasters (e.g., floods or earthquakes), from pandemics, or from major political upheavals (e.g., war or revolution), just to mention some (Begg et al., 2003). In the short run, an economy-wide negative supply shock will cut the aggregate supply curve, decreasing the output and increasing the price level (Hall & Lieberman, 2012). The sudden price increases imposed by the OPEC in the 1970s appeared as adverse supply shocks to oil importers (Begg et al., 2003), and the imposition of an embargo on trade in oil would cause an adverse supply shock, since oil is a key factor of production for a wide variety of goods (Hall & Lieberman, 2012).

The economic consequences of adverse supply shocks by oil are well-surveyed in the literature (Aastveit et al., 2015; Alsalman & Karaki, 2019; Bjørnland, 2000; Gisser & Goodwin, 1986; Hamilton, 1983, 1996, 2003, 2009; Kilian, 2009; Wu et al., 2013), and the findings suggest that higher energy prices typically lead to an increase in production costs and inflation, thereby reducing overall demand, output and trade in the economy. Also, the effects by adverse supply shocks regarding loans are well surveyed (Gambetti & Musso, 2017; Hristov et al., 2012; Peek et al., 2003). The latest set of studies of adverse supply shock are related to the COVID-19 pandemic (Borjas & Cassidy, 2020; del Rio-Chanona et al., 2020; Rajput et al., 2021). Single commodity adverse supply shocks usually generate macroeconomic disturbance, usually in the form of inflation (Barro, 2020; Fratzscher et al., 2020; Guerrieri et al., 2020; Zahran, 2020). The literature on adverse supply shocks focuses on single commodities, but what happens, as in the case of the Russian–Ukrainian war, if several adverse shocks for different commodities occur simultaneously? This work assumes this question as a research question.

In addition to this price shock, a complementary trade effect is expected. That wars have a profound impact on trade is known, both in terms of demand and supply (Glick & Taylor, 2010), as sudden trade collapses between countries (Gulan et al., 2021). The literature on the impact of wars and sanctions on trade is flourishing after the great crisis and the recent trade wars between the United States and China. Pandya and Venkatesan (2016) show that the diplomatic confrontation between France and the United States over the 2003 Iraq war significantly reduced trade between the two countries in a short period of time. In a similar vein, Crozet and Hinz (2020), using firm-level data for French exporting firms, study the case of the Russia sanctions in 2014. More recently, Crozet et al. (2021), using a similar database of French firms, and analyzing a wider range of sanctions (Russia, Iran, Myanmar, etc.), found that the sanctions imposed to Russia and Iran partly act via increased market entry costs, and the strongest effects are found in the firms more dependent on trade finance instruments.

Complementary, Ahn and Ludema (2020), also using firm-level data, analyzed how the exporting performance of firms were affected by the sanctions applied by the United States and European Union against Russia in 2014. They found losses in operating revenue, asset values, and employees for sanctioned firms, which are greater in sectors dependent upon Western service inputs. This effect highlights the relevance of inter-sectoral connections operating at the firm level, something that we aim to capture at the regional level using the EUREGIO-2017, a multiregional and multisectoral input–output table developed at the NUTS-2 level and described in the next section.

Another relevant example is provided by Nguyen and Do (2021), who also analyzed the impact of economic sanctions imposed by Western countries on the exports of Russia and its retaliatory measures against imports. By means of a gravity equation and a panel of 49 countries between 2011 and 2018 they found that such sanctions reduced Russian export by 25.25%, and Russian imports by 25.92%. They also found that the sanctions severely affect the Russian exports of oil (−36.56%). Moreover, the countersanctions cause a decline in the Russian imports of agricultural products by 54.52% and by 20.86% in non-agro items. Such results offer a good base for our trade effect, knowing that the effects were significant both for exports and imports, being relevant despite the lower breath and scope of the 2014s conflict and sanctions, compared to the ones associated with the 2022 one.

All previous references deal with the economic consequences of shocks computed at the macro (countries) or microlevel (firms). The list of equivalent studies using interregional setups is much shorter. In relation to price-shock events, it is worth it to mention Dong et al. (2020), who by means of a multiregional dynamic computable general equilibrium model, analyzed the effects of international oil price shocks and RMB exchange rate changes on China's regions. Other interesting example is found in Kilian and Zhou (2022), who analyzed the response of Canadian regional housing markets to oil price shocks, developing a theoretical model that differentiates between oil-producing and nonoil-producing regions and incorporates multiple sectors, trade between provinces, government redistribution, and consumer spending on fuel.

Regarding previous analysis on the impact of wars at the regional level, a few references are worth mentioning. Two obliged cites are Davis and Weinstein (2002) and Brakman et al. (2004), who analyzed the persistence of the spatial economic effects of the Allied bombing in Japan and in Germany during the Second World War. From an alternative perspective, Hodler and Raschky (2014) study the effects of economic shocks on civil conflict at the subnational level using a panel data set of 5689 administrative regions from 53 African countries. In this case, they adopt an inverse causality approach, measuring how the probability of civil conflicts is correlated by the presence of previous economic shocks. From a complementary perspective, but with a clear spatial scope, Conzo and Salustri (2019) examine the long-term effect of conflict on trust by using changes in places and timing of combats during World War II using NUTS-2 regions in Europe. Finally, Haddad et al. (2023), by means of an interregional IO model for Ukraine, analyzed the negative spillovers of the conflict, considering the internal geography of the country and the damage caused to physical infrastructure and supply chain disruptions.

The aim of our analysis is to visualize the maximum shock of a full collapse in trade with the two affected economies, plus the price shock commented, more than to predict the actual impact of the measures that are being adopted in cascade, whose final scope is now difficult to foreseen.

3 | DATA AND METHODS

3.1 | The EUREGIO-2017 multiregional multisectoral framework

This work uses the EUREGIO-2017[1] framework recently developed in the context of the ESPON-IRIE Project (Almazán-Gómez et al., 2023; ESPON, 2022). In comparison to its precedent, the EUREGIO-2013 (Thissen et al., 2019), the EUREGIO-2017 expands the FIGARO multicounty framework at the NUTS-2 level, including the region-to-region flows for all the EU27-countries plus United Kingdom, Norway, Iceland, Switzerland, and Liechtenstein. While the previous EUREGIO data sets (Thissen et al., 2018, 2019, 2020) used the WIOD and the Eurostat SUTS tables, the EUREGIO-2017 relays on the most updated and homogeneous FIGARO main figures as constrains. Note that, The FIGARO tables and the EUREGIO-2017, contain not only sector-region-to-sector-region flows across Europe, but also the ones with other countries such as the United States, China, Japan, Russia, among others, are also included at the sector-country level. Thus, this multiregional and multisectoral framework is the most complete and updated inter-sectoral interregional framework available nowadays in Europe. As we will see, previous EUREGIO data sets and similar methods have been applied to assess the regional implications for Brexit (Chen et al., 2018; McCann, 2018; Thissen et al., 2020) and to check the changes in GVCs (Bolea et al., 2022).

Once the database is described, some insights about the multiregional and multisectoral input–output framework are needed. First, let's define $\mathbf{Z}$ as a block matrix with $\mathbf{Z}^{rs}$ matrices that capture the interindustry relations between regions r and s. So, each submatrix $\mathbf{Z}^{rs}$ is a n-by-n matrix where n is the number of sectors accounted. The matrices on-diagonal ($\mathbf{Z}^{rr}$) capture the domestic intermediate flows (intraregional intermediate flows). By contrast, all off-diagonal matrices ($\mathbf{Z}^{rs}\ \forall\ r \neq s$) contain the interindustry interregional flows, where Z_{ij}^{rs} is the value of the production generated by sector i in region r that is being used as an intermediate input by sector j in region s (interregional interindustry flow). The gross output of each industry is depicted by a column vector $\mathbf{x}$.

Then, dividing each element of the intermediate inputs matrix (Z_{ij}^{rs}) by the gross output of the sector j of the region s (x_j^s) we obtain the so-called matrix of technical coefficient, in matrixial form: $\mathbf{A} = \mathbf{Z}\hat{\mathbf{x}}^{-1}$. Each element of this

[1]The EUREGIO-2017 is a multiregional input–output table at the NUTS-2 level, embedded in the FIGARO table for 2017 (Remond-Tiendrez & Rueda-Cantuche, 2019), which contains multiregional input-output tables at the country-to-country level for 64 sectors. The EUREGIO-2017 data set uses the regions NUTS-2 Rev.2016 for EU27 and United Kingdom, and NUTS-2 Rev.2021 for Norway and Switzerland.

matrix (A_{ij}^{rs}) inform us about the requirements that have the industry j of region s from the industry i from region r to produce an output of 1 monetary unit (one million Euros in our case).

It is now convenient to define a matrix of VA generated as $\mathbf{M}$, where each component M_{cj}^{s} depict the component c of VA (gross operating surplus, compensation of employees, taxes, etc.) associated to industry j from region s. For the sake of simplicity, it is assumed that there are no other components on the supply side, so we aggregate the matrix $\mathbf{M}$ to obtain a row vector called $\mathbf{m}\left(m_j^s = \sum_c M_{cj}^s\right)$. Then, dividing the $\mathbf{m}$ vector element to element by the gross output, we obtain, for each sector of each region and country the share of VA over the total output, which is labeled as vector $\mathbf{v}$. Then, the sum of the matrix of intermediate inputs transposed plus this vector ($\mathbf{A}'\mathbf{e} + \mathbf{v} = \mathbf{e}$) is equal to a vector of ones ($\mathbf{e}$).[2]

Then, the final demand matrix, usually called $\mathbf{Y}$, is also a block matrix of matrices $\mathbf{Y}^{rs}$ where each component Y_{id}^{rs} represent the final demand that make the agent d (households, government, NPISHs, etc.) of region s from industry i of region r.

