The impact of the Russia-Ukraine conflict on world trade

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Keywords
Global trade, GME model, gravity model, Russian-Ukraine war

Abstract
   Following on from the Covid global pandemic, the world shared a common hope that international trade would soon get back on track. However, the events of February 2022 created a new reality as the Russian-Ukrainian war impacted on all the aspects of world trade.

   It is now predicted that world trade will decrease by 1%, which may significantly deepen the impending recession. This article is an attempt at answering the question about the effect that the Russian/Ukranian war has on world trade. The changes that have occurred in the global coal, oil, gas and grain markets are enormous. The war has disrupted global and in particular European supply chains and Russia which was one of the main suppliers of coal to Europe before the introduction of embargos has meant that the countries of the European Union must now find new sources of supply for these essentials .,Some countries, such as Germany, have, in retrospect, made strategic mistakes by closing some of their coal fired nuclear power plants and now they have to reopen these power plants, which will in turn increase their demand for coal. In addition, most Western European countries have closed their coal mines, which means that they too are now forced to import coal and while coal producers will be able to increase production it will certainly not happen before the winter of 2022 which will clearly   make things hard for most European citizens . Additionally, over 50% of gas imported to the EU comes from Russia which can cut supplies off at any moment and Europe is caught in a bind of its own making and does not know how to get out of this clinch. Russia has already cut off gas to some countries, such as Bulgaria, Poland, Lithuania, the Netherlands, Denmark, Latvia and Finland demonstrating the vulnerability of the dependent nations on their main source of supply. Moreover, European countries must find new sources of oil and petroleum-based products because starting at the end of December 2022 there will be an additional embargo imposed on the import of these products from Russia.

    The war has also disrupted the global grain market because Ukraine is one of largest grain producers in the world. Is Europe in danger of going hungry? Maybe not, but such a disruption to the supply chain can have a devastating effect on Africa. A famine in Africa may destabilize local governments and cause a new wave of immigrants into Europe. Additionally, if there is a real recession combined with high inflation and an increase in unemployment in Europe, the public mood may become radicalized, and it can thus affect the policy of the European Union. Of course, nobody knows for sure what the future will bring. Three years ago, no one thought about a pandemic and hardly anyone thought that Russia would attack Ukraine in 2022. In the face of these changes and many other unknowns, it is difficult to unequivocally predict how these events will affect the world trade of goods.

1) The Introduction
   Already before the war in Ukraine, the world economy was struggling with numerous challenges, such as climate change, diversification of energy supplies, the departure from dependence on fossil fuel resources and in the background, there was also a migration crisis and a potential next wave of of people from Africa into to Europe. These changes were accompanied by economic shocks, i.e., supply and demand shocks.

   The first such shock was undoubtedly the COVID pandemic, which caused a temporary closure of many sectors of the economy and an economic slowdown. In addition, supply chains were broken, and it highlighted how dependent the Western countries had become on Far Eastern countries, particularly China. There was a medium-term decrease in supply and a short-term decrease in demand. To avoid

recession, many countries tried to stimulate business by subsidizing the most sensitive sectors of the economy. The pandemic created a second economic shock, namely a global increase in inflation which was accelerated and intensified by the outbreak of the Ukrainian-Russian war. With the emergence of high inflation and war there was a sharp reduction in demand which significantly slowed down the GDP dynamics and caused regional recessions. The third shock derived indirectly but also directly from the above-mentioned factors that affect the world economy, mainly world trade, because the war created a significant food and energy crises. It would seem that this local crisis would not affect the global economy, but the modern world economy is a system of interconnected vessels and if there is a blockage somewhere (i.e., a bottleneck), it translates into the entire economy and globally affects such economic powers as the USA and China who also have their own internal post-pandemic problems. Russia uses the food and energy crisis as a weapon against the West. The energy crisis will contribute to the economic slowdown of the principle European economies as well as to a deterioration in the quality of life for their citizens . In addition, the food crisis may cause famine in the Middle East and African countries, which could result in new waves of migration to Europe. The aim of the article is to analyse the impact of the Russian-Ukrainian war on world trade, mainly in the area of trade in energy resources (oil, gas, coal) and agricultural products (mainly cereals: wheat, rye, corn). To better illustrate the role of Russia and Ukraine in world trade, the gravity model of trade is presented.

