THE EFFECT OF RUSSIAN INVASION OF 2022 ON UKRAINE'S INTERNATIONAL TRADE

by

Klymenko Marko

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Thesis Supervisor: _____ Professor Elena Besedina

Approved by _____

Head of the KSE Defense Committee, Professor

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Date _____

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ABSTRACT

TITLE

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Russian invasion of 2022 has made profound changes in the world, changing global security and economy. It has also tremendous effect on the Ukrainian economy, with mass migration, destruction of human capital and productive capacity. It also negatively affected Ukraine's ability to engage in international trade. The flow of grain exports that were shipped by marine transport from Ukraine had stopped for nearly 6 months and required UN and Turkey mediation to resume. Other changes in trade are not as visible as Ukrainian export profile consists of not only agricultural goods, but also iron, steel, ore and machinery.

In this work, we try to evaluate the effect of the war on Ukrainian exports using gravity model. In particular, we look at extensive and intensive export margins as well as average volume per category using HS 2-digit and HS 6-digit trade statistics. The data covers 2017-2022 and explores Ukraine's top export categories, as well export as a whole.

The war seems to have a diverse effect across different categories of goods. While agricultural goods export suffered a moderate decrease and fast recovery, the exports of iron, steel and ore decreased substantially with little to no recovery. The results suggest that non-agricultural exports appear to be more vulnerable to disruption of trade by war, in particular, due to the sea routes blockade.

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LIST OF ABBREVIATIONS

EU. European Union.

GRP. Gross Regional Product.

LFS. Labor Force Survey

FTA. Free Trade Agreement

IIP. Index of Industrial Production

WTO. World Trade Organization

HS. Harmonized system

AVE. ad-valorem equivalent

Chapter 1

INTRODUCTION

The Russian full-scale invasion started in February 2022 has been affecting Ukraine not only directly through devastation and occupation of the territory but also brought tighter control of the state, increases in spending, and fiscal uncertainty (Blanchard and Pisani-Ferry, 2022). The effect of war on the ordinary life of citizens in the first weeks of invasion appeared in empty shops, panic and uncertainty. The increased demand for food, medicine and basic utilities surge could not be matched but the available supplies. But as the time goes on, the equilibrium returns, demand decreases and supply is available. In goods where domestic product is not available, the imported one becomes available. Therefore, the effect of the war as whole is both a shock and constant stress.

Initial assault on Kyiv and across other axis of advance, not only due to military movements and battle, but exodus of citizens, empting the shelfs and lines at water stations. This was the initial shock, which ended in early April, when Russian Armed Forces retreated from Kyiv, Chernihiv, Zhytomyr and Sumy oblasts and the battle of Kyiv was won by UAF. The next month's saw battles in Donetsk, Luhansk, Kharkiv, Mykolaiv, Zaporizhzhia and Kherson oblast, the frontline was stabilized and therefore Ukraine's survival as a state became certain. However, mass migration of the workforce, martial law and draft became a strain on the economy. During the first year of the war, the estimated decrease of Ukraine's economy was estimated as 35%[1]. The unemployment increased to 24.5% in December 2022, compared to 2021.

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[1] ACAPS, Impact of conflict on the Ukrainian economy: implications for humanitarian needs, 2022. https://www.acaps.org/sites/acaps/files/products/files/20230213_acaps_thematic_report_of_the_impact_of_conflict_on_the_ukrainian_economy.pdf

Internarial trade also suffered a significant decrease due to the war. Total imports in Q1 2022 fell by 23%, compared to Q1 2021. Total exports were less affected in Q1 2022 given that one and a half months of normal trade somewhat mitigated the effect, did not decrease but increased by 3.7% compared to Q2021. However, in the second quarter of 2022, the effect is more visible, both exports and imports fell by 46.5% and 42.2%, respectively. Furthermore, even though there was an overall decrease in import and export, trade flows with some countries were less affected. For example, Poland only saw a decrease by 35% in import and 37% in import. Later in the year, a recovery was observed, as well as an increase in the share of neighboring countries in Ukraine's exports.

In this paper, a gravity model is used to estimate the effect of the war on Ukraine's disaggregated exports. The gravity model is used to explain import and export of a given country by the relative size of their trading partners' economies, represented by GDP in most studies, and by a set of control variables, such as distance, common border, language, trade policies, such as FTA, and so much more, deeper discussed in literature review. But the main idea of the gravity model comes from Newton's Law of Universal Gravitation, which states that heavy celestial bodies attract each other. A simple concept, in turn, explains the attractiveness and potential trade of two given countries by their size and distance (Head and Mayer, 2014).

This explains the relatively lower magnitude of the decrease in trade from and to Poland and Baltic Countries, compared to Germany and France or China, due to simple geographical features. The precise effect of war for China is also different not only due to distance, but also trade logistics. Most of the Ukraine grain trade before February 2022 has been going through seaports of Odessa, Mykolaiv and Kherson. The proportions were different before 2014, when the Crimean Peninsula was illegally annexed by the Russian Federation, not only in terms of

seaports of the said peninsula, but sea ports of Azov sea, the access to which was lost shortly after the construction of the Kerch Bridge. The bridge itself is suitable for the passage of cargo ships of a certain size, as Rostov port was and is being used. It was the policy of the Russian Federation and its economic war on Ukraine that closed the passage of cargo ship used in Mariupol or Berdiansk ports.

Therefore, the impact is not only in changes in trade partners, but in trade routes. The cost of seafaring is lower to rail transportation, so even with the same destination, the transportation costs are different. This increases the price and, in turn, decreases the competitive edge of Ukraine's goods. During the war, the land route saw an increase in throughput. And not only trade by neighboring countries, such as Poland and Romania, but also all other counties, which re-routed they trade with Ukraine through sea-port (and then rail) of Lithuania and Poland (Hans von der Brelie, 2022).

Changes in the trade can be evaluated in terms of extensive and intensive margins. Extensive margin of trade represents the variety of goods exported, while intensive – their volume. Changes in both of these factors of trade are fundamental. As such, decrease in extensive margin is associated with lower market presence, as not all possible export opportunities are taken. For Ukraine this means that goods on potential markets can be substituted after a long period of zero trade flow, losing the market share they had before the war. Therefore, there are possible difficulties in the continuation of export in this category for Ukraine.

This study aims to discuss the influence of war on international trade in both extensive and extensive margins. My research focus is on how much the invasion changed Ukraine's exports. In this thesis I want to investigate the direction and magnitude of such changes in the structure of Ukrainian foreign trade. The novelty of research comes from the fact the conflict described is still ongoing and results presented should be early in research of the topic as a whole.

The rest of the thesis is structured as follows. Chapter 2 presents a literature review of related studies, with a special focus on gravity model. Chapter 3 discuss the details of the methodology used. Chapter 4 contains the description of the data, while Chapter 5 presents the estimation results and their interpretation. Chapter 6 draws some conclusions and provides policy advice.