3.2 | Price and trade impacts

Once the EUREGIO-2017 has been defined and contextualized in the standard multiregional-multisectoral literature (Miller & Blair, 2009), it is convenient to define the specific analysis conducted, which considers two channels of impact, one working through trade, and the other through prices.

Given the complex nature of the shock analysis, we proceed in the following way: Starting from the detailed analysis of how the Russian and Ukrainian economy is related to the rest of the world through its exports and imports of goods and services, the affected flows have been identified in the EUREGIO-2017 framework. Such identification is immediate in the case of Russia, which appears as a specific national economy within FIGARO. Thus, the inter-sectoral and final trade flows of any sector of Russia with the ones of each other NUTS-2 European region are known, and vice-versa. However, Ukraine has not an input–output table available within the FIGARO data set (neither in the OECD-ICIO or any other equivalent data set). Thus, the first step here is to estimate some Ukrainian totals to be accounted as Ukrainian figures included in the Rest of the World (ROW). To do this, we use Russian figures as priors, see more details in the Supporting Information S2: Online Appendix.

Then, we focus on the price shock, where we assume a cost-push transmission effect, starting with a very relevant increase in the prices of the main commodities where Russia and Ukraine are main suppliers to the world, and more specifically, to Europe. The initial shock is transmitted upstream through the intersectoral interregional linkages, increasing the prices of all sectors in all regions and countries, affecting both goods and services. Then, it is assumed that this inflation effect impacts households' consumption behavior. Given the short-term nature of our analysis, and the fact that all the commodities provided by Russia and Ukraine can be considered as essential products (low price elasticity), it is assumed that households keep constant their purchase of essential goods (food and energy), and then adjust the rest of their consumption basket. According to this hypothesis, the increase in the price of "essential goods" would not be translated into falls in the consumption of these products, but rather, into a reduction in the consumption of all the other nonessential products.

As indicated previously, in the absence of any shock: $\mathbf{A}' + \mathbf{v} = \mathbf{e}$. Where the first part of the equation represents the part of the price of each product that is consequence of the intermediate input costs, and the second part indicates the part corresponding mainly to the primary inputs' costs (capital and labor). So, if we assume a starting point in which all prices are 1, a shock (percentual increase) in the prices of any commodity raise the intermediate cost of all sectors according to the intensity of use of that commodity in their production process. This is formally described in Equation (1) where $\mathbf{p}^*$ is the vector of output prices and $\mathbf{p}$ is the vector that contains the price shock.

[2] This is built upon the outcome of the following: $\sum_{ri} Z_{ij}^{rs} + m_j^s = x_j^s \leftrightarrow \sum_{ri} \frac{Z_{ij}^{rs}}{x_j^s} + \frac{m_j^s}{x_j^s} = 1 \leftrightarrow \sum_{ri} A_{ij}^{rs} + v_j^s = 1$

$$\mathbf{p}^* = \mathbf{A}'\mathbf{p} + \mathbf{v}. \quad (1)$$

The vector **p** has been estimated using the observed daily price in the most relevant markets (energy, metals, and agricultural products) from January 1 to March 11. Additional information can be seen in the Supporting Information S2: Figure OA.1. Our initial hypothesis is that such higher commodity prices remain high for 1 year.

Then, as mentioned, the final demand of the households of each region (Y_{ih}^{rs}) is recalculated. This new final demand provokes changes in the production needed to be satisfied. Using the Leontief input–output model, the new output can be calculated as shown in Equation (2); consequently, assuming Leontief production functions, the changes in the VA can be calculated as shown in Equation (3).

$$\mathbf{x} = \mathbf{Ax} + \mathbf{y} \Leftrightarrow \Delta\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\Delta\mathbf{y}, \quad (2)$$

$$\Delta\mathbf{m} = \hat{\mathbf{v}}(\mathbf{I} - \mathbf{A})^{-1}\Delta\mathbf{y}, \quad (3)$$

where **I** is the identity matrix, the $(\mathbf{I} - \mathbf{A})^{-1}$ is the well-known Leontief inverse matrix, $\hat{\mathbf{v}}$ is the requirement of VA per unit of output diagonalized vector, and **y** is an aggregated vector of final demand ($y_i^r = \sum_{sd} Y_{id}^{rs}$). $\Delta\mathbf{y}$ is calculated by subtracting the recalculated households' final demand to the benchmark ($\Delta y_i^r = \sum_{sh} Y_{ih}^{rs*} - Y_{ih}^{rs}$). Then, $\Delta\mathbf{m}$ is the vector of changes in the VA at the sector-region level caused by the increase in commodity prices highly linked to Russian and Ukrainian.

Note that the Leontief model is a linear model, so, percental changes in the output depict the same percental changes in the VA at the sector-region level ($(x_i^{r*} - x_i^r)/x_i^r = (m_i^{r*} - m_i^r)/m_i^r$), and percental changes in the employment.

3.3 | Assumptions and scenarios description

Once the price effect has been calculated for each sector of each region, the simulation of the effect of no-commerce with Russia and Ukraine is carried out through the "hypothetical extraction method" (HEM), which allows quantifying the effects derived from the fact that neither Russia nor Ukraine export or import from the rest of the world during on year. As commented, such approach is like the one previously applied by Chen et al. (2018) for the case of Brexit.

The application of the HEM in an input–output framework allows the estimation of the existing linkages between the different productive sectors. Although the original application was aimed at quantifying sectoral dependency in uniregional models, its subsequent use in the framework of interregional models has allowed the assessment of relationships between the different regions (countries) within multiregional models (Dietzenbacher et al., 1993; Dietzenbacher & van der Linden, 1997; Los, 2004). Recently, Dietzenbacher et al. (2019) developed the hypothetical generalized extraction method (GEM) for multiregional models, which redistributes imports from the extracted region among the rest of the regions.

The HEM is inspired by the extreme case of this hypothetical extraction or isolation. Its ultimate objective is to assess the linkages of the country (region or sector) extracted. This is achieved by comparing the results of the complete model (without extraction), and the model with extraction, in which all the rows and columns referring to the extracted region are zeroed. In this way, it provides a quantification of the economic relations that the extracted part maintains within the system.

This exercise has made it possible to quantify the maximum effect if said isolation were complete. It is important to note that the hypothetical extraction can be described as a double effect of demand and supply. On the demand side, both Russia and Ukraine would stop importing goods and services from all over the world. From a supply perspective, these economies would stop producing and exporting to all the world's economies, generating the corresponding bottlenecks in the supply chain, with effects on the intermediate demands of all the countries and regions included in the model. We define the total effect calculated by the HEM as trade effect (to differentiate of the price effect).

In this point we describe four scenarios for the trade shock:

- S1 (Baseline): the trade effect assumes a complete isolation of Russia and Ukraine for 1 year, affecting all countries and sectors. Such a scenario is materialized in the application of the HEM to Russia + Ukraine. The rows and columns of Russia are completely zeroed. The Rest of the World rows and columns are rearranged to discount Ukrainian figures.
- S2: in this scenario, we applied a partial HEM to the crosses between Europe and United States with Russia and Ukraine. By doing so, we consider that just Europe and the United States, the core of NATO countries, are the ones that radically cancel all exports/imports with Russia.
- S3: next, we again apply a partial HEM to the same crosses than in S2, except for the ones corresponding to the energy sectors, that is, “B” “C19” and “D_E”. This scenario corresponds to a moderate trade punishment by the core of NATO countries, leaving gas and oil out of the sanctions truly applied.
- S4: this final scenario is like S2, but applying an ad-hoc version of the GEM (Dietzenbacher et al., 2019). This scenario allows Russia to reassign to third countries the trade flows (imports and exports) canceled by the core of NATO's countries (Europe + United States). In this version of the GEM, not only imports are reassigned, but also the exports.

Note that S1–S3 opts for the HEM as an attempt to assess the maximum level of exposure. Meanwhile, S4 wants to offer a more realistic alternative, closer to the one we are leaving before the summer of 2022.

3.3.1 | Alternative results: What if the shock moderates and shortens?

According to the described strategy, our baseline scenario (S1) is based on a complete paralysis of economic transactions with Russia and Ukraine for a full year, as well as the maintenance of the price shock at the same intensity observed in the first weeks of warfare, also for a full year. As it is evident, this is not taking place even after more than a year of fierce battles. Despite the sanctions, Russia is producing and exporting a large part of its more profitable products such as oil or gas. Indeed, by the time this paper is submitted for publication, the EU27 has just agreed on a partial embargo to the Russian exports of gas and oil, just cutting supplies by boat, but not through pipe. However, it is convenient to measure the maximum effect that a complete embargo will bring to the European economy, since such option is currently considered as a desired measured in the short and midterm. While the first academic papers are published, there is a proliferation of rigorous analysis dealing with the potential effects of the war and the sanctions in the short and long run, depending on the actual restriction of the European imports of Russian gas and oil (Chepeliev et al., 2022).

Logically, the final effect will depend on both the duration of the conflict and the intensity of sanctions, both in terms of trade and prices. Given the difficulty of foreseeing the future of the conflict and its final effects, it is prudent to draw alternative scenarios. The previous section described three alternative ones (S1–S4), related to the breath of the trade effect, also connected with the extraction method applied. Complementary, in this section we want to discuss the effect of the time intensity of the shock, with two different hypotheses that apply to each scenario. This multiplies the number of scenarios by 2, which we will call type A scenarios and type B scenarios. For the shake of simplicity, this explanation focuses in our S1 baseline scenario.