2) Literature review

The theory of international exchange is, next to international finance, one of the two key areas into which international economics is divided (Krugman and Obstfeld, 2009). When analysing international trade, an important question should be raised: What creates the need for international trade? Why an economic, political and social analysis of the exchange between two partners from two different countries are so different from the analysis of the effects of trade between trading partners within the domestic market? (Trebilcock and Howse, 1999). One can also ask why countries participate in international exchange. The answer seems quite simple and for two main reasons. Firstly, countries that differ from each other can benefit from each other, but only on condition that each country produces goods in which are produced better by them and are in turn desired by the potential trading partner. Second, countries trade because they take advantage of economies of scale. By producing certain goods that as a country they can do so more efficiently and on a greater scale than if it tried to produce everything , that specialisation becomes their USP in trading. Simplified illustrative models allow for a better understanding of the reasons for cooperation between countries reasons for mutual trade (Krugman and Obstfeld 2009). A. Smith in 1776 formulated the statement that when two countries voluntarily trade with each other, they must benefit from it. If any the country would lose out or not gain profits - it would resign from cooperation (Smith, 1776). The theory formulated by A. Smith is regarded as the first theory of international trade.

Traditional theories explain the flow of goods and services between countries in terms of either absolute or comparative advantages. On the other hand, old trade theories explain the flow of goods in terms of a combination of cross-country differences in factors of abundance or cross industry differences in factors of intensity ("Heckscher-Ohlin" comparative advantage). Foreign trade strengthens the state's position on the world stage. The basic effects of the development of trade between countries, presented by the first theoreticians of international economics are possible because they include mutual benefits related to the improvement of efficiency in production; the possibility of specialization and production on a larger scale, increase in salaries, increase in labour migration, exchange rate fluctuations (Krugman, 1980). Those old theories focus on "inter-industry trade" where countries export a certain type of goods and import another (Bernard, Redding, Stephen, Schott, 2007). In 1985, Krugman and Helpman integrated "old" trade theories with "new" trade theories. They combined horizontal product differentiation with an increasing model of scale. The theory of intra-industry trade assumes that it is a necessary condition in the occurrence of specialization and internal economies of scale with the simultaneous possibility of product differentiation, as well as the love of variety on the part of potential consumers, all of which play a key role in the contemporary world (Ruffin, 1999), (Serwach, 2011). However, whether the exchange between countries will take place and on what scale it will be carried out depends on the economic situation on

international markets, the specificity of the market of potential trading partners and the characteristics of products (Ziółkowski, 2013).

In 1999, Helpman introduced an enhancement in NTT combining existing model differences in technology, factor price inequality and trade costs. Nowadays, the theory of international trade is "accelerating" and mainly discusses the issue of why some enterprises venture outside the home market.

Therefore, the intensity of trade influences the conditions of international cooperation that determine the strength of each attracting other states to trade. This force may depend on certain factors such as (Ruffin, 1999):

geographical proximity, which is conducive to intra-industry trade because it creates an opportunity reducing transaction costs and transport costs. It has a special important in the case of differentiated goods, which are characterized by high elasticity of demand, i.e., they react to any decrease in demand or increase in prices, which the greater the elasticity of demand for differentiated goods, the greater intra-industry trade between countries is more intensive (Czarny, 2006).

removal of trade barriers – it strengthens the intensity of trade, which is of particular importance in intra-industry trade (cf. model gravitational trade), because, like lowering transport costs, it is an incentive to increase trade.

integration ties are positively correlated with intra-industry trade. Particularly, an increase in its dynamics is observed among the countries belonging to it to integration blocks, e.g., the European Union, CUSFTA. Integrative ties they connect countries with a similar degree of development, making the process easier liberalization (Mahdavinia, 2009).

cultural community, similarly, to economic integration, positively affects intra-industry trade. In areas that share a common cultural heritage, whose inhabitants use a common language, they have a common one religion, the intensity of the exchange is greater. Examples include Scandinavian countries, French-speaking countries and South American countries.