Chapter 2

LITERATURE REVIEW

The topic of the effect of war on trade has been vividly discussed for a long time. In National Power and the Structure of Foreign Trade, Hirschman (1945) writes that discussion about state is also discussion about war. Further in the book the war is presented as a continuation of policies and as a result of them. In particular, the policies concerning international trade are the most influential in state affairs. The argument was made that economic concerns and needs of German state draw it for expansion. The desire to find markets for export and import draw was an important aspect of state policy. In this way, imperialistic Germany wanted to fulfill her ambitions for a better place on the world scene through war (Ward and Hoff, 2005). The argument is that the war in general seems to change the structure of trade and change overall patterns of it.

In this regard, as discussed by Krpec and Hodulak (2019), war not only brings direct losses to all affiliated sides of conflict but also indirectly affects third-party countries. Main mechanism of this is international trade. As war starts, trade between nations decreases or ceases at all, and so does the trade with other countries. States at war see the decrease in trade with them and also may find some import reliant sectors of the economy struggle. War also makes previously available markets unavailable due to breakdown in trade routes. Some countries find changes from war profitable, as a way to open new markets for their goods, especially raw. Prime example is the USA after World War I, when exhausted and demolished European countries, such as Britain and France, were forced to decrease their economic influence and trade with South American countries. In turn, the US used this opportunity for expansion of their industrial exports, while also continuing their protectionism policies. Furthermore, export of raw material and agricultural

products also increased. This was due to increasing demand by the European countries, which led to the increase in price. It is concluded by Krpec and Hodulak (2019) that this surge of prices during and after the war led to the Great Depression, as many businesses and farmers took the loans they could not repay when the price stabilized.

In further understanding the impact of war, it is needed to define goods that are traded. Broadly, those are commodity goods, raw material, agricultural products and manufactured goods. Markets for those goods were a reason for many colonial wars and both world wars as well. Manufacture of goods led to a higher added value and higher wealth. Thus it was paramount for countries to secure production of such goods to ensure prosperity of the nation. In this regard, the structure of international trade, a ratio of manufactured goods and commodity goods, is a measure of success and development Krpec and Hodulak (2019).

Therefore, the approach of measuring the impact of war is not only through the overall export and import level but also the trade structure. As the world moved from the colonial wars and so did the theory about war and trade. In the post World War II world, for European countries peace was perceived through trade, as conflict and trade theoretically have negative correlation Polachek (1980). In this paper, 10-year data from 1958 to 1967, about pairs of countries, their export, import and country characteristics were used to explain the net conflict index. This index shows the frequency of conflict events, ranging from sanctions and embargoes to full-scale war. As it can be assumed the trade and conflict may influence one another Pollins (1989), two-stage least squares were used to account for simultaneous effect. The result is that doubling trade would lead to a 30% decrease in the frequency of conflict Polachek (1980).

This conclusion is not supported by Barbieri and Schneider (1999), where they cite that although the model presents statistically significant results, it does not answer

the question about conventional war. From the work as a whole it is evident that the relationship of trade and conflict is often observed through prevention or explanation of war. The study itself concludes that multiple explanations exist and there is a divide between theoretical and empirical approaches, as the former states the inability of international trade to pacify states by itself, and the latter relying on experience of democratic peace to prove the possibility of peace through trade.

A popular method of studying and predicting trade and trade flows is the gravity model. It is built on a principle Newton's Law of Universal Gravitation Yotov et el. (2014), where celestial bodies are attracted to each other by their mass and distance. In this way, the gravity model explains trade between countries by their size of the economy and distance. In this regard, close relation to physics was the reason of the low popularity of the model at the very beginning of its development, Head and Mayer (2014).

It certainly raises the question if distance or borders should be accounted for in the modern globalized world. The model explains very well the differences in trade among countries and the reason Japan and the EU countries do not have relatively the same amount of trade flowing between them, compared to Japan and Korea.

As the model became used on a wider scale, it required more specification to explain better the differences in trade. The multilateral trade resistance term was supplemented by variables, such as language, common border or trade policies. In this way those variables can be explained and discussed each of their own. This was an improvement in explaining the power of gravity model. The model was also expanded with fixed effects, which explains features of the countries that are static or have little changes in time. Fixed effects are close in the regard to Ricardian comparative advantage, although in relative terms, fixed effects often show that features can also have a negative impact on trade.

With that, the gravity model is used to measure the impact of war. The more recent work about the impact of war on trade by Kamin (2022). In this working paper, the gravity model uses the cross-pair fixed effects. In such a case, trade between nation j and i is predicted by the ratio of GDPs and by a set of variables about the war which are specific for the pair, such as, whether they both, either or none are a side in a conflict. It is also augmented by other variables such as preferential agreement or proximity to states at war. The model is well suited to show the spillover effect, when the conflict not only impacts sides, but also close allies and even neutrals. The "war" dummy variables are separate for different types of conflict, such as interstate or internal. In conclusion, it was stated that international conflict decreases trade by 24.4%.

In continuation on the topic of war, Cábelková et al. (2022) is a one of the recent works on impact of military conflict on international trade. Mainly focusing on post-Soviet countries, the multilateral resistance term in the gravity model is a proxy with fixed effects. In their study, military conflict was measured by conflict scores (in logs) from the Institute for Economics and Peace. In addition, they controlled for the Russian language (=1 if it has official status), as well for economic performance and infrastructure indicators. The results of the study show that ongoing military conflict decreases international trade, while a positive effect of Russian language status. Russian sphere of influence does not suffer from the conflicts as much as those outside it, which explains the positive effect. This fact combined showed that international conflict may have a varied effect depending on its severity.

Estimating the effect of conflict on different categories of manufactured goods using the gravity model was also done in Karam and Zari (2015). The conflict constituted conventional war, civil wars and one-sided conflicts. In this study, the trade in MENA countries was investigated in the period of 1980-2006. The effect

observed was later calculated into ad-valorem equivalents, using demand elasticities. It was found out that the conflicts result in 5 to 65 percent tariff across different categories of goods. The most affected goods were agricultural products, leather and chemicals. The effect of the armed conflict was observed as positive in AVE. Authors also investigated trade in serviced and found out little to no effect of conflict, in contrast with manufactured goods.

As the variety of goods exported is important, the extensive margins of trade is used to express it. In the Dutt et al. (2011), the impact of joining WTO is observed in both intensive and extensive margin, which account for volume and variety of trade respectively. In this study, WTO is concluded to have a negative effect on intensive margins, while also having a positive effect on extensive. These results are noted to be inconsistent with an idea that removing trade barriers increases trade, in both margins.