For the price effect, we opt for elaborating over the historical background, investigating how the oil price have evolved after similar episodes, such as the price shock observed in mid-2008 and at the beginning of 2011 (Supporting Information S2: Figure OA.2). While the first was corrected relatively quickly, the second had a greater temporal persistence. These two alternative market reactions can be extrapolated to our current situation, drawing two diametral evolutions in the following months.

Taking these two episodes as a reference, two alternative profiles for the evolution of the recent price shock induced by the war in Ukraine have been designed (see Supporting Information S2: Figure OA.3).

In the case of the trade effect, the design of scenarios is somewhat more complex as there is no similar background where the direct effects of an armed conflict are combined with the imposition of such a wide and coordinated package of sanctions with effects in terms of the flows of goods, services and capital.

The closest historical reference could be found in the armed conflicts in the Balkans in the 90', associated with the disintegration of the former Yugoslavia. Although it is not easy to find homogeneous series of evolution of trade during this war period, using monthly data from the World Trade Organization (WTO) we can reproduce the evolution profiles of total exports from two of the areas in conflict, the former Yugoslavia and Croatia, with respect to the months before the conflicts (such trends are summarized in Supporting Information S2: Figure OA.4).

As in the case of oil, two different profiles arise, one with a more pronounced drop (Yugoslavia in 1991), and another more moderate (Croatia since mid-1993). Despite the limitations of the data available for Yugoslavia and Croatia, we can use both references to design alternative profiles of the evolution of the current Russian–Ukrainian conflict (such profiles are drawn in Supporting Information S2: Figure OA.5).

Then, combining these profiles of prices and trade, we define two alternative situations encoded as scenario type A and type B (see details in Supporting Information S2: Figure OA.6 and Table OA.2):

- S1A—moderate intensity: Moderate trade shock and transitory price shock
- S1B—high intensity: Intense trade shock and sustained price shock.

These intensity adaptation scenarios are developed and programmed, and results are available under request. However, the results showed in this work, for the sake of simplicity, are the associated to the full intensity. Note that moderate intensity or high intensity are percental reductions on the shock and the model is linear. Then results can also be calculated applying those percental reductions to the results of the full intensity scenarios. Full intensity scenarios are coded without letters: S1.

The elaboration of intensity adapted results meets to the need to develop scenarios that better fit the observed reality and to show the capacity of the model to assume hypotheses in this regard.

3.4 | Methodological strengths and weaknesses

Before analyzing the results obtained, and still within the methodological section of the paper, it is convenient to further elaborate on the virtues and drawbacks of the empirical approach deployed here, as well as the scenarios described before.

To start with a critical view of our approach, it is worth it to mention the open discussion about the short-run versus long-run nature of IO analysis as well as on the trade-offs between IO, computable general equilibrium (CGE), and other alternative general equilibrium approaches to deal with national and regional events (Giesecke & Madden, 2013; Lecca et al., 2014; McGregor et al., 2006; Rickman, 2010). To this regard, McGregor, et al. (2010) comment recent developments in regional CGEs, which unlike partial equilibrium approaches, such as the IO frameworks, can trace the impact of an economic shock through the various sectors, allowing long-term adjustments in factors, output and prices. They also account for the major criticism of the first generation of CGE models, view by many as a "black box," as well as their dependence of partial equilibrium analysis for calibration. In the same vein, Rickman (2010), describes potential avenues for improving the classical regional models with the new trends developed in macroeconomics, with a special reference to theory-based approaches such as dynamic stochastic general equilibrium (DSGE) and DSGE-VAR approaches. In this line of thoughts, it is convenient to cite some recent papers trying to illustrate how regional impact analysis conducted using IO and CGE frameworks, can incorporate such new features required for a proper long-term analysis, able to address, for example, spillover effects between the treated and not treated regions (Lecca et al., 2020), "supply constrain" or infeasible input–output relations due to simultaneous demand and supply shocks (Cardenete & Sancho, 2012; Pichler & Farmer, 2022), forward-looking mechanisms (Lecca et al., 2013) or capital-skill complementarity and matching frictions in the labor market following the Diamond–Mortensen–Pissarides tradition (Lecca et al., 2023).

Moreover, the previous discussion about the limitations of the IO analysis for a long-term view of the potential effects of the war, and as an example on how modern macroeconomic modeling approaches can be combined with classic IO analysis, Felbermayr et al. (2023) has recently analyzed the long-term effects of decoupling the East economy from the West, with an express reference to the Russian–Ukraine conflict and the long-term effects of different scenarios. Such reference serves to illustrate how the IO frameworks can serve to build more sophisticated models, but also how such approaches might face trade-offs in terms of sectoral and spatial disaggregation. This paper also helps us to further elaborate on the economic rationale of the scenarios described before, which basically corresponds to the expected long-term effect of a progressive decoupling of the West (NATO) versus East (China–Russia–India) economies, if the "friend-shoring" paradigm succeed.

Felbermayr et al. (2023) uses a computable general equilibrium trade model calibrated with the latest version of the GTAP database, the "Kiel Institute Trade Policy Evaluation" model ("KITE model"), which is based on Caliendo and Parro (2015), who provide a multisector version of the Eaton and Kortum (2002) gravity model with input–output linkages. Their analysis considers five scenarios: (1) A decoupling of the EU 27 and China; (2) A decoupling of the United States and its allies from China; (3) A decoupling of the United States and its allies from Russia; (4) A decoupling of the EU 27 from the BRIC countries; and (5) A decoupling of the United States and its allies from the BRIC countries. Empirically, decoupling is conducted by reducing imports from the target country, using simulated nontariff-barriers to trade. Although such reference was published once that our empirical analysis was conducted, it came to press just in time to support most of the scenarios considered in our trade shock. Despite that, our analysis, although lacks the capacity of considering long-term effects such as competition and substitution effects, between goods, services, trade partners and labor/capital technical relationships, adds the novelty of simultaneously consider the price shock, and the subnational granularity of the interregional relations for the whole Europe.

As we comment below, the scenarios considered for the trade shock are very similar to the ones of Felbermayr et al. (2023). To this regard, it is interesting to consider that, beyond the likely restrictions to trade of goods and services imposed by the hostilities and the economic sanctions, which are operating in the short-run (e.g., first year of war), such initial movements might trigger more structural changes in the economic behavior of exporters and importers at all levels, nations, regions, firms and consumers. As we will comment, some of these changes might lead to creation and deviation effects, substitution of original source countries, firm reallocation and shortening of the actual global value chains following the so-called paradigm of "next-shoring" or "friend-shoring." The substitution of Russian energetic products observed in 2022 is a clear example on this dynamic effects.

Thus, although our trade effect, simulated with a linear relation of an IO analysis, assumes the stability of the current international and interregional relations not subject to the HEM, it is likely that the persistence of hostility, and such substitution effects, might lead to additional changes not considered in our short-run analysis. To this regard, it is convenient to consider additional long-term effects, which might require other methodological approaches, able to deal with effects such as changes in firm location, FDI and shortening of the global value chain (Ruta, 2022), the long-term effect in inflation expectations (Afunts et al., 2023), reactions in terms of migration, brain drain or capital mobility (Patrinos et al., 2022), or the ones associated with the postwar reconstruction or the secular scars of war (Artuc et al., 2022; Chupilkin & Kóczán, 2022; Conzo & Salustri, 2019). Obviously, such analyses remain out of the scope of this paper.

Finally, it is necessary to say a word regarding the special situation in which the unprovoked invasion took place, which also conditions the short and long-term effects of the shock considered. To this regard, elaborating on the recent literature on the economic shock of COVID-19 and the "new normality scenario" at the regional level (Capello & Caragliu, 2021), it is important to remark that, the year of reference considered in our analysis (2017) is different than 2022, when the hostilities started. The negative effect of the trade and price effect caused by the war and the sanctions, overlapped with the ones caused by the sharp restriction to personal mobility, and unprecedented interventions in terms of fiscal, rents and monetary policy. For all European regions, "rains, it pours," but the effects of both shocks are heterogeneous from the spatial and sectoral viewpoint. To this regard, it is interesting to consider that, since the COVID-19 shock mainly heated the southern European countries (Spain, Italy, France, Portugal, etc.), whose economies are more dependent on tourism and other service sectors directly associated with personal mobility, the shock caused by the war, as we will see in the next section, followed an East-West gradient, being the neighboring regions to Russia and Ukraine the ones suffering the most. Although the combination of these two shocks remains out of the scope of this article, the results produced here might be downward bias and has to be interpreted with the corresponding prudence.

4 | RESULTS

By way of contextualization, we begin the results section by showing the trade exposure of the European regions with the economies in conflict. This will help us to show the differences between direct exposure via trade and total effects. Then, the results in terms of VA and employment of S1 (full intensity) at the NUTS-2 level are reported. Here we clearly see that not only the regions most linked via trade with Russia are those affected by the hypotheses behind S1. Finally, focusing on the geographical and sectoral propagation, this work shows how a trade-embargo on a selected list of items, affects not only to the sector and regions that mainly produce those items.