Other questions are why certain enterprises export and others do not, and why most companies deliver goods just for the internal market (Ziółkowski, 2013). The further development of research in the field of international trade has resulted in that in the 21st century the attention of economists was directed to the meso and microeconomic approach to international exchange. The "new new" trade theories (NNTT) try to find answer to that question (Bernard, Redding, Stephen, Schott, 2006), (Melitz, Ottaviano, 2005), (Helpman, Melitz, Rubinstein, 2007). These models provide natural explanations for some of the empirical and theoretical challenges noted above.

The main change introduced by Marc Meliz was the assumption that enterprises are differentiated in terms of productivity. The Melitz framework has stimulated a great deal of analysis into the implications of firm heterogeneity for a wide range of issues in international trade theories. The changes that have taken place in the modern world economy are to a large extent a response to globalization processes. The main factor determining exports is the productivity of a given enterprise. Those with lower productivity produce only for the domestic market, those with higher productivity for foreign markets, and finally become international enterprises (Łukasiewska, 2019).

To better illustrate the importance of Russia and Ukraine in the international trade, a gravity model was used to analyse the development of trade. The concept of the gravity equation for trade flows between states was introduced by Tinbergen.

3) Research methodology

The concept of the gravity equation for trade flows between countries as presented by Tinbergen.

Inspired by Newton's law of gravity he assumed that the value of trade between any two countries is proportional to the product of the national income of these countries and inversely proportional to the distance between them. Gravity models for panel data most often use a generalized version of the Tinbergen equation that allows for a wider range of variables explanatory variables and other explanatory variable than trade turnover (Tinbergen, 1962).

In order to evaluate the model, the python language and the gme package were used in the modelling (Herman, 2021). The GME module estimates the structural equation of gravity using the Poisson Pseudo Maximum Likelihood (PPML) estimator, which is a special case of the GLM model (Herman, 2021). In this

model, X_{ij} is the value of exports from country i to j and Y is the GDP of country i, E_j is the expenditure of country j, Y_i is global production, t_{ij} is the global cost of trade between country i and j, sigma is the elasticity between goods exchanged between countries (Herman and Ahmad, 2018). On the other hand, S_i and P_j represent mutual barriers between exporting and importing countries (access to the market of the importing country by the exporter):

$$X_{ij} = \frac{Y_i E_j}{Y} \left(\frac{t_{ij}}{S_i P_j} \right)^{1-\alpha}$$

The PPML approach was used where a variety of fixed effects are possible. In the packed? for the estimation the following equitation was used:

$$X_{ijt} = exp[\gamma_{it} + \eta_{jt} + \lambda_{ij} + \beta Z_{ijt}] + \varepsilon_{ijt}$$

where: γ_{it} are exporter time-varying fixed effect, η_{jt} are importer time-varying fixed effects, λ_{ij} are exporter-importer time-invariant fixed effects, and Z_{ijt} is the vector of time-variant bilateral determinants of trade (Herman and Ahmad, 2018).

The PPML followed the approach in the packed introduced by Santos Silva and Tenreyro (2006). In addition, fixed effects were taken into account in the modelling (Modelling multilateral trade resistance in a gravity model).

4) Findings/results

In this analysis, the classical gravity model of trade was used . During modelling the CEPII data was employed to estimate gravity equations. The analysed model includes 36 countries. These are the countries of the European Union, Great Britain, the United States, Brazil, South Africa, Australia, India, China, Ukraine and Russia. The choice of these countries was not accidental. Due to the fact that the conflict in question is taking place in Europe, most of the countries are European countries. In addition, major exporters/importers from other regions of the world with which either Russia or Ukraine has had economic ties were also selected. The classic Tinbergen model reflects well the factors affecting the volume of trade, the main factor being the size of the GDP or the size of the population of a given country. In the model the following variables were considered: contig (dummy equal to 1 if countries are contiguous), comlang_off (1 if countries share common official or primary language), comlang_ethno (1 if countries share a common language spoken by at least 9% of the population), comcol (1 if countries share a common colonizer post 1945), dist (simple distance between most populated cities in km), GDP (current thousands US$), tradeflow_baci (trade flow (in thousands current US$) (source: BACI)). As mentioned above, size matters. The size of country's GDP stimulates new trade streams, and geographical location also affects the size of trade. A common language or cultural community is also important, it also facilitates trade. The variables used in the model are statistically significant and affect foreign trade (see table in the appendix; more extensively in the next section).