Another study that uses the gravity model with extensive and intensive margins is the study on the impact of trade promotion institutions by Martincus et al. (2010). The data used was bilateral trade in Latin America and Caribbean in the period of 1995-2004. In this paper, authors used OLS estimation in intensive, extensive margins and average volume per category to calculate the impact of the number of embassies and consulates. The results show the difference of the effect in different margins, as the most pronounced effect was associated with intensive margin, while average volume per category was twice lower. This general trend followed all other variables in the gravity model.

In May 2022 the European Council announced the temporary trade liberalization and other trade concessions with regard to certain Ukrainian products[2]. Trade

[2] Council of the EU Press release, 24 May 2022, "Ukraine: Council adopts temporary trade liberalisation with Ukraine",

liberalization by the EU towards Ukraine was long awaited and discussed. In relation of the gravity model and European Admission, Shepotylo (2010) estimated the result in economic terms of Ukraine's admission to EU and, as alternative, close integration in the Customs union in 2004. Study showed that integration to any of the aforementioned unions would have benefited Ukraine. Integration effect was particularly visible for manufactured goods. Their share increased by 26% in EU integration and 16% for CIS Shepotylo (2010). Raw materials share on the other hand decreased and overall export diversification was achieved. In this way, integration in either case would lead to higher economic growth from a higher share of manufactured goods, Hausmann et al.(2007).

Kutlina-Dimitrova and Lakatos (2013) use dynamic computable general equilibrium to discuss the effect of the FTA between EU and Singapore. Such a model shows the effect of trade policy change on macroeconomic variables. The trade policy often has different tariffs and barriers across industries, the level of data reflects that. As such, results across sectors of the economy also depend on the initial level of tariffs. Study shows that for the EU the highest value increase is in commercial sector, followed by machinery and high-tech manufacturing. In relative terms the increase for EU export is small, the highest being 7.72% increase in commercial and 5,56% increase in tobacco. This is explained by the relative size of the economies. Singapore instead had 102% increase in textile and 32% in primary energy sources. In absolute terms and expressing Ricardian comparative advantage, the chemical sector amount to increase by 2,1 billion euro, by far benefiting most for Singapore. Although such methods does not account for differences between countries, especially the distance or sizes of the economy, it explains the benefits of FTA for both EU and Singapore. In this regard, FTA has

a positive impact on trade although its precise effect depends on the countries and their features.

Such a case is presented in Bakas, Jackson and Magkonis (2019) who discuss 2019 news about renegotiation of NAFTA agreement, FTA between Canada, Mexico and USA. The authors point out the relative absence of literature describing breakdown in trade and aim to explore it. Panel vector autoregressive framework is used with export share to the target country in pairs of them as explanatory variables. Furthermore, GDP, investment and consumption along with trade price level (proxy by oil prices). In conclusion authors state that shock in trade relationships or drop in trade activity leads to long-lasting economic effects. Interconnection of the economies plays a huge role in them as Canada and USA are connected more than with each other than Mexico, and the latter suffered less from shocks. With that, the role of changes in trade agreements and policies become even more pronounced.

To conclude literature review, I want to reiterate that war and international conflict have a significant impact on international trade and vice versa. In turn, the precise effect often depends on features of the country, such as geography, language or religion, not only by war itself but how the economic activity is conducted. In this regard the gravity model is best suited to explain the effect of war as it encompasses all the features simultaneously. The effect on extensive and intensive margins of trade is also a vital point of the research. It gives an insight in the export profile changes and how categorical differences in goods are related to the magnitude of the effect. Furthermore, international conflict rarely affects only a pair of countries; it has a spillover effect, especially in restructuring the trade flows and allowing for a new one to arise. Literature is plentiful on the effect of such free-trade enabling events, the topic especially important for Ukraine even before the war.

Chapter 3

METHODOLOGY

In this thesis, I follow the specification of the gravity model suggested by Head and Mayer (2014) and extended further as in Karam and Zari (2015). The formula describing bilateral trade goes as follows:

$$X_{ni} = GS_i M_n \phi_{ni} \quad (1)$$

X_{ni} shows share of export from country *i* to *n,* S_i represent the capacity of i to export goods, M_n are characteristics of n's market as an importer at large, with G being gravity constant. ϕ_{ni} is multilateral resistance term, resenting terms that decreases or increases export from i to n, it captures trade costs and elasticity. It exists in the range of $0 \leq \phi_{ni} \leq 1$.

The chosen estimation will be OLS with robust standard errors. In OLS, the coefficients are interpreted as semi-elasticities Karam and Zari (2015). The estimation would be done for extensive and intensive margins as well as average volume per category. Extensive margin of trade is the number of goods in a category. The intensive margin, on the other hand, is the volume of trade in the category, counted in $. The average volume, therefore, is the volume divided by the number of goods in the category. This division is used to estimate the effect of each variable separately on export margins. Our estimation equation for intensive margin is as follows:

$$\text{Ln } X_{ikt} = \beta_0 + \beta_1 ln\ Dist_i + \beta_2\ Contig_i + \beta_3\ Comcol_i + \beta_4 ln\ (1 + tar_{it}) + \beta_5 ln\ GDP_{it} + \beta_6\ liber_{ik} + \beta_7\ ln\ Covid_{it} + \beta_8\ war1 + \beta_9\ war2 + \beta_{10} IIP_{it} + \beta_{12} IIP_{it-1} + \epsilon_{it} \quad (2)$$

Where X_{ikt} is bilateral volume of Ukrainian export to trading partner *i* in $.

$ln\ Dist_i$ is bilateral distance between Ukraine and trading partner, *i*;

$Contig_i$ and $Comcol_i$ are two dummy variables controlling for border and colonizer, 1 for common border or colonizer, 0 otherwise.

tar_{it} is tariff level for country Ukraine exporting to country *i*.

$liber_{ik}$ is a dummy variable that controls for liberalization in trade policy in sector *k* by country *i* with relation to Ukrainian exports.

War1 is a dummy, taking value 1 for Q2 of 2022, while War2 is a dummy for the latter periods of the war, Q3-4 2022. The reason for such divide is that the effect of war is not the same across its duration. Therefore, the initial shock and uncertainty which the events of February of 2022 created should be captured. As the data is aggregated quarterly, it is impossible to differentiate between the periods of January 2022 to 23rd February 2022 and 24th February 2022 and 1st April 2022. Therefore, the war dummies capture the period where the decline is present.

IIP_{it} represents the Index of Industrial production in country *i*.

$Covid_{it}$ is the number of new cases in country *i* in a given period *t*.

As the main target of the research is Ukraine's international trade, the regression will not be done with country-pairs, but pairs of Ukraine and its trade partners. This way, it cannot be possible to include fixed effects in the estimation.