4.1 | Trade exposure to the Russian economy

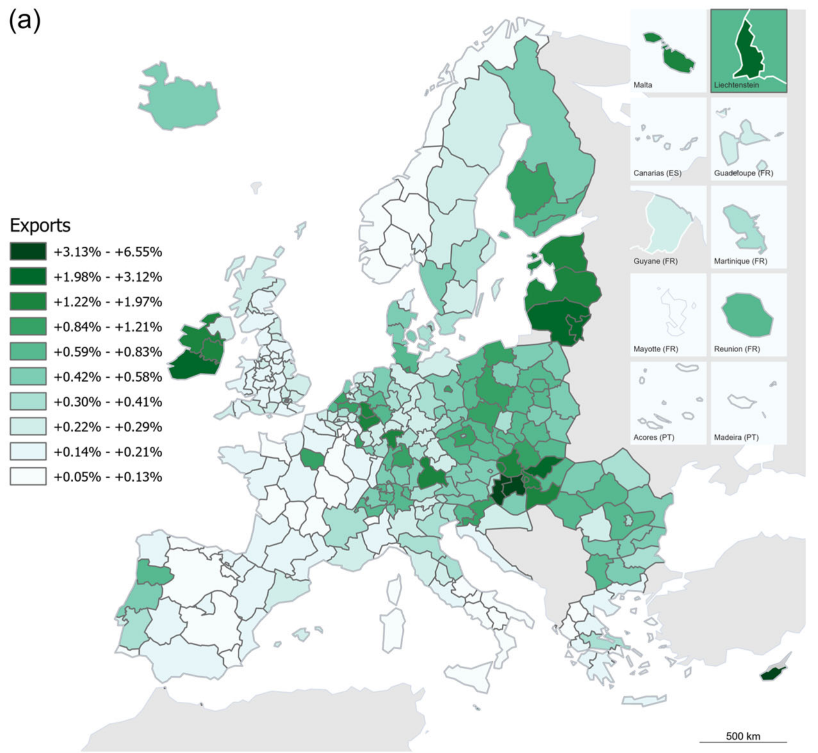
The exposure of the European regions to Russia differs significantly if we look at it from the point of view of exports or imports. Panel A) displays, based on the EUREGIO-2017, the exports to Russia and Ukraine, as a share of the GDP of each region, including goods and services. Not suppressively, the main concentration is observed in Easter Europe, mainly in Lithuania, Latvia, Estonia, Hungary, Slovakia, and Poland, but also Ireland. With this standpoint important exposures are also found in Cyprus, and certain regions in Finland, Portugal, Germany, Greece, and Italy.

Complementary, from the import dimension, the exposure to the Russian economy is more concentrated from the sectoral viewpoint than from the spatial dimension. As can be seen in Figure 1b), the percentages of imports from Russia over the regional GDP is less intense than for exports. Moreover, although the regions of Finland, Lithuania, Latvia, Estonia, Cyprus, and Greece are clearly highlighted, the gradient is less conditioned by the geographical proximity to the Russian–Ukrainian border, finding relatively important exposures in the southern regions of Italy, France, and Spain, as well as in Ireland.

4.2 | Simulation results: S1—full intensity (the maximum impact)

As mentioned, the total effect of the conflict is a conjunction of two differentiated effects: the price effect and the trade effect, both described in Section 3.2. The price effect is linked to the effects of the reduction on the demand caused by the price increasements caused by the conflict. For its part, the trade effect is related with the changes in bilateral trade associated to the hypothesis made to simulate the trade-embargos.

The first remarkable result under the price effect analysis is that, according to the assumptions taken, the world's inflation could increase about 4% if all the estimated increases in production costs are transmitted to final



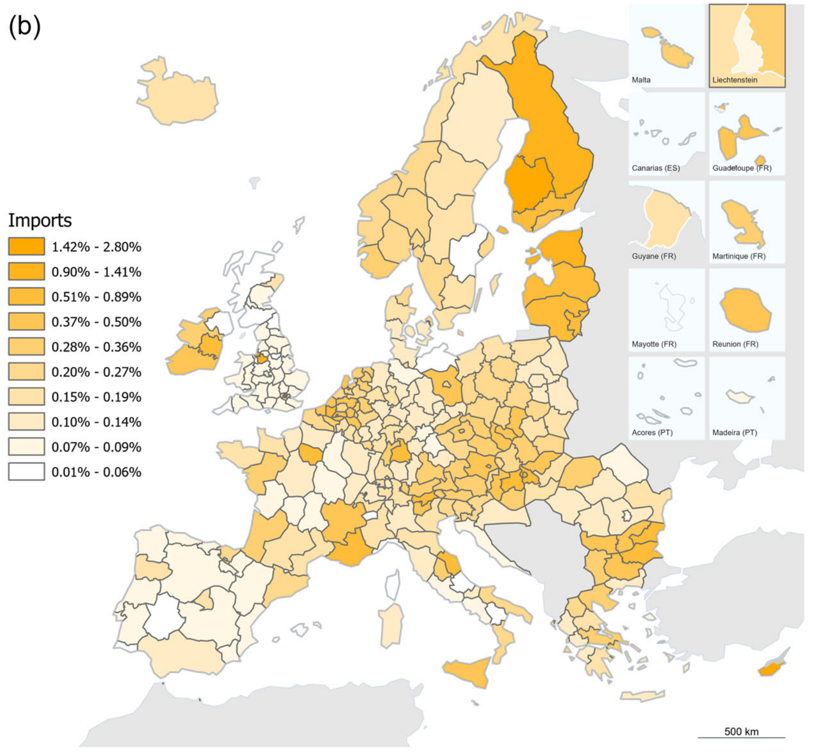


FIGURE 1 Economic exposure to Russia through international trade. (a) Based on the EUREGIO-2017, the exports to Russia, as a share of the GDP of each region, including goods and services. (b) The imports from Russia over the regional GDP. *Source*: Own elaboration. [Color figure can be viewed at wileyonlinelibrary.com]

prices. Note that these effects are an indirect effect caused only by the Russian's invasion, so such figures should be added to the prewar inflation rates.

By country, the inflation caused covers a wide range: ranging from 6.5% in Bulgaria, or 5.6% in Hungary, to just over 0.9% in Luxembourg or 1.5% in Malta. At the NUTS-2 level, the largest raises are clearly concentrated in Eastern Europe, with also important effects in regions in Portugal, Spain, Italy, United Kingdom, and the Netherlands (see Supporting Information S2: Figure OA.7). These price increasements lead to a range of VA reductions by 0.49% to 1.82% (Supporting Information S2: Figure OA.8).

Regarding the trade effect, our simulation points out to a globally impact on VA of about −1.25%. At the country level, the larger impact is for Cyprus (−6.2%), followed by Lithuania (−4.0%) and Ireland (−3.9%). At the NUTS-2 level, the largest negative shocks are obtained in: HU22, Nyugat-Dunántúl: −4.75%; IE05, Southern: −4.69%; HU21, Közép-Dunántúl: −4.22%; LT02, Vidurio ir vakaru Lietuvos regionas: −3.97%; LT01, Sostines regionas: −3.96%DEA1, Düsseldorf: −3.64%; SK01, Bratislavský kraj: −3.58%; IE06, Eastern and Midland: −3.40%; IE04, Northern and Western: −3.32%; SK02, Západné Slovensko: −3.12%; DE21, Oberbayern: −2.94%; DE71, Darmstadt: −2.85% (see Supporting Information S2: Figure OA.10). The sectoral perspective is provided in Supporting Information S2: Figure OA.11.

We now focus on the overall impact, adding the price and trade total (direct + indirect) effect (Figure 2), still considering both in their maximum intensity. Note the similarities in the patterns shown in Figure 1 (economic exposure) versus the ones in Figure 2, they are caused by the most evident direct effect. By contrast, the indirect effects capture the spillover effects of a shock, that affect not only the directly affected regions but also those that are indirectly linked through supply chains or other interregional flows. These effects magnify the impact of the shock and propagate through the regions and sectors causing widespread disruptions in production and trade.

The direct effects show that the regions with largest trade-exposures tend to be the ones more affected (by the sanctions). However, the total effects are spatially heterogeneous even within countries, and it seems that the strongest regions in each country suffer the most, but it is not necessarily the most trade-exposed regions of each country. This suggests that large indirect effects are also involved.

At the country level, the impacts on GDP are ranging between the −6.88% for Cyprus and the −0.96% for Norway. Apart from Cyprus, all the Eastern European countries received strong impacts, especially Lithuania, Slovakia, Latvia, Estonia, and Hungary. Ireland, Liechtenstein, and Luxembourg also have large impacts. Germany might suffer a −2.38%, outstanding as the most affected among the large-economies, something that can practically only be explained with spillover effects.

At the regional level, it is noteworthy that the impacts are spatially diverse, even within individual countries, and that it appears that the most prosperous regions within each country are affected the most, as would be expected. It is also interesting to note that these regions are not necessarily those with the highest exposure at the national level, indicating that there are significant spillover effects in play in this scenario. Please note that job losses are derived from the "employment" intensity of each sector in 2017. No further hypothesis is included with regard to the performance of each sector, region, or country in terms of policies oriented towards maintaining labor or avoiding business destruction, a point that requires further research.

Digging deeper in the geographical distribution of the impact, Figure 2a shows the total effect over the GDP at the NUTS-2 level. Meanwhile, Figure 2b shows the total effect over the employment. The 10th largest effects (ranked by % of the GDP) fall on: CY00, Kypros: −6.88% (GDP): −17,938 (job losses); HU22, Nyugat-Dunántúl: −5.88% (GDP); −21,637 (job losses); IE05, Southern: −5.28% (GDP); −30,280 (job losses); HU21, Közép-Dunántúl: −5.27% (GDP); −18,646 (job losses); LT01; Sostines regionas: −4.98% (GDP); −20,943 (job losses); LT02, Vidurio ir vakaru Lietuvos regionas: −4.96%; −29,900 (job losses); SK01, Bratislavský kraj: −4.78% (GDP); −29,693 (job losses); SK02, Západné Slovensko: −4.36% (GDP); −32,529 (job losses); DEA1, Düsseldorf: −4.31% (GDP); −69,064 (job losses).