5) Discussions and conclusions

Despite the war and huge uncertainty, it is forecast that global trade should hit a record $32 trillion in 2022 but the economic slowdown which began in the half of year will be strongly visible in 2023.

For trade development currently the following factors are important:

war between Russia and Ukraine,

mainland China approach towards COVID,

not fully restored supply chains in post-COVID world,

uncertainty among some regions, e.g., Israel-Iran, Turkey-Greece, mainland China -Taiwan, North Korea vs. South Korea and Japan,

economy slow down/regional recessions.

The Russia-Ukraine war has significantly disrupted the global energy markets , mainly fossil fuels in Europe.

Looking at Russia's exports in general, the main products that this country exports are: Crude oil, Refined Petroleum Products, Precious metals, Coal and coke, Natural gas, petroleum gases and gaseous hydrocarbons. Together, these five products account for over 50% of total exports in terms of value.

According to S&P Global Market Intelligence Statistics Russia was the third-largest exporter of coal after Australia and Indonesia in 2021. Moreover, these three countries together reach more than 60% of the global coal exports in 2021, leaving all others far behind. When it comes to global ranking of coal importers, the top three positions were taken by India, mainland China, and Japan. Accounting for 607 million metric tons of coal imports in 2021 (Ziółkowski, 2022).

Major coal Exporters (USD, metric tons)

Reporter	2019		2020		2021	
	USD	Quantity	USD	Quantity	USD	Quantity
Australia	44,507,603,891.00	396,629,912.00	29,686,869,199.00	371,342,685.00	47,261,946,028.00	365,782,069.00
Indonesia	18,866,280,671.00	374,935,888.00	14,547,620,657.00	341,547,645.00	26,538,187,677.00	345,453,174.00
Russia	15,987,182,860.00	205,395,796.00	12,388,244,071.00	197,928,585.00	17,583,741,551.00	210,695,349.00
United States	9,859,335,663.00	85,023,949.00	6,055,058,454.00	62,525,524.00	9,751,628,946.00	77,192,182.00
South Africa	4,735,283,626.00	78,507,416.00	3,838,446,089.00	74,897,399.00	6,039,830,030.00	66,252,295.00
Colombia	4,883,977,407.00	71,549,084.00	3,542,690,382.00	67,834,586.00	4,380,488,439.00	55,600,381.00
Canada	5,334,481,024.00	36,564,934.00	3,389,503,697.00	31,537,494.00	6,094,355,196.00	31,654,877.00
Netherlands	3,111,117,138.00	27,578,028.00	1,857,535,241.00	19,580,783.00	3,306,263,579.00	24,735,368.00
Philippines	460,551,700.00	11,035,512.00	231,103,391.00	7,358,231.00	596,372,203.00	10,592,949.00
Kazakhstan	197,001,225.00	2,224,594.00	114,620,989.00	1,390,314.00	199,525,917.00	7,182,942.00

Source: Own calculations based on: S&P Global Market Intelligence. Global Trade Analytics Suite

Major coal Importers (USD, metric tons)

Reporter	2019		2020		2021	
	USD	Quantity	USD	Quantity	USD	Quantity
India	22,624,479,318.00	249,317,774.00	15,866,956,247.00	218,252,668.00	25,669,044,910.00	219,823,514.00
China	18,929,929,599.00	197,267,753.00	16,367,187,858.00	204,917,090.00	26,841,223,939.00	204,569,741.00
Japan	23,194,819,463.00	186,207,844.00	15,947,691,114.00	173,754,558.00	24,988,778,287.00	182,629,409.00
South Korea	14,093,332,771.00	141,400,469.00	9,503,444,424.00	123,493,338.00	14,533,919,660.00	125,616,496.00
EU (External Trade)	14,125,386,437.00	120,262,680.00	7,085,740,855.00	78,451,983.00	13,853,343,019.00	98,763,630.00
Taiwan	6,984,007,016.00	67,088,626.00	4,933,876,630.00	63,032,845.00	8,096,502,310.00	68,784,699.00
Germany	4,594,033,404.00	41,351,123.00	2,719,867,544.00	29,731,446.00	5,278,182,877.00	38,663,711.00
Netherlands	4,338,821,457.00	38,305,995.00	1,728,441,494.00	22,591,974.00	5,153,794,690.00	37,409,394.00
Turkey	3,514,808,314.00	37,752,670.00	2,729,846,824.00	40,245,940.00	4,064,011,605.00	36,533,609.00
Malaysia	2,918,889,329.00	34,435,766.00	2,298,887,394.00	36,095,850.00	4,006,097,476.00	35,079,313.00