Extensive margin estimation follows the same principle as intensive:

$$\text{Ln } N_{ikt} = \beta_0 + \beta_1 ln\, Dist_i + \beta_2\, Contig_i + \beta_3\, Comcol_i + \beta_4 ln\,(1 + tar_{it}) + \beta_5 ln\, GDP_{it} + \beta_6\, liber_{ik} + \beta_7\, Covid_{it} + \beta_8\, war1 + \beta_9\, wa2 + \beta_{10} IIP_{it} + \beta_{11} IIP_{it-1} + + \epsilon_{it} \quad (3)$$

N_{ikt} is a number of subcategories (HS 6-digit disaggregation level) of goods traded in sector *k*. All other variable follows the same explanation as before.

Table 1. Explanatory Variables and expected signs

Variable	Expected effect
Distance	Negative
Common border	Positive
Common colonizer	Positive
Tariff	Negative
GDP, partner	Positive
Liberalization	Positive
Covid-19	Negative
War1	Negative
War2	Negative
IIP	Positive
IIP_{t-1}	Positive

The expected signs for War1 and War2 are negative, with different levels of magnitude – the effect should be lower at War2 and higher at War1. Covid should have a negative effect due to the breakdown of the supply routes caused by restrictions. Furthermore, the Covid period saw a decrease in consumption and demand, therefore, the incentive to trade decreased.

The variables that are expected to negatively affect Ukrainian exports are Distance and Tariff, both representing barriers to trade and hence, higher trade costs. The positive effect is expected from common border and common colonizer. These variables explain cultural connections between countries. In the case of Ukraine, the colonizer is USSR, a characteristic shared across all FSU countries. Another set of variables with positive expected effect is GDP and IIP. The former represents the size of the economy, while the latter shows changes in demand in a given country due to increase or decrease in economic activity.

Chapter 4

DATA

4.1. Data preparation

Gravity model in our chosen specification requires allotment of a large data set, explaining export, economy size, multilateral resistance term. Such data is not available as a single dataset and has to be assembled through various sources.

Changes in extensive margin of trade were captured by using monthly bilateral trade statistics for Ukraine export by UN Comtrade. The data were collected as HS 2-digit aggregation level with 99 categories for a 5-year period, 2017-2022. As monthly data is subject to changes and recalculations (source), it was aggregated to quarters. As the data is aggregated in quarters, this means that Q1 of 2022 represents both periods of peace (01 January - 23 February) and war (24 February – 31 March). As such, the most representative quarter is the second one, which can be later seen in the figures, where volumes of trade are higher in Q1 compared to Q2. To conclude about export in this dataset, Ukraine exported to 208 target countries, with, on average, 46 categories exported to each country. The volume of trade was reported in current $ dollars and thus was deflated using 2015 US dollars CPI.

Annual GDP in 2015 US $ prices from the World Bank database was used as a measure of economy size. Countries with no GDP data available, such as Afghanistan and Iran, were dropped. Changes in demand were captured by IIP provided by UNIDO. They are quarterly and are more readily available, complementing the annual GDP. The index itself, on the other hand, is marked for ISIC, which is not comparable with HS. Considering this, "C, total manufacturing" chapter index was used. Both GDP and IIP suffered greatly from

absence of observations, resulting in about 20% of observations being omitted. This amounted to about 93% of all trade being explained.

Distance between countries, languages and common colonial history was captured by statistics provided by CEPII. Main explanatory variables used are the length of common border between countries, and distance between capitals of a given country pairs.

Tariff data was also collected for export reported HS 2-digit chapters. The data was provided by ITC and it contains weighted mean HS 2-digit tariffs in a given year by partner. The weights and calculation was made by ITC from HS 6-digit level data and thus could not be made to HS 1-digit level. Data represent the overall level of them for a given country and chapter as reported by Ukraine. To calculate the extensive margin, the number of tariff lines in a given HS 2-digit category (aggregated from HS 6-digit by ITC) was used. This data was provided in the same dataset as tariff data. Furthermore, it was possible to aggregate to HS 1-digit level for an extensive margin analysis.

After this, data was collected for Covid-19 period from Q2 2020 to Q3 2021. One of the methods to calculate the impact of Covid is the number of new cases by country[3]. The data used was WHO, which is provided on a daily basis by country. It was then aggregated to quarters by summing up monthly values. This variable should capture decrease in trade due to restriction imposed by the pandemic as new cases amount.

As discussed before, changes in trade policies, such as trade liberalization between EU and Ukraine, also need to be captured. As such, a dummy variable was created from the ITC Market Access Map dedicated to the Russian invasion of Ukraine.

[3] United Nation, Impact of the Covid-19 Pandemic on Trade and Development: Lessons Learned, 2022, https://unctad.org/system/files/official-document/osg2022d1_en.pdf

Each time there were liberalization actions in relation to Ukraine's export, their quarter of the year and goods affected were captured by this dummy. Another dummy variable was created for war itself, capturing the period of Q1 to Q4 of 2022. The effect of this variable in the matter of interest of this work.

4.2. Data description

The total number of observations is 120,712, as it is based on all recorded exports from Ukraine to 208 countries and territories around the world. Statistics is recorded in ISO3 code, as such even the smallest transactions are recorded, evident by a minimum export.

Table 2. Data description

Statistic	N	Mean	St. Dev.	Min	Max
Export volume, thsd	120,712	2,209.417	15,382.630	0.00002	931,034.700
Distance, thsd. km	119,877	3,872.070	3,514.760	399.461	17,284.290
HS-6 categories	100,053	158.233	188.216	5	1,011
Average Tariff, %	100,053	0.033	0.057	0.000	0.512
Parter GDP, bil	117,523	978.212	2,904.092	0.044	20,953.200
Partner IIP	96,197	113.417	16.327	37.800	456.700
Covid Cases	120,712	330,536.100	1,999,716.000	1	77,306,567

The highest amount of export in a given dataset was 931 mil. $ of "Ores, slag and ash" to China in the second quarter of 2021. The mean value of an export flow is 2,209 thousand $, while standard deviation is seven times higher at 15,382 thousand $, meaning there is a large variation across goods. Highest 6 articles exported are "Cereals, "Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants; straw and fodder", "Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes.",

"Ores, slag and ash", "Iron and steel" and "Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles respectively. The volume of export for each of these categories can be observed in Figure 2.