In this case, the high relevance of the most-affected sectors (energy and food), and the higher exposure of some large EU economies (i.e., Germany and Eastern Europe), tend to magnify the spillovers effects over the whole European economy. The next section digs deeper on such indirect effects.

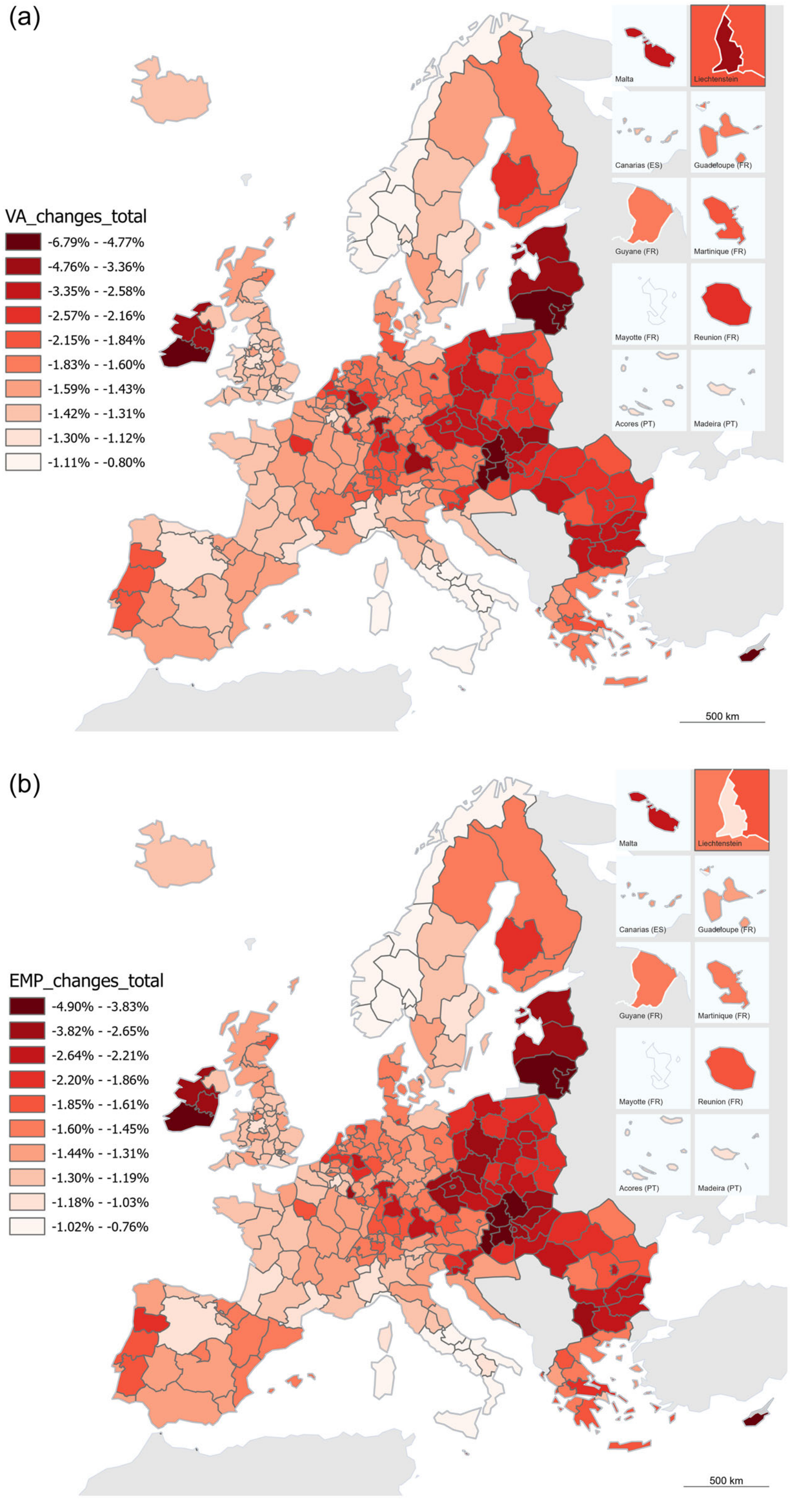


FIGURE 2 Overall impacts at the regional level (trade + price effects). (a) The total effect over the GDP at the NUTS-2 level. (b) The total effect over the employment. *Source*: Own work. [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 1 Origin-destination of the price effect at the NUTS-2 level.

Cause the impact		Receive the impact		Value-added changes (million €)
LU00	Luxembourg	UKI3	Inner London—West	−7.818
ITC4	Lombardia	UKI3	Inner London—West	−7.250
FR10	Île de France	ITC4	Lombardia	−6.279
FR10	Île de France	BE10	Brussels	−5.113
FR10	Île de France	UKI3	Inner London—West	−4.848
ITC4	Lombardia	FR10	Île de France	−4.422
ES51	Cataluña	FR10	Île de France	−4.094
FR10	Île de France	DE21	Oberbayern	−3.999
FR10	Île de France	DE11	Stuttgart	−3.900
FRK2	Rhône-Alpes	ITC4	Lombardia	−3.863

Note: Top 10 effects.
Source: Own work.

4.3 | A focus on the geographical and sectoral propagation

As commented, one of the virtues of our empirical strategy is the possibility of estimating direct and indirect effects associated with the trade and price shock considered. In this section, we want to focus on the indirect effects, depicting the main spatial and sectoral channels through which the initial shocks are transmitted. By doing so, we want to emphasize the high level of interconnection of the European economy, and how the final effects can appear in regions whose exposure to the initial shock was not evident. Such analysis is also needed to help policy makers to be aware that when adopting certain measures (i.e., total blockage of imports of Russian gas and oil), although the initial political opposition is associated with the countries that are directly more exposed to the measure, intense indirect effects might arise in other locations. With this aim, Table 1 depict the top-ten origin-destination indirect price effects in Europe, expressed in aggregate terms across sectors.

Remarkably, the main connections are related to two locations heavily dependent on the financial sector (Luxembourg–London). The ones between Lombardia (Milan) with London, Île-de France, Rhone-Alpes (Lyon) are also noteworthy since they configurate a triangle of strong spillovers between Italy (one of the non-Eastern countries more affected by the trade and price effect), the United Kingdom and France. The ones connecting Île-de France with Brussels, London, Catalonia, Oberbayern or Stuttgart also stands out, linking some of the most industrialized and open regions in Europe. Complementary, the Supporting Information S2: Table OA.3 include one additional table with the top-10 origin-destination main channels of transmission corresponding to the trade effect.

5 | CONCLUSIONS AND FINAL REMARKS

After Russian invasion of Ukraine, most of the OECD countries have reacted with powerful economic sanctions, aimed at strangling the Russian economy, both in the sphere of trade (goods and services) and financial flows. In this article, through two complementary versions of the input–output analysis, and by using the EUREGIO-2017, we estimate the possible impact of the armed conflict and the economic sanctions adopted. The analysis focuses on the transmission channel related to the trade of goods and services, with a short-term approach, which contemplates an effect of trade and prices. Regarding the trade effect, four scenarios are considered regarding the number of countries applying a total trade embargo, the possible exemption of oil and gas, and the potential deviation of trade with third countries such as China and other Russian satellite countries. The worst scenario implies the fall in GDP might be 1.89%, which might represent a 4.1 million jobs losses in Europe.

In general, the trade effects on European regions prevail over the one performing through prices. For the European regions, within the trade effect, indirect effects are more important than direct effects, something that indicates that, although the direct exposure to Russian and Ukrainian economies is low, the high relevance of the most affected sectors (energy and food), and the higher exposure of some large EU economies (i.e., Germany and the Eastern Europe), tend to magnify the indirect inter-sectoral effects over the whole European economy. Regarding the territorial distribution of the impacts, and focusing on the worst scenario, the largest effects are obtained in Cyprus, and all the Eastern European, especially Lithuania, Slovakia, Latvia, Estonia, and Hungary. For other reasons, Ireland, Liechtenstein, and Luxembourg also have strong impacts.

Aware of the strengths of the methodology applied here, it is also convenient to make the corresponding warnings about its limits. However, if the abovementioned dimensions on complementary transmission channels (e.g., uncertainty, monetary and fiscal policy) not considered in this work will be included, it is expected minor changes in the results.

These findings are based on methodological hypotheses that are valid mainly for a short-term analysis. To this regard, the paper briefly addresses the limitations of IO modeling for addressing long-term effects, and the need to complement it with CGE approaches, more dynamic but usually more aggregated. Moreover, our IO analysis takes 2017 data as the baseline for comparison given that this is the date of reference for the EUREGIO data set used. However, it is important to remark that the Russia invasion to Ukraine and the shocks caused by the sanctions took place during the first phase of post-COVID-19 recovery (Barbero et al., 2022; Capello & Caragliu, 2021). To this regard, it is important to remark that the intention of this paper is not to predict the true regional figures in 2023, but to simulate potential effects of the isolated shock of the Russian–Ukraine conflict over the 2017 baseline. The cumulative effect of all these shocks, and the potential effect of NGEU funds will be addressed in future research.