Source: Own calculations based on: S&P Global Market Intelligence. Global Trade Analytics Suite

If we take into account a more detailed breakdown of coal into more granual structure: anthracite and bituminous coal, among the top five exporters of anthracite coal were Russia, Indonesia, China, South Africa, and Peru, while the top five importers were China, South Korea, Japan, the EU, Ukraine, and Russia. Therefore, Russia, China, and Indonesia were both the largest exporters and importers (Ziółkowski, 2022).

Major Anthracite Coal Exporters (USD, metric tons)		
Reporter	**USD**	**Quantity**
Russia	2,068,856,581.81	24,738,768.56
Indonesia	222,378,802.70	1,889,192.09
China	355,315,589.00	1,495,849.60
South Africa	92,014,654.11	1,286,053.63
Peru	61,190,201.11	823,209.98
Belgium	131,349,339.93	770,506.83
Vietnam	101,287,219.89	674,377.97
United States	45,292,486.00	331,238.00
Netherlands	55,750,996.76	302,990.62
EU (External Trade)	31,402,951.99	154,511.82

Source: Own calculations based on: S&P Global Market Intelligence. Global Trade Analytics Suite

Contrary to that, top five exporters of bituminous coal were Australia, Russia, Indonesia, the US, South Africa, and the top five importers were Japan, mainland China, South Korea, the EU, Taiwan, and Turkey.

Major Bituminous Coal Exporters (USD, metric tons)		
Reporter	**USD**	**Quantity**
Australia	47,261,323,547.28	365,779,310.50
Russia	15,439,802,661.87	184,722,880.32
Indonesia	6,963,255,068.60	71,386,734.84
United States	9,465,604,844.00	71,035,751.00
South Africa	5,835,466,305.71	63,710,115.79
Colombia	4,373,198,569.19	55,490,660.13
Canada	6,083,473,558.13	31,570,406.00
Netherlands	2,451,731,730.74	17,837,668.17
Kazakhstan	161,172,092.58	6,184,143.79
Poland	557,412,481.34	3,672,627.55

Source: Own calculations based on: S&P Global Market Intelligence. Global Trade Analytics Suite

Russia was a major exporter —more than 50% of the thermal coal supply to Europe comes from that country. Some Europen Union countries are completely dependent on Russian coal (more than 90% of their coal imports coming from Russia). These countries include Cyprus, Lithuania, Greece and Romania. Although the above-mentioned countries are heavily dependent on Russia, the same measure cannot be applied to everyone, because if we look at the volume expressed in metric tons, countries such as Cyprus or Greece import little compared to other importers. In addition to the countries listed above, we can also distinguish those for which imports from Russia accounts for over 50%. These countries include Bulgaria, Poland, Denmark, Croatia, Ireland, and Italy (Ziółkowski, 2022).

As a result of the above events, some European countries have reoriented their coal imports. Currently, the main suppliers are Colombia, Australia and South Africa. Russia, on the other hand, exports its coal to the countries of the Far East, mainly China and India. In addition, some countries, such as Poland have increased their domestic production, while Germany reopened its closed mines. In addition, the technological progress that is taking place in Europe in the perspective of two decades will mean that coal will not be used in energy production, and it will only be an oregarded as an emergency backup source .

The war also disrupted oil and gas supplies. The changes that have been initiated as a result of warfare will have far-reaching effects. A significant number of the countries of Western Europe, or more broadly speaking, the "Western world", have decided not to extend their oil supply contracts from the Russian direction. This reorientation of supplies has certain consequences. As a result of these changes, Russia is losing its position as the vice-leader in oil exports, and in the longer term, the importance of this country will decrease. The main exporter in 2022, both in terms of volume and value, is Saudi Arabia (351 mln t and $240 bilion). According to the current forecast the share in 2022 is equal to 15.6% but by the end of the forecast period will decrease to 9.1%. Russia, which was holding the second place till 2021 (with volume 224 mln t and value $111 bln), will be losing its position and at the end of the forecast period will reach 6th place with a share of 6.7%.