These six categories represent two-thirds of all exports in the period of 2017-2022. As expected, grain exports are the largest flows. It is followed by the Iron and Steel category. Electrical machinery scored the lowest at mentioned chapters above. 2021 was the year of the highest export, as some chapters achieved their period maximum. "Cereals", "Oil seeds and oleaginous fruits" with "Animal fats or vegetable fats and oils" follows a natural cyclical trend, while the other chapter shows no such trend. Overall, invasion, represented by a dive in all categories of trade in Q1 of 2022, highlighting the significant decrease in exports. Only certain goods recovered from it. "Iron and Steel" and "Ores, slag and ash" suffered the most, closing a volume of 100 million $, compared to pre-war ranges of 500-1200 and 200-700 respectively. Figure 2 also provides export by country of destination, whether it borders Ukraine or not. In all but one category, "Electrical machinery", export is dominated by non-neighboring countries. The structure changed significantly after the beginning of the invasion, as, for example, in Q2 Poland as a destination increased its share from 9.12% to 19.72%. While Romania gone from 2.73% to 10.08%. This represents how blockade of seaport impacted trade as export via land routes became more attractive, though not necessarily more effective than via the sea.

As noted before, Q1 does not represent full changes in imports. Q2 on the hand shows significant change in trade partners for Ukraine. Poland scores 20% of all exports, which is combined with the fact that Q2 saw the lowest export turnover, meaning that Poland was the only sufficiently close trading partner. In this regard, Romania increased in placing from second last in the list to second best in Q3. In

Q2 it shares the placing with Bulgaria, though export share to the latter decreases in Q3. Results for Q3 shows countries that are relatively close, such as the aforementioned Bulgaria, Romania and Poland, alongside Turkey and Germany, had their share increased. China, India, Italy, Egypt saw decrease in their relative share, but also started regaining position in Q3 2022.

This can be explained that even though there exists some benefit in trade with neighbors, as the overall situation improved, expansive markets of China and India still attract Ukraine's exports.

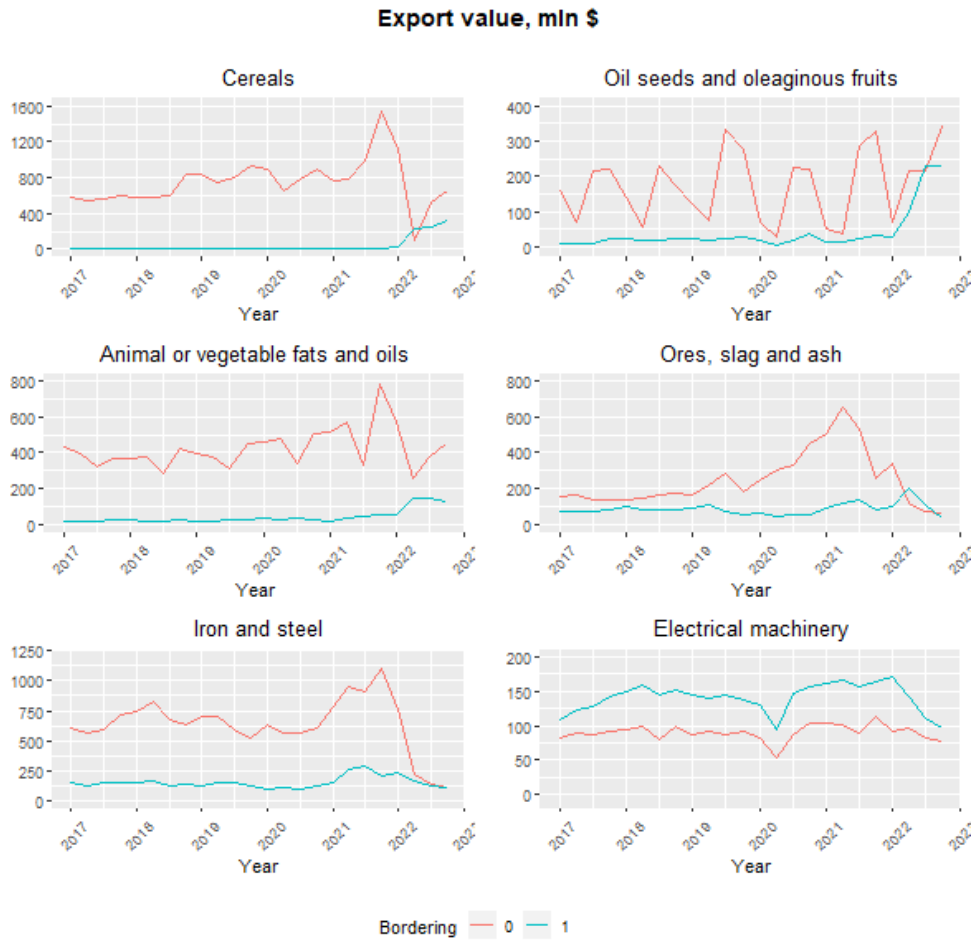

Figure 1 The volume of export by sectors, mln $

GDP in current $ was used represent the size of the economy of each country. As quarterly data is not readily available, annual figures were used. Table 1 shows the that average partner economy is 10 times bigger than Ukraine's. High standard deviation shows that there are multitude of partners with various sizes of the economy. GDP of interest is Ukraine's GDP of 2022. As there is no official figure about Ukraine's GDP in 2022, the figure of 35% decrease was used. It was provided in the Global Economic Prospect report in January 2023 by World Bank Group[4]. As such, in 2022 Ukraine's economy amounted to 112 bn $, compared to 200 bn $ in 2021.

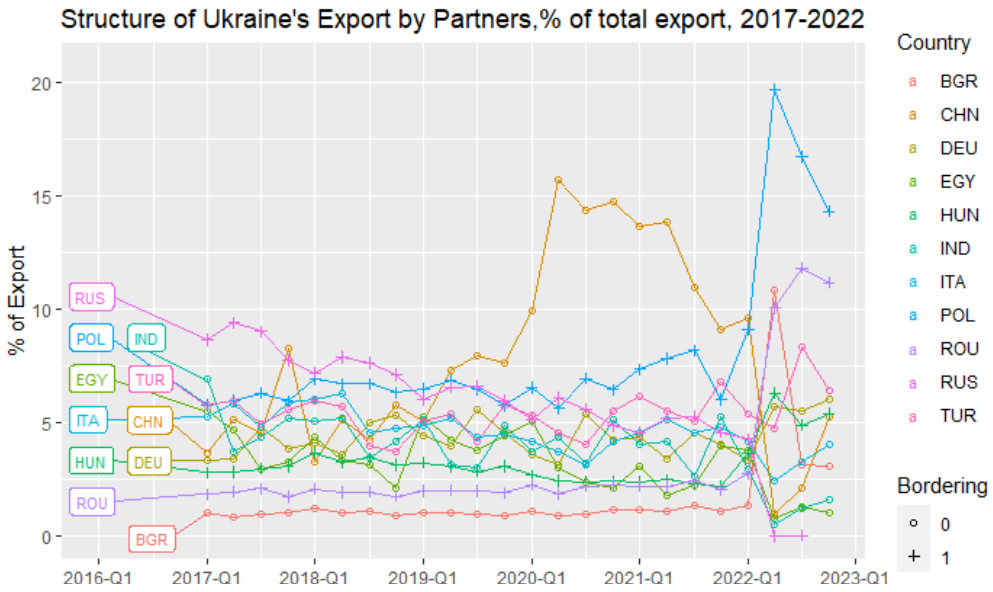

Figure 2, Structure of Ukraine's export by partner country

Liberalization dummy variable represents all instances when trade liberalization was introduced by a partner. This spans across 40 countries, most of which are

[4] World Bank Group, Global Economic Prospect report January 2023 https://openknowledge.worldbank.org/bitstream/handle/10986/38030/GEP-January-2023.pdf

from the EU. Countries outside the EU introducing liberalization policies often explained it by food security concerns, and such were not directed towards Ukraine in particular. In such cases, unless the type of food is specified, liberalization across chapters HS-1 to HS-15 were accounted for. Another frequent occurrence would be HS-72, "Iron and steel", which was applied toward Ukraine's export directly, an economic stimulus for a country at war.