With these initial limitations, our analysis assumes just two transmission channels, the one of trade of goods and services, and the cost-push of prices working through the intermediate demand. There are additional factors determining the economic resilience to withstand the shock and adapt to the new conditions emerging. First, the magnitude of the direct and indirect effects that the war and the economic sanctions will depend on the magnitude of the event, both in terms of the degree of destruction inflicted on the economies of both countries, as well as the decision with which such measures are applied. Second, the breadth of the actions taken against Russia, or those that Russia could take against the rest of the countries. The outcome will be different if the economic measures include energy (gas and oil) or raw materials where Russia's position is dominant. Third, the duration of the war and the sanctions will determine the scope of the effects. Regarding the price shock, the longer the period of economic blockade, the greater the risk that the shock will become structural, generating second-round effects. The duration of the conflict and the sanctions also favor the strategic actions of agents to reduce their exposure, changing their consumption patterns. Certain technological and organizational changes depend also on this factor. The reaction of the energetic sector is critical in this regard.

The policy implications that emerge from this study point at two main problem areas that need to be addressed. First, the adverse supply shock will lead to increasing prices on products from Ukraine and Russia. In the latter case, it is mainly fossil fuel, minerals, and metals. Second, the old economic colonial-like structures to Eastern Europe materialize in the regional effects we have estimated in this study. It is to no surprise to find the former Soviet

Union republics as well as the former Communist satellite countries to face the hardest negative hit of the adverse supply shocks emerging in the wake of the Russian war on Ukraine. These countries are hit especially hard in terms of inflation, unemployment, and GDP losses, and for some regions in these countries, the negative effects will lead to economic hardship for the governments as well as for the population. The goal of using energy as an economic weapon is to get the European Union and its member states to give in to Russian demands to re-establish colonial control over Eastern Europe (Jonsson, 2023). While Estonia, Latvia, and Lithuania try to cut the remaining economic colonial-like structures to Russia, Hungary, but also Slovakia and Czech Republic, hesitate to do so due to their economic colonial-like ties to Russia.

Russia's strategic efforts to make the European Union dependent on Russian energy to force it into giving in to Russia's political ambition in restoring the Russian Empire (Kragh, 2022) clashes against several of the programs EU launched even before Russia started its war on Ukraine; the Just Transition Fund (European Commission, 2022), the Recovery and Resilience Fund (European Commission, 2021) and the Green Deal (The European Green Deal, Communication from the European Commission. COM (2019) 640 Final, 2019)—all aim at reducing the dependency of fossil energy and transform society into using sustainable energy sources. If these programs are fully implemented, Russia's energy weapon is lost. It is against this background that Russia has a need to create division and discord between EU member states as well as tensions and conflicts within the member states. The goal is to cut the aid to Ukraine and, when citizens freeze and cannot afford to cook, to buy Russian energy again (Jonsson, 2023).

The geopolitical aspects are profound. The systematic destruction of the social overhead capital in Ukraine will also force the European Union to take two different actions. One is, on a short-term basis, to substitute Ukrainian products for products from other countries. The other focuses on a long-term perspective, and is about rebuilding Ukraine's economic capacity, social overhead infrastructure and bring Ukraine into the western side of the resurrected 'iron curtain' Russia is building. Hence, Ukraine will be an attractive market for producers in European Europe to meet the enormous needs Ukraine faces in the rebuilding of its economic capacity. To have the EU bordering to Russia is probably the last thing Russia wants, and hence the war continues.

Russia's indiscriminate violence against civilians and the systematic destruction of the Ukrainian social overhead capital aim at destroying the Ukrainian economy on a long-term basis (Kragh, 2022). To reinforce a colonial-like dependency to Moscow has been the norm throughout history (Raeff, 1984). The underlaying rationale for Stalin's "great famine" in the Ukraine in the early 1930s was the same as today: to make Ukraine dependent on Moscow again (Applebaum, 2017). The collapse of the Soviet Union cut the political ties to Moscow for many of the East European post-Soviet countries, but the economic ties remained. Under Putin's reign, the reinforcement of the colonial-like economic dependency to Moscow for countries such as Ukraine, Belarus and Georgia are high on the Russian political agenda (Gessen, 2012). As long as this geopolitical objective does not change—a resurgent Russian empire—the conflict between Russia and the surrounding world will intensify. Using energy as a weapon is only one of many tools in this conflict.

The findings in this paper contribute to the literature in several ways: (1) to our knowledge, this is the first paper to analyze simultaneous multiple adverse supply shocks of different commodities. We have identified energy (oil and gas), food, raw materials for components and high-tech production, and fertilizers. Higher energy prices typically lead to an increase in production costs and inflation, but little is known on what happens with multiple adverse supply shocks and with simultaneous shocks for key commodities. (2) The empirical strategy adopted to combine a demand and supply shock using a MRIO model (EUREIGO-2017), embedded in a multicountry framework (FIGARO), which covers the entire World. More specifically, the combination of the trade and price effect offers a wider perspective of the maximum total shock, in contrast to other analysis just considering one of these dimensions (see Chen et al., 2018, for an example of a trade analysis for Brexit; see Wu et al., 2013, for an example in a price analysis). (3) The possibility of quantifying the indirect effects working through the global and regional value chains, offering novel layers on the region-to-region main channels of transmission, with the inclusion, for the first time, of some relevant non-EU countries such as Switzerland or Norway. Such analysis helps to illustrate the large indirect effects retrieved, which are even larger than the expected direct effects for the countries more exposed to the Russia and Ukrainian economies.

The main policy implication of this study is that it shows the importance of breaking Russia's colonial economic ties to the countries in Eastern Europe. Until this is not done, the effects of Russia's war on Ukraine pointed at in this study will increase.

ACKNOWLEDGMENTS

This article has been developed in the context of the ESPON IRIE Project: https://www.espon.eu/interregional-relations-europe-new-project-espon, developed by a big consortium during 2020–2022. We want to acknowledge the collaboration received from the European Commission—Joint Research Centre (EC-JRC), and particularly from Giovanni Mandras, Andrea Comte, and Jose Manuel Rueda-Cantuche, for their collaboration and insights on the related work developing the EUREGIO-2017. We also want to thank all comments received from all our colleagues from the IRIE Project, the project officer in ESPON EGTC, Nicolas Rosignol from ESPON and Xabier Velasco, manager of the project, at NASUVINSA. This paper was also developed in the context of another research project: the H2019/HUM-5761 INNOJOBMAD-CM Program from the Autonomous Community of Madrid. The authors are grateful for the comments received from the participants at the 5th investigation in internationalization conference (May 2022). Miguel Ángel Almazán-Gómez also wants to thank the Ministry of Science and Innovation of the Spanish Government (PID2022-140010OB-I00) and the Department of Science, University and Knowledge Society of the Government of Aragon (S40_23R).

DATA AVAILABILITY STATEMENT

The data that supports the findings of this study are available in the supporting Information material of this article.

ORCID

Miguel Ángel Almazán-Gómez http://orcid.org/0000-0003-4537-9619
Julián Pérez http://orcid.org/0000-0002-4214-5991
Daniel Rauhut http://orcid.org/0000-0002-9146-9984

REFERENCES

Aastveit, K. A., Bjørnland, H. C., & Thorsrud, L. A. (2015). What drives oil prices? Emerging versus developed economies. *Journal of Applied Econometrics*, *30*(7), 1013–1028. https://doi.org/10.1002/jae.2406

Afunts, G., Cato, M., & Schmidt, T. (2023). Inflation expectations in the wake of the war in Ukraine CERGE-EI Working Paper Series No. 745. https://doi.org/10.2139/ssrn.4392756

Ahn, D. P., & Ludema, R. D. (2020). The sword and the shield: The economics of targeted sanctions. *European Economic Review*, *130*, 103587. https://doi.org/10.1016/j.euroecorev.2020.103587

Almazán-Gómez, M. Á., Llano, C., Pérez, J., & Mandras, G. (2023). The European regions in the global value chains: New results with new data. *Papers in Regional Science*. https://doi.org/10.1111/pirs.12760

Alsalman, Z. N., & Karaki, M. B. (2019). Oil prices and personal consumption expenditures: Does the source of the shock matter. *Oxford Bulletin of Economics and Statistics*, *81*(2), 250–270. https://doi.org/10.1111/obes.12276

Applebaum, A. (2017). *Red Famine: Stalin's war on Ukraine*. (A. Lane, Ed.).

Artuc, E., Gomez Parra, N., & Onder, H. (2022). *The true cost of war*. The World Bank. https://doi.org/10.1596/1813-9450-10217

Barbero, J., Conte, A., Crucitti, F., Lazarou, N.-J., Sakkas, S., & Salotti, S. (2022). The impact of the recovery fund on EU regions: A spatial general equilibrium analysis. *Regional Studies*. https://doi.org/10.1080/00343404.2022.2123467

Barbero, J., Mandras, G., Rodríguez-Crespo, E., & Rodríguez-Pose, A. (2021). Quality of government and regional trade: Evidence from European Union regions. *Regional Studies*, *55*(7), 1240–1251. https://doi.org/10.1080/00343404.2021.1873934

Barro, R. J. (2020). Inflation and growth. In J. Rabin & G. L. Stevens (Eds.), *Handbook of monetary policy* (Issue 1235, pp. 423–442). Routledge. https://doi.org/10.4324/9780429270949-35

Begg, D. K. H., Fischer, S., & Dornbusch, R. (2003). *Economics*. McGraw-Hill.