Top 5 Oil Exporters shares (%)	2021		2022		2025	
	USD	Volume (metric ton)	USD	Volume (metric ton)	USD	Volume (metric ton)
Saudi Arabia	14.7%	14.5%	16.7%	15.6%	16.1%	15.1%
Russia	10.6%	10.7%	7.8%	9.4%	4.6%	5.9%
Canada	7.6%	7.8%	8.5%	10.8%	8.8%	11.1%
Iraq	7.3%	7.6%	7.7%	7.8%	8.4%	8.5%
United Arab Emirates	6.8%	6.7%	7.9%	7.3%	7.8%	8.1%
United States	6.6%	6.6%	7.6%	7.2%	8.5%	7.0%

Source: Own calculations based on: S&P Global Market Intelligence.

In terms of crude oil imports, the main importers are China (share of world imports 21.0% in 2022 and 26.4% at the end of the forecast), the United States (16.0% and 19.8% respectively) and India (9.8% and 11.5% respectively).

Top 5 Oil Importers shares (%)	2021	2022	2025
	Volume (metric ton)	Volume (metric ton)	Volume (metric ton)
China (mainland)	22.7%	21.0%	22.1%
United States	13.0%	16.0%	16.2%
India	10.0%	9.8%	10.2%
South Korea	6.1%	6.2%	5.8%
Japan	5.8%	5.8%	5.3%

Source: Own calculations based on: S&P Global Market Intelligence.

As for gas exports, the United States will remain the main gas exporter until the end of the forecast period, but its share in global exports will increase significantly from 14.6% to over 40% at the end of the forecast period.

Top 5 Gas Exporters shares (%)	2021	2022	2025
	Volume (metric ton)	Volume (metric ton)	Volume (metric ton)
United States	32.3%	14.7%	17.0%
Qatar	7.1%	10.2%	11.3%
Australia	6.7%	8.9%	6.0%
Norway	5.1%	9.8%	10.1%
Russia	4.6%	5.1%	3.8%

Source: Own calculations based on: S&P Global Market Intelligence.

Qatar takes second place with a share of 10.2%, while in 2040 this share will decrease to 7.9%. The third exporter is Norway, but its share in the global exports will decrease (from 9.8% to 5.1%). Australia comes next with shares of 8.9% and 3.7% respectively. Among the top five exporters will be Russia, which

is currently redirecting its supplies from the west to the east. Its share in global exports was 5.1% in 2022 and will decrease (2.4% at the end of the forecast period).

As for gas imports, the main importers are Mexico (18.5% share of global imports in 2022 and 28.5% at the end of the forecast), Germany (7.2% and 5.9% respectively) and China (7.2% and 8.4% respectively).

Top 5 Gas Importers shares (%)	2021 Volume (metric ton)	2022 Volume (metric ton)	2025 Volume (metric ton)
Mexico	21.5%	18.5%	21.3%
Germany	9.3%	7.2%	8.2%
China (mainland)	8.6%	7.2%	7.1%
United States	5.8%	8.3%	5.8%
United Kingdom	5.2%	7.5%	6.5%

Source: Own calculations based on: S&P Global Market Intelligence.

In 2021, the main countries from which Russia imported products by value were China, Germany, Belarus, South Korea, Italy. Their share in the total imports by Russia was respectively: 26.5%, 11.5%, 5.7%, 3.6%, 3.3%. However, if we take into account the main markets to which Russia exports its goods in terms of value, these are: China, the United States, Turkey, the Netherlands. It should be emphasized that significant numbers of exports to Western European countries and the United States will decrease as a result of the embargo imposed on imports of goods from Russia. In the long term, there will be a relocation of Russia's exports from Western Europe to the countries of East Asia and the Middle East. It should also be remembered that African countries may be a potential recipient of Russian goods.

Russia's aggression against Ukraine is already significantly affecting the prices of agricultural products, mainly cereals. These two countries together account for a quarter of global wheat exports. A sharp decline in exports from Ukraine and Russia will reduce the global supply of cereals and will affect food security in many regions of the world - especially in Africa and the Middle East. Due to the rich soils and geographical locations of Russia and Ukraine, Russia was one of the main exporters of cereals to these markets. In addition, the climate changes that are taking place in the modern world are having a negative impact on the production capacity in other countries of the world, which further delays the possibility of replacing Russia and Ukraine with other producing countries of equal capacity.