Chapter 5

ESTIMATION RESULTS

5.1. Intensive margin analysis

The results are presented in Table 3. First three categories (col 1-3) can be attributed to Agricultural products while others (4-6) are attributed to Non-agricultural respectively. The results for geographical are not entirely consistent with expected signs. Distance has an expected negative sign, with comparable magnitude with Martincus et al. (2010). Common border has also the expected sign and the highest coefficient is attributed to Electrical machinery, at 2.507. This represents the fact that in this category of goods Ukraine is most likely to trade with its close neighbors. On the other hand, common colonizer leads to a decrease in trade of raw materials and goods, such as Iron and Steel, and Ores, slag and ash. Furthermore, the common colonizer has positive (col2) and negative (col3) or insignificant (col1) results, which shows that different types of agricultural products are traded with FSU countries. Positive sign is present at Animal or vegetable fats and oils (col2) and the negative is associated with Oil seeds and oleaginous fruits (col3. This clearly represents the export profile of Ukraine, as seeds are usually traded overseas, but not the fats and oils.

In terms of Covid, the results are mostly insignificant, with an exception of Animals fats and oils, where the sign is positive. The effect is a 3.5% increase in export of this category during Covid. Liberalization is significant in three cases, and has a positive effect, consistent with the methodology. The magnitude on the other hand is higher compared to other variables, a 206% increase in Iron and Steel and 653% in Ores, slag and ash with a 576% increase in Cereals. In most of the cases, the liberalization represents a zero tariff trade, a significant one-time decrease in tariffs and thus the effect is large in magnitude.

Table 3. Intensive margin regression results

	Intensive margin (log)					
	10	12	15	26	72	85
	(1)	(2)	(3)	(4)	(5)	(6)
Distance	-1.557***	-2.122***	-0.687***	-1.496***	-0.772***	-1.114***
	(0.179)	(0.128)	(0.077)	(0.175)	(0.080)	(0.076)
Continuous border	-0.425	0.238	-0.011	1.710***	1.225***	2.777***
	(0.396)	(0.266)	(0.201)	(0.318)	(0.194)	(0.194)
Common colonizer	-0.501	-0.591**	0.686***	-1.843***	-0.853***	1.936***
	(0.383)	(0.264)	(0.195)	(0.358)	(0.184)	(0.177)
Log Covid Cases	-0.011	-0.003	0.035***	0.002	-0.004	-0.010
	(0.018)	(0.014)	(0.009)	(0.017)	(0.009)	(0.009)
Liberalization	1.912**	0.209	-0.330	2.019**	1.119**	0.239
	(0.882)	(0.612)	(0.425)	(0.990)	(0.470)	(0.402)
War1	-1.691**	-0.118	0.186	-2.141***	-2.658***	-0.642**
	(0.696)	(0.444)	(0.303)	(0.788)	(0.373)	(0.256)
War2	0.861**	1.021***	0.010	-1.181***	-2.119***	-0.468***
	(0.370)	(0.264)	(0.175)	(0.436)	(0.213)	(0.165)
Log (Tar+1)	33.887***	0.534	6.348**	56.168***	238.931***	-89.621***
	(3.851)	(10.219)	(2.592)	(14.793)	(38.542)	(8.590)
IIP_t	0.013	0.017	-0.011	0.013	-0.001	0.004
	(0.014)	(0.011)	(0.007)	(0.014)	(0.007)	(0.007)
IIP_{t-1}	0.004	0.003	0.012*	0.026*	0.012	0.00001
	(0.015)	(0.011)	(0.007)	(0.015)	(0.008)	(0.007)
log GDP	0.726***	0.793***	0.596***	0.854***	0.332***	0.902***
	(0.063)	(0.049)	(0.028)	(0.079)	(0.030)	(0.028)
Observations	1,290	1,177	1,605	778	1,476	1,802
R^2	0.149	0.349	0.283	0.315	0.246	0.649
Adjusted R^2	0.142	0.343	0.278	0.305	0.240	0.647
Residual Std. Error	3.470 (df = 1278)	2.511 (df = 1165)	1.911 (df = 1593)	2.746 (df = 766)	1.924 (df = 1464)	1.888 (df = 1790)

Note: *p<0.1; **p<0.05; ***p<0.01
"The categories are: 10 Cereals; 12 Oil seeds and oleaginous fruits; 15 Animal or vegetable fats and oils; 26 Ores, slag and ash; 72 Iron and steel; 85 Electrical machinery and equipment " *p**p***p<0.01

The main explanatory variables, War2 and War1, are significant in most cases but the signs, on the other hand, are not as expected in the case of col 1-3 categories. Cereals, for example, have the War1 sign as negative, but the War2 as positive. This may be explained by the fact that this category of goods recovered the fastest in the second half of 2022. Same goes for Oil seeds, even though the War1 coefficient is not significant, but negative. For these both goods, War2 coefficients represent 136% and 177% increase in volume of export. Despite having a large share in export, Animals and vegetable fats are not significant in both cases. This may be explained by the natural cycle of these goods, they are subject to decrease in the middle of the year, as can be seen on the Figure 2. Other categories have their signs significant and as expected. The highest decrease is in the Iron and Steel category. The overall effect for the aforementioned category is lower for War2, at only 87.9% decrease, but War1 has a similar effect of 92.9% decrease.

The lowest decrease is present in Electrical machinery, which further reinforced the idea of this category of goods being less susceptible to war due to reliance on trade with neighbors via border, rather than sea. In this regard, the category saw only 37.4% decrease in the latter half of 2022, and 47.7% decrease from the Q2 2022 itself. The effect of War1 is higher, at 88.2% decrease in volume, compared to 65%. The effect of War2 is similar to the previous regression results, thus shows the general trend among all categories of goods of slowing down in decrease. In this regard, agricultural goods are even recovering to the pre-war levels, as evident in Figure 2.

