# Modeling of some aspects of the impact of the war in Ukraine on the food security of European countries

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Given the current difficult socio-economic and political conditions associated with the war in Ukraine, the consideration of food security issues in the EU countries is important and relevant. The russian invasion of Ukraine is a clear example of the vulnerability of both the national and global economies to the consequences of armed conflicts. These impacts include reduced grain production in the agricultural sector, crop failures, disruptions to global food supplies and rising world food prices. Known as the «breadbasket of Europe», Ukraine boasts a significant 25 % of the world's black soil, fueling a highly developed agricultural sector that contributed over 10 % of its GDP in 2021 [1]. Both Ukraine and russia are major global grain exporters. which together account for 40 % of world grain exports. The ongoing conflict between russia and Ukraine, lasting more than a year and a half since the russian invasion on February 24, 2022, has raised concerns around the world about international trade and food security [2].

The UN has warned that the combination of the COVID-19 pandemic and the russian-Ukrainian crisis has led to the biggest food crisis since World War II. The war of the russian federation against Ukraine has clearly demonstrated the vulnerability of national and world economic systems to armed conflicts and their consequences: a slowdown in agricultural grain production, crop failures, disruption of world food supplies and rising world food prices. Ukraine and russia account for about 30 % of world wheat exports and 15 % of corn, as well as about 80 % of trade in sunflower products [3].

Currently, about 1/3 of Ukrainian fields remain unsuitable for sowing due to hostilities. As a result, the continued war of the russian federation against Ukraine will lead to deep economic shocks that will affect the liquidity of agricultural producers, the growth of world demand for agricultural products, the reduction of food stocks in many countries, rising food prices and accelerating inflation. As a consequence, this conflict has led to a significant increase in world food prices, with far-reaching consequences [4]. For a possible solution to the problem of the negative impact of the war in Ukraine on the food security of European countries, the structure of exports from Ukraine to European countries is analyzed. Based on the dominant commodity positions in the overall structure of Ukraine's exports, the supplies of wheat, corn and sunflower oil are considered. On the basis of multivariate regression analysis, the impact of Ukrainian food exports on the corresponding world prices, as well as on the food security of European countries, was studied. Strategic measures have been developed to reduce the impact of the war in Ukraine on the food security of European countries [5].

The detail structure of Ukrainian exports and proportions are illustrated on Fig. 1. The largest export positions are taken by “10 Cereals” which accounts for 20.6 %, “15 Animal or plant fats and oils”- 13.5 % and “12 Oil seeds and fruits”-8,5 %.

Let is calculate the models of the interdependence of $Y_i$ – the Harmonized Index of Consumer Prices (food) (HICP (food)) on the volume of Ukraine`s main food exports and natural gas from russia by the countries that are the largest food importers from Ukraine: Germany, Hungary, Italy, Netherlands, Poland, Romania, Spain.

Will consider such factors:

- $X_i$ – Wheat, export from Ukraine,
- $Z_i$ – Maize, export from Ukraine,
- $C_i$ – Sunflower /cotton-seed oil and their fractions; whether or not refined, but not chemically modified, export from Ukraine,
- $S_i$ - Sunflower seeds; whether or not broken, export from Ukraine,
- $P_i$ - Petroleum gases and other gaseous hydrocarbons, Import from russian federation:

Germany: $Y_1 = 138{,}412 - 6{,}3376S_1 - 0{,}9516P_1$, $R^2$=60,93 %
Hungary: $Y_2 = 171{,}98 + 0{,}7273Z_2 - 1{,}5583S_2$, $R^2$=42,28 %
Italy: $Y_3 = 121{,}261 + 12{,}881S_3 - 0{,}0054P_3$, $R^2$=88,42 %
the Netherlands $Y4 = 130{,}938 + 1{,}8436Z_4 - 0{,}2352P_4$, $R^2$=66,88 %
Poland: $Y_5 = 152{,}538 + 3{,}23466X_5 + 3{,}076Z_5 - 3{,}3307P_5$, $R^2$=65,34 %
Romania: $Y_6 = 127{,}591 + 0{,}1521Z_6 + 0{,}2515C_6 - 0{,}2861S_6$, $R^2$=66,87 %
Spain: $Y_7 = 119{,}878 + 0{,}9998X_7 + 1{,}3464Z_7$, $R^2$=74,33 %

The russian invasion of Ukraine has starkly illuminated the vulnerabilities of both national and global economies to the ramifications of armed conflicts. The impact encompasses diminished grain production, crop failures, disruption of food supply chains, and elevated global food prices. The ongoing conflict heightens concerns about exacerbating energy and food security challenges on a global scale. This war's effects extend to substantial increases in cereal and oil prices, contributing to global inflation. The interdependency of over 1.7 billion individuals on these nations for their sustenance elevates the significance of their stability.

Analyzing the problem of food security, one of the solutions is to change the supply chains. In particular, it is necessary to decentralize the grain supply system by sea. For this purpose, the Black Sea Grain Initiative served as a kind of shield for Ukrainian exports.


Figure 1 – Export of Ukraine, % of the total volume (developed by the author)

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Conducted research based on multifactor regression analysis confirmed hypnoses of the existence for each country - exporter of Ukrainian food products of its components from a set of main product items, which affect the HICP (food) of these countries during the military conflict. In particular, sunflower oil from Ukraine and natural gas from russia turned out to be such for Germany; Hungary - Export Maize from Ukraine; Italy - mostly sunflower oil from Ukraine and a small amount of natural gas from russia; the Netherlands – export of Ukrainian sunflower and natural gas from russia; Poland - export of wheat, maize and natural gas from russia; Romania - export of maize, sunflower and sunflower oil from Ukraine; Spain - export of wheat and maize). The level of influence of these indicators on the formation of the HICP (food) for each country was found.

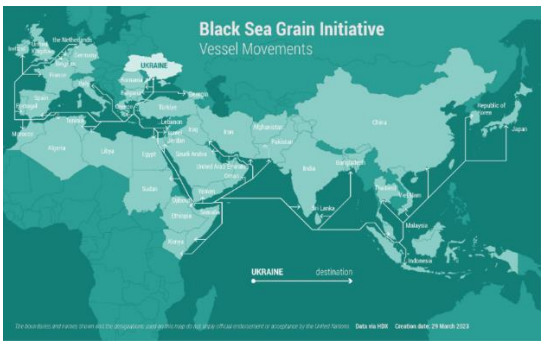


Figure 2 – Black Sea Grain Initiative: Vessel Movements

*Source: The Humanitarian Data Exchange (HDX): https://data.humdata.org/showcase/bsgi-vessel-movements*

Enhancing the precision of calculations could be achieved through the inclusion of a broader range of influential factors and adjusting the specifications of the calculated models by altering the data sample. However, due to constraints related to data availability and the time frame covered, such an approach is not feasible. It's important to note that the models generated are not employed for predictive purposes or to establish precise predictive values. Instead, they serve as a foundation for insightful analysis, but serve as a basis for meaningful analysis, which allows making some assumptions in view of the statistical criteria of the calculated models.

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