As for other grains, Ukraine and Russia also played a significant role. Russia and Ukraine were the fifth and sixth exporters of rye, respectively. Their share in world exports was over 10%. The largest exporter is Poland - 40% of world exports, however, due to geographical proximity to Russia and Ukraine and the uncertain situation on the cereals market, Poland reduced its exports, retaining part of the surplus in warehouses.

Ukraine was the world's third largest sunflower exporter. The sunflower is a plant with many uses. The two main directions of production are cultivation of seeds for direct consumption or for processing, e.g., for oil. The sunflower is the fourth largest crop among oilseeds. The seeds are used to produce food and fodder, while the dried stems and oil can be used to produce biofuels.

Ukraine is the first corn exporter in Europe and the third in the world after the United States and Argentina. Unlike wheat, the EU is a net importer of corn, which is essential for feed production.

Top 5 Exporters shares (%, 2021)							
Wheat		**Rye**		**Corn**		**Sunflower**	
Russia	13.3%	Poland	40.7%	United States	38.2%	Canada	30.2%
Australia	12.7%	Germany	19.0%	Argentina	18.2%	Australia	13.1%
United States	12.5%	Latvia	5.3%	Ukraine	11.8%	Ukraine	11.4%
Canada	11.5%	Canada	5.3%	Brazil	10.0%	Romania	8.4%
Ukraine	9.9%	Russia	5.3%	Romania	3.2%	France	6.1%

Source: Own calculations based on: S&P Global Market Intelligence.

The European Union, to make up for the declining imports from Ukraine, is likely to increase purchases of maize from the USA, Brazil and Argentina (these three countries account for approximately 65% of global corn exports) there is also an alternative possibility - the EU will allocate more wheat for food production which will result in an even greater reduction in the supply of this grain. It should not be forgotten that Ukraine and Russia are among the top ten exporters of barley and oats. The most important recipients of Ukrainian wheat were Egypt, Indonesia, Turkey, Pakistan, Morocco; Ukrainian sunflower: Germany, Holland, Belgium, Pakistan, France; Ukrainian corn: China, Spain, Netherlands, Egypt.

6) Limitations and direction for future research

The study shows that the gravity model is successful and can be used to describe international exchange. Uncertainty in the global market is high. The COVID pandemic has already disrupted global supply chains and slowed down the production process. The Russian-Ukrainian war is having a significant impact on the post-pandemic economy. All forecasts are affected with quite a large error, namely the underestimation of all variables affecting the model. Some statistics can be unreliable. Russia and China do not currently show full foreign trade statistics, one country due to the war and the other due to the ongoing restrictions related to COVID, which affects the export capacity of this global giant. Another uncertain factor is the lack of full statistics for Q4 2022. In addition, constant new embargoes also force further adjustments to world trade forecasts.

Bearing in mind the saying of President John Kennedy that "the tide raises all boats", we can apply this to the global situation, who can cope with these difficult conditions and will sail into global waters of prosperity?

Appendices

Generalized Linear Model Regression Results

Dep. Variable:	tradeflow_baci	No. Iterations:	1000		
Model:	GLM	**Df Residuals:**	19381		
Model Family:	Poisson	**Df Model:**	1167		
Link Function:	Log	**Scale:**	1.0000		
Method:	IRLS	**Log-Likelihood:**	-1.4557e+10		
Covariance Type:	HC1	**Deviance:**	2.9113e+10		
No. Observations:	20549	**Pearson chi2:**	3.83e+10		

	coef	std err	t	P>|t|	[0.025	0.975]
gdp_o	1.757e-10	9.23e-12	19.023	0.000	1.58e-10	1.94e-10
gdp_d	3.492e-08	5.69e-10	61.356	0.000	3.38e-08	3.6e-08
contig	0.7295	0.023	31.252	0.000	0.684	0.775
comlang_off	1.0092	0.057	17.851	0.000	0.898	1.120
comlang_ethno	-0.5497	0.060	-9.178	0.000	-0.667	-0.432
comcol	1.9954	0.082	24.373	0.000	1.835	2.156
dist	-0.0002	6.48e-06	-25.729	0.000	-0.000	-0.000

All model results contain 121 pages. Just first page presented.

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