The overall analysis of volume shows that in the HS 2- level of aggregation the effect of War2 and War1 was negative, with a number of exceptions, mainly in agricultural goods. Liberalization efforts were shown to be of greater effect than war, possibly off-setting the damage and thus preventing an even greater level of decrease in Ukraine's export. The War1 shows that war indeed has a shock value,

in that across 4 main categories of export, the decrease was observed. War2 on the other hand, showed that the recovery had occurred, but not across all good. Non-agricultural goods showed diverse results, with a possible explanation that the production as a whole plays a major role, rather than only changes in supply routes.

5.2. Extensive margin analysis

The overall results for extensive margin are similar to results for intensive one's margin. They are presented at Table 4. The coefficients for geographical variables, even though decreased in magnitude, have the same sign as in intensive. The change in magnitude is common, as evident in the Martincus et al. (2010). Common colonizer is a negative for Cereals (col 1) and Ores, slash and ash (col 4). The effect of the common border and the common colonizer is highest for the Electrical machinery. Therefore, the variety in export is dependent on the geographical features as well. Some goods, such as certain categories of agriculture, are not traded with neighbors, but rather oversea.

Covid does not have a significant effect, the effect of the former is close to 1%, negative for Ores, slash and ash (col 4) and positive Cereals (col1). Combined with intensive, the results show little impact of Covid on export. Liberalization as well does not have an observable effect on the extensive margin. That can be explained by the fact that the variety of exported goods cannot be expanded this fast from introduction of zero tariffs. Much of the Liberalization is observed in the summer-autumn of 2022, and thus the effect might be lagging.

War1 coefficients are negative and significant for non-agricultural goods and Cereals. The highest decrease in the number of subcategories traded was in Iron and Steel category of goods (col5), 55.7%, while other groups suffered 20-30% decrease.

The effect of War2 is lower compared to War1, and even positive in the case of agricultural goods, just as in the intensive margin. The extensive margin of those goods was increased by 11-25% and for Cereals (col1) this effect is more than War1. In this regard, the recovery from the first months of the war were the most in agricultural goods. This can be explained by the short life cycle of those goods and thus a heightened importance to export. Furthermore, the extensive margin for agricultural goods is less prone to change in a span of a year due to the cyclic nature of the production. Therefore, the war might have a long lasting effect on the extensive margin of the agricultural goods the model cannot capture. This also means that agricultural products can be less affected by the shock of War1, as the coefficients are significant only for Cereals (col1).

In terms of non-agricultural goods, the effect of War2 is not significant, while the War1 has a significant negative effect. The initial shock, therefore, exists, but in the second half of 2022, those categories recovered, though the rate is less than in intensive margin. The exception is the Iron and Steel (col5), where the decrease was the highest in both volume and variety. It is evident the recovery is observed, but the rate of it shows that high decline is associated with slow recovery.

The GDP effect on extensive margin is significantly lower compared to either HS 1-digit aggregation results or intensive margin. The effect ranges from 0.12% to 0.45%. The interpretation of this is that the relative size of the market impacts the volume more than the variety of goods exported. The highest effect is observed at Electrical machinery and equipment (col6), consistent with intensive margin. The meaning of this is that the increase in GDP leads to higher increase in demand for a variety of Electronic machinery and the lowest in Cereals.

The conclusion for extensive margin analysis can be formulated that the war decreased the variety of goods exported by Ukraine. The effect is dependent on the category of good, with some, such as Metals, being more vulnerable.

Table 4. Extensive margin regression results

	Extensive margin (log)					
	10	12	15	26	72	85
	(1)	(2)	(3)	(4)	(5)	(6)
Distance	-0.311***	-0.515***	-0.291***	-0.361***	-0.620***	-0.496***
	(0.026)	(0.027)	(0.021)	(0.025)	(0.031)	(0.029)
Continuous border	0.172***	0.541***	0.560***	0.619***	0.899***	1.190***
	(0.059)	(0.057)	(0.054)	(0.045)	(0.077)	(0.073)
Common colonizer	-0.182***	0.053	0.611***	-0.172***	0.151**	1.404***
	(0.056)	(0.055)	(0.053)	(0.050)	(0.072)	(0.067)
Log Covid Cases	0.009***	0.001	0.001	-0.007***	0.002	0.003
	(0.003)	(0.003)	(0.002)	(0.002)	(0.004)	(0.003)
Liberalization	-0.037	-0.038	-0.041	0.103	0.096	0.044
	(0.129)	(0.127)	(0.114)	(0.139)	(0.183)	(0.155)
War1	-0.213**	-0.134	-0.084	-0.267**	-0.816***	-0.359***
	(0.102)	(0.092)	(0.080)	(0.111)	(0.142)	(0.099)
War2	0.224***	0.211***	0.106**	-0.001	-0.621***	-0.099
	(0.055)	(0.055)	(0.047)	(0.062)	(0.081)	(0.063)
Log (Tar+1)	1.306**	0.826	-0.451	3.402	-18.794	-25.144***
	(0.558)	(2.167)	(0.700)	(2.071)	(15.151)	(3.256)
IIP_t	-0.00003	-0.001	0.002	0.003	0.006**	0.004
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
IIP_{t-1}	0.001	0.001	-0.002	0.0002	-0.002	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
log GDP	0.101***	0.177***	0.134***	0.174***	0.148***	0.374***
	(0.009)	(0.010)	(0.008)	(0.011)	(0.012)	(0.010)
Observations	1,290	1,177	1,605	778	1,476	1,802
R^2	0.275	0.493	0.488	0.590	0.530	0.710
Adjusted R^2	0.268	0.489	0.484	0.584	0.526	0.708
Residual Std. Error	0.495 (df = 1278)	0.516 (df = 1165)	0.506 (df = 1593)	0.378 (df = 766)	0.730 (df = 1464)	0.713 (df = 1790)

Note: *p<0.1; **p<0.05; ***p<0.01
"The categories are: 10 Cereals; 12 Oil seeds and oleaginous fruits; 15 Animal or vegetable fats and oils; 26 Ores, slag and ash; 72 Iron and steel; 85 Electrical machinery and equipment

Categories with close ties with neighbors before, were affected less, example of which is Electrical machinery.

What must be noted is the increase in the variety of exported agricultural goods. As the export of agricultural goods renewed in the second half of 2022, the extensive margin increased. It is possible that due to food security and rising prices, more varied exports became possible.

5.3. Average volume per category of good.

As the average number of products per category depends on the number of categories and volume of goods, the results are similar to those presented before. The geographical variables are at large the same as in extensive and intensive margins. The only difference occurs sing that are different are in for common border effect for Cereals (col1) and Animal or vegetable fats and oils (col3). In extensive analysis, there are negatives, but on average level analysis, they are positive. The signs are opposite to those that are in extensive analysis. This shows that the trade with neighbors is more diversified and has on average, less volume per category. On the other hand, non-agricultural products are traded in greater volume. The exception exists in Iron and Steel (col5), where intensive margin is negative, while extensive is positive. The average is positive, which means that with FSU the trade is more diversified and with less volume per category.