Bjørnland, H. C. (2000). The dynamic effects of aggregate demand, supply and oil price shocks—A comparative study. *The Manchester School*, *68*(5), 578–607. https://doi.org/10.1111/1467-9957.00220

Bolea, L., Duarte, R., Hewings, G. J. D., Jiménez, S., & Sánchez-Chóliz, J. (2022). The role of regions in global value chains: An analysis for the European Union. *Papers in Regional Science*, *101*(4), 771–794. https://doi.org/10.1111/pirs.12674

Borjas, G. J., & Cassidy, H. (2020). The adverse effect of the COVID-19 labor market shock on immigrant employment. IZA Discussion Paper No. 13277. https://doi.org/10.2139/ssrn.3608526

Brakman, S., Garretsen, H., & Schramm, M. (2004). The strategic bombing of German cities during World War II and its impact on city growth. *Journal of Economic Geography*, *4*(2), 201–218. https://doi.org/10.1093/jeg/4.2.201

Caliendo, L., & Parro, F. (2015). Estimates of the trade and welfare effects of NAFTA. *The Review of Economic Studies*, *82*(1), 1–44. https://www.jstor.org/stable/43551463

Camagni, R., Capello, R., & Perucca, G. (2022). Beyond productivity slowdown: Quality, pricing and resource reallocation in regional competitiveness. *Papers in Regional Science*, *101*(6), 1307–1330. https://doi.org/10.1111/pirs.12696

Capello, R., & Caragliu, A. (2021). Regional growth and disparities in a post-COVID Europe: A new normality scenario. *Journal of Regional Science*, *61*(4), 710–727. https://doi.org/10.1111/jors.12542

Cardenete, M. A., & Sancho, F. (2012). The role of supply constraints in multiplier analysis. *Economic Systems Research*, *24*(1), 21–34. https://doi.org/10.1080/09535314.2011.615824

Chen, W., Los, B., McCann, P., Ortega-Argilés, R., Thissen, M., & van Oort, F. (2018). The continental divide? Economic exposure to Brexit in regions and countries on both sides of the channel. *Papers in Regional Science*, *97*(1), 25–54. https://doi.org/10.1111/pirs.12334

Chepeliev, M., Hertel, T. W., & van der Mensbrugghe, D. (2022). Cutting Russia's fossil fuel exports: Short-term pain for long-term gain (April 11, 2022). https://doi.org/10.2139/ssrn.4081300

Chupilkin, M., & Kóczán, Z. (2022). *The economic consequences of war: Estimates using synthetic controls*. https://public.tableau.com/app/profile/maxim.chupilkin/viz/EconomiesatWarAtlas/Menu

Conzo, P., & Salustri, F. (2019). A war is forever: The long-run effects of early exposure to World War II on trust. *European Economic Review*, *120*, 103313. https://doi.org/10.1016/j.euroecorev.2019.103313

Crozet, M., & Hinz, J. (2020). Friendly fire: The trade impact of the Russia sanctions and counter-sanctions. *Economic Policy*, *35*(101), 97–146. https://doi.org/10.1093/epolic/eiaa006

Crozet, M., Hinz, J., Stammann, A., & Wanner, J. (2021). Worth the pain? Firms' exporting behaviour to countries under sanctions. *European Economic Review*, *134*, 103683. https://doi.org/10.1016/j.euroecorev.2021.103683

Davis, D. R., & Weinstein, D. E. (2002). Bones, bombs, and break points: The geography of economic activity. *American Economic Review*, *92*(5), 1269–1289. https://doi.org/10.1257/000282802762024502

Dietzenbacher, E., van Burken, B., & Kondo, Y. (2019). Hypothetical extractions from a global perspective. *Economic Systems Research*, *31*(4), 505–519. https://doi.org/10.1080/09535314.2018.1564135

Dietzenbacher, E., & van der Linden, J. A. (1997). Sectoral and spatial linkages in the EC production structure. *Journal of Regional Science*, *37*(2), 235–257. https://doi.org/10.1111/0022-4146.00053

Dietzenbacher, E., Linden, J. A., & Steenge, A. E. (1993). The regional extraction method: EC input–output comparisons. *Economic Systems Research*, *5*(2), 185–206. https://doi.org/10.1080/09535319300000017

Dong, B., Ma, X., Wang, N., & Wei, W. (2020). Impacts of exchange rate volatility and international oil price shock on China's regional economy: A dynamic CGE analysis. *Energy Economics*, *86*, 103762. https://doi.org/10.1016/j.eneco.2017.09.014

Eaton, J., & Kortum, S. (2002). Technology, geography, and trade. *Econometrica*, *70*(5), 1741–1779. https://doi.org/10.1111/1468-0262.00352

ESPON. (2022). *Dataset for Interregional relations in Europe, Applied research project*. https://www.espon.eu/interregional-relations-europe-new-project-espon

European Commission. (2021). *The recovery and resilience facility*. https://commission.europa.eu/business-economy-euro/economic-recovery/recovery-and-resilience-facility_en

European Commission. (2022). *Commission welcomes political agreement on REPower EU under the recovery and resilience facility*. https://ec.europa.eu/commission/presscorner/detail/en/ip_22_7717

Ezcurra, R., & Rodríguez-Pose, A. (2014). Trade openness and spatial inequality in emerging countries. *Spatial Economic Analysis*, *9*(2), 162–182. https://doi.org/10.1080/17421772.2014.891155

Felbermayr, G., Kirilakha, A., Syropoulos, C., Yalcin, E., & Yotov, Y. V. (2020). The global sanctions data base. *European Economic Review*, *129*, 103561. https://doi.org/10.1016/j.euroecorev.2020.103561

Felbermayr, G., Mahlkow, H., & Sandkamp, A. (2023). Cutting through the value chain: The long-run effects of decoupling the East from the West. *Empirica*, *50*(1), 75–108. https://doi.org/10.1007/s10663-022-09561-w

Felbermayr, G., Morgan, T. C., Syropoulos, C., & Yotov, Y. V. (2021). Understanding economic sanctions: Interdisciplinary perspectives on theory and evidence. *European Economic Review*, *135*, 103720. https://doi.org/10.1016/j.euroecorev.2021.103720

Fratzscher, M., Grosse-Steffen, C., & Rieth, M. (2020). Inflation targeting as a shock absorber. *Journal of International Economics*, *123*, 103308. https://doi.org/10.1016/j.jinteco.2020.103308

Gambetti, L., & Musso, A. (2017). Loan supply shocks and the business cycle. *Journal of Applied Econometrics*, *32*(4), 764–782. https://doi.org/10.1002/jae.2537

Gambogi, J. (2021). Titanium and titanium dioxide. In *Mineral commodity summaries—US geological survey*. https://pubs.usgs.gov/periodicals/mcs2022/mcs2022-titanium.pdf

Garfinkel, M. R., Syropoulos, C., & Yotov, Y. V. (2020). Arming in the global economy: The importance of trade with enemies and friends. *Journal of International Economics*, *123*, 103295. https://doi.org/10.1016/j.jinteco.2020.103295

Gessen, M. (2012). *The man without a face: The unlikely rise of Vladimir Putin*. Riverhead Books.

Giesecke, J. A., & Madden, J. R. (2013). Evidence-based regional economic policy analysis: The role of CGE modelling. *Cambridge Journal of Regions, Economy and Society*, *6*(2), 285–301. https://doi.org/10.1093/cjres/rst003

Gisser, M., & Goodwin, T. H. (1986). Crude oil and the macroeconomy: Tests of some popular notions: Note. *Journal of Money, Credit and Banking*, *18*(1), 95. https://doi.org/10.2307/1992323

Glick, R., & Taylor, A. M. (2010). Collateral damage: Trade disruption and the economic impact of war. *Review of Economics and Statistics*, *92*(1), 102–127.

Guerrieri, V., Lorenzoni, G., Straub, L., & Werning, I. (2020). Macroeconomic implications of COVID-19: Can negative supply shocks cause demand shortages (April 2, 2020). University of Chicago, Becker Friedman Institute for Economics Working Paper No. 2020-35. https://doi.org/10.2139/ssrn.3570096

Gulan, A., Haavio, M., & Kilponen, J. (2021). Can large trade shocks cause crises? The case of the Finnish–Soviet trade collapse. *Journal of International Economics*, *131*, 103480. https://doi.org/10.1016/j.jinteco.2021.103480

Haddad, E. A., Araújo, I. F., Rocha, A., & Sass, K. S. (2023). Input–output analysis of the Ukraine war: A tool for assessing the internal territorial impacts of the conflict. *Regional Science Policy & Practice*, *15*(1), 8–55. https://doi.org/10.1111/rsp3.12582

Hall, R. E., & Lieberman, M. (2012). *Economics: Principles and applications* (6th ed.). South-Western.

Hamilton, J. D. (1983). Oil and the macroeconomy since World War II. *Journal of Political Economy*, *91*(2), 228–248. https://doi.org/10.1086/261140

Hamilton, J. D. (1996). This is what happened to the oil price-macroeconomy relationship. *Journal of Monetary Economics*, *38*(2), 215–220. https://doi.org/10.1016/S0304-3932(96)01282-2

Hamilton, J. D. (2003). What is an oil shock. *Journal of Econometrics*, *113*(2), 363–398. https://doi.org/10.1016/S0304-4076(02)00207-5

Hamilton, J. D. (2009). Causes and consequences of the oil shock of 2007–08 (October 2009). FRB Atlanta CQER Working Paper No. 09-02. https://doi.org/10.2139/ssrn.2583456

Hodler, R., & Raschky, P. A. (2014). Economic shocks and civil conflict at the regional level. *Economics Letters*, *124*(3), 530–533. https://doi.org/10.1016/j.econlet.2014.07.027

Hristov, N., Hülsewig, O., & Wollmershäuser, T. (2012). Loan supply shocks during the financial crisis: Evidence for the Euro area. *Journal of International Money and Finance*, *31*(3), 569–592. https://doi.org/10.1016/j.jimonfin.2011.10.007

Jonsson, O. (2023). *Hotet från Ryssland* (Mondial, Ed.).

Kapoor, I., Pratt-Rogers, W., & Kahraman, M. M. (2022). The problem of conflict minerals: A review of current approaches and a web 3.0 inspired road ahead. *Resources Policy*, *79*(September), 103064. https://doi.org/10.1016/j.resourpol.2022.103064

Kilian, L. (2009). Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market. *American Economic Review*, *99*(3), 1053–1069. https://doi.org/10.1257/aer.99.3.1053

Kilian, L., & Zhou, X. (2022). The propagation of regional shocks in housing markets: Evidence from oil price shocks in Canada. *Journal of Money, Credit and Banking*, *54*(4), 953–987. https://doi.org/10.1111/jmcb.12847

Kragh, M. (2022). *Det fallna imperiet: Ryssland och väst under Vladimir Putin* (Fri-Tanke, Ed.).

Lecca, P., Christensen, M., Conte, A., Mandras, G., & Salotti, S. (2020). Upward pressure on wages and the interregional trade spillover effects under demand-side shocks. *Papers in Regional Science*, *99*(1), 165–182. https://doi.org/10.1111/pirs.12472

Lecca, P., McGregor, P. G., & Swales, J. K. (2013). Forward-looking and myopic regional computable general equilibrium models: How significant is the distinction. *Economic Modelling*, *31*, 160–176. https://doi.org/10.1016/j.econmod.2012.11.010

Lecca, P., McGregor, P. G., Swales, J. K., & Yin, Y. P. (2014). Balanced budget multipliers for small open regions within a federal system: Evidence from the Scottish variable rate of income tax. *Journal of Regional Science*, *54*(3), 402–421. https://doi.org/10.1111/jors.12113

Lecca, P., Persyn, D., & Sakkas, S. (2023). Capital-skill complementarity and regional inequality: A spatial general equilibrium analysis. *Regional Science and Urban Economics*, *102*, 103937. https://doi.org/10.1016/j.regsciurbeco.2023.103937

Lenzen, M. (2011). Aggregation versus disaggregation in input-output analysis of the environment. *Economic Systems Research*, *23*(1), 73–89. https://doi.org/10.1080/09535314.2010.548793

Los, B. (2004). Identification of strategic industries: A dynamic perspective. *Papers in Regional Science*, *83*(4), 669–698. https://doi.org/10.1007/s10110-004-0221-3

Mamonov, M., Onega, S., & Pestova, A. (2021). *Crime and punishment? How Russian banks anticipated and dealt with global financial sanctions* (N°. DP16075; CEPR Discussion Paper). https://ssrn.com/abstract=3846165

McCann, P. (2018). The trade, geography and regional implications of Brexit. *Papers in Regional Science*, *97*(1), 3–8. https://doi.org/10.1111/pirs.12352

McGregor, P. G., Partridge, M. D., & Rickman, D. S. (2010). Innovations in regional computable general equilibrium (CGE) modelling. *Regional Studies*, *44*(10), 1307–1310. https://doi.org/10.1080/00343404.2010.530889

McGregor, P. G., Swales, J. K., & Yin, Y. P. (2006). A long-run interpretation of regional input-output analysis. *Journal of Regional Science*, *36*(3), 479–501. https://doi.org/10.1111/j.1467-9787.1996.tb01113.x

Miller, R. E., & Blair, P. D. (2009). Input–output analysis: Foundations and extensions *(Second)*. Cambridge University Press.

Nguyen, T. T., & Do, M. H. (2021). Impact of economic sanctions and counter-sanctions on the Russian Federation's trade. *Economic Analysis and Policy*, *71*, 267–278. https://doi.org/10.1016/j.eap.2021.05.004

Pandya, S. S., & Venkatesan, R. (2016). French roast: Consumer response to international conflict—Evidence from supermarket scanner data. *Review of Economics and Statistics*, *98*(1), 42–56. https://doi.org/10.1162/REST_a_00526

Patrinos, H. A., Djankov, S., Goldberg, P., & Angrist, N. (2022, April 27). *The loss of human capital in Ukraine*. CEPR.

Peek, J., Rosengren, E. S., & Tootell, G. M. B. G. M. B. (2003). Identifying the macroeconomic effect of loan supply shocks. *Journal of Money, Credit, and Banking*, *35*(6a), 931–946. https://doi.org/10.1353/mcb.2003.0046

Pichler, A., & Farmer, J. D. (2022). Simultaneous supply and demand constraints in input–output networks: The case of Covid-19 in Germany, Italy, and Spain. *Economic Systems Research*, *34*(3), 273–293. https://doi.org/10.1080/09535314.2021.1926934

Raeff, M. (1984). *Understanding imperial Russia*. Columbia University Press. https://doi.org/10.7312/raef94502

Rajput, H., Changotra, R., Rajput, P., Gautam, S., Gollakota, A. R. K., & Arora, A. S. (2021). A shock like no other: Coronavirus rattles commodity markets. *Environment, Development and Sustainability*, *23*(5), 6564–6575. https://doi.org/10.1007/s10668-020-00934-4

Remond-Tiendrez, I., & Rueda-Cantuche, J. M. (2019). *EU inter-country supply, use and input-output tables—Full international and global accounts for research in input-output analysis (FIGARO)*. Statistical Working Papers (EUROSTAT). https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2019.pdf

Rickman, D. S. (2010). Modern macroeconomics and regional economic modeling. *Journal of Regional Science*, *50*(1), 23–41. https://doi.org/10.1111/j.1467-9787.2009.00647.x

del Rio-Chanona, R. M., Mealy, P., Pichler, A., Lafond, F., & Farmer, J. D. (2020). Supply and demand shocks in the COVID-19 pandemic: An industry and occupation perspective. *Oxford Review of Economic Policy*, *36*, S94–S137. https://doi.org/10.1093/oxrep/graa033

Rodríguez-Pose, A. (2012). Trade and regional inequality. *Economic Geography*, *88*(2), 109–136. https://doi.org/10.1111/j.1944-8287.2012.01147.x

Ruta, M. (2022). Long-term effects of the war in Ukraine on global value chains. In M. Ruta (Ed.), *The impact of the war in Ukraine on global trade and investment* (1st ed., pp. 80–83). World Bank Group. https://documents1.worldbank.org/curated/en/099750104252216595/pdf/IDU0008eed66007300452c0beb208e8903183c39.pdf

S&P Global Ratings. (2022). *The macro and credit effects of Russia's invasion of Ukraine*. https://www.spglobal.com/_assets/documents/ratings/research/101248235.pdf

Su, B., & Ang, B. W. (2010). Input–output analysis of CO_2 emissions embodied in trade: The effects of spatial aggregation. *Ecological Economics*, *70*(1), 10–18. https://doi.org/10.1016/j.ecolecon.2010.08.016

Su, B., Ang, B. W., & Liu, Y. (2021). Multi-region input-output analysis of embodied emissions and intensities: Spatial aggregation by linking regional and global datasets. *Journal of Cleaner Production*, *313*(May), 127894. https://doi.org/10.1016/j.jclepro.2021.127894

The European Green Deal. (2019). Communication from the European Commission. COM(2019) 640 final, Communication from the Commission to the European Parliament, the Eruopean Council, the Council, the European Economic and Social Committee and the Committee of the Regions. COM(2019) 640 final 1.

The International Working Group on Russian Sanctions. (2022). *Strengthening financial sanctions against the Russian federation*. Working Group Paper #4. https://fsi.stanford.edu/working-group-sanctions

Thissen, M., Ivanova, O., Mandras, G., & Husby, T. (2019). *European NUTS 2 regions: Construction of interregional trade-linked supply and use tables with consistent transport flows* (JRC115439).

Thissen, M., Lankhuizen, M., van Oort, F., Los, B., & Diodato, D. (2018). EUREGIO: The construction of a global IO database with regional detail for Europe for 2000–2010 (November 16, 2018). Tinbergen Institute Discussion Paper 2018-084/VI. https://doi.org/10.2139/ssrn.3285818

Thissen, M., van Oort, F., McCann, P., Ortega-Argilés, R., & Husby, T. (2020). The implications of Brexit for UK and EU regional competitiveness. *Economic Geography*, *96*(5), 397–421. https://doi.org/10.1080/00130095.2020.1820862

World Bank. (2022). *World integrated trade solution (WITS) | data on export, import, Tariff, NTM*. World Integrated Trade Solution. https://wits.worldbank.org

Wu, L., Li, J., & Zhang, Z. (2013). Inflationary effect of oil-price shocks in an imperfect market: A partial transmission input–output analysis. *Journal of Policy Modeling*, *35*(2), 354–369. https://doi.org/10.1016/j.jpolmod.2012.01.008

Zahran, M. (2020). Can a negative supply-driven uncertainty shock cause a demand-deficient recession? *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3891156

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Almazán-Gómez, M. Á., Llano, C., Pérez, J., & Rauhut, D. (2023). Socioeconomic impacts of Russian invasion of Ukraine: A multiregional assessment for Europe. *Journal of Regional Science*, 1–22. https://doi.org/10.1111/jors.12676