The coefficient on Liberalization shows that it had a positive effect on Ukrainian exports .The magnitude of it also is comparable to War1 and War2 coefficients. Those countries that implemented it, therefore, have an increased export from Ukraine that mitigates the decrease from war. As the effect of it on extensive trade is not significant, this means that the average volume is primarily increased intensively.

Table 5. Average volume per category regression results

	Average volume per category (log)					
	10	12	15	26	72	85
	(1)	(2)	(3)	(4)	(5)	(6)
Distance	-1.130***	-1.599***	-0.385***	-1.104***	-0.104*	-0.616***
	(0.170)	(0.112)	(0.071)	(0.162)	(0.060)	(0.063)
Continuous border	-0.693*	-0.197	-0.438**	1.129***	0.391***	1.633***
	(0.375)	(0.230)	(0.184)	(0.294)	(0.143)	(0.160)
Common colonizer	-0.321	-0.620***	0.274	-1.682***	-0.952***	0.643***
	(0.364)	(0.231)	(0.179)	(0.332)	(0.136)	(0.146)
Log Covid Cases	-0.020	-0.002	0.035***	0.008	-0.005	-0.011
	(0.017)	(0.012)	(0.009)	(0.016)	(0.007)	(0.007)
Liberalization	1.880**	0.239	-0.199	1.838**	0.942***	0.191
	(0.838)	(0.533)	(0.388)	(0.918)	(0.351)	(0.329)
War1	-1.411**	0.021	0.307	-1.786**	-1.713***	-0.292
	(0.662)	(0.387)	(0.278)	(0.732)	(0.282)	(0.211)
War2	0.669*	0.777***	-0.080	-1.114***	-1.392***	-0.402***
	(0.351)	(0.230)	(0.160)	(0.404)	(0.160)	(0.136)
Log (Tar+1)	29.867***	4.234	9.485***	53.316***	257.321***	-60.866***
	(3.650)	(8.877)	(2.381)	(13.683)	(28.590)	(7.089)
IIP_t	0.013	0.016*	-0.013**	0.012	-0.006	0.001
	(0.013)	(0.010)	(0.006)	(0.013)	(0.006)	(0.006)
IIP_{t-1}	0.003	0.004	0.014**	0.024*	0.013**	0.001
	(0.014)	(0.010)	(0.006)	(0.014)	(0.006)	(0.006)
log GDP	0.586***	0.609***	0.471***	0.661***	0.187***	0.548***
Distance	(0.060)	(0.043)	(0.026)	(0.074)	(0.023)	(0.023)
Observations	1,290	1,177	1,605	778	1,476	1,802
R^2	0.119	0.272	0.212	0.250	0.248	0.474
Adjusted R^2	0.111	0.266	0.206	0.239	0.242	0.470
Residual Std. Error	3.303 (df = 1278)	2.218 (df = 1165)	1.746 (df = 1593)	2.552 (df = 766)	1.429 (df = 1464)	1.578 (df = 1790)

Note: *p<0.1; **p<0.05; ***p<0.01
"The categories are: 10 Cereals; 12 Oil seeds and oleaginous fruits; 15 Animal or vegetable fats and oils; 26 Ores, slag and ash; 72 Iron and steel; 85 Electrical machinery and equipment

The overall trend of split of the effect of war between agricultural and non-agricultural goods is present as well. As evident from table 5, average volume is increased in War2 coefficients for Cereals (col1) and Oil seeds (col2), while the categories Ores, slash and ash (col4) with Iron and Steel (col5) have negative coefficients. The overall effect for Ores, slash and ash is 67% decrease in average volume in the second half of the year, and 83.2% in the Q2 of 2022. For Iron and Steel (col5) the difference is even smaller, at 75.1% and 81.9%. The recovery is present, but it is slow. Agricultural goods had their effect from War2 as positive, indicating a dynamic growth, rather than a decline. Electrical machinery has the smallest decrease in average volume. The factors contributing are the same in intensive and extensive margins, smaller size and higher trade with neighbors, and this non-reliance on seaport trade. Non-agricultural goods decline therefore, lies in decrease of in extensive margin. For them the average volume per category decline from war was mitigated by liberalization. Once the liberalization will be over, due to its temporal nature, the effect of it will be similar to the beginning of the war.

5.4. Extensive, Intensive margin and average volume summary

The summary of the extensive and intensive margin as well as average volume is presented in Table 9. The regression was done using disaggregated data across all categories which is pooled together. As a result, the coefficients are lower in magnitude. The signs for geographical variables coefficients are in accordance with the methodology. Covid is significant in average volume and extensive margin, yielding a 0.5% effect.

War2 coefficient is significant in most cases. Coefficient for War1 is significant for extensive margin. Concisely, the effect of war in generals is lower than in the category analysis. On the other hand, it can be seen that the overall average volume is lower, and the magnitude is higher than in extensive or intensive.

Changes in tariff levels affect average volume and intensive positively, while decreasing the extensive margin. Such an effect should be reversed, as the increase in a tariff should have negative or zero effect. Increase in trade from the introduction of tariffs is counterintuitive and must be investigated further.

Furthermore, IIP and its one period lag is mostly significant, showing an increase of 0.3% in the intensive margin from increase in demand. In terms of extensive analysis, IIP seems to increase the variety of traded goods and decrease it in a longer term, comparable to short term increase in demand. But overall, IIP increase leads to increase in average volume and intensive margin.

It can be concluded that the war had an overall negative effect on trade. The most effect was closer to the beginning, the most affected was the intensive margin, which decreased from 12.9% to 28.2% on average. The extensive margin suffered the least, where only the initial changes were most impactful. In the latter half of 2022 the effect became negligibly positive. In this regard it can be concluded that the initial shock causes the most decrease in extensive margin, but the war in general decreases the intensive margin and the average volume per category.

Chapter 6

CONCLUSIONS AND POLICY RECOMENDATIONS

The impact of war is hard to measure, when the effects of it are still present. This research tried to delve into Ukraine's international trade to evaluate how the Russian Federation invasion changed it. The results presented show that the effect varies in both magnitude and direction. The changes are tightly interconnected with Ukraine's export profile, which consists of agricultural products, natural resources and machinery. In this regard, it may be useful to divide the effects along these lines.

Due to the humanitarian impact of food security, the question of Ukrainian grain export was solved very quickly. As evident from regression, the impact of war on agricultural goods is as devastating as any other. Yet, in the second half of 2022, the export of all agricultural goods, including grain, expanded and in some regard returned to pre-war level average. This is evident in the extensive margins, where the variety of export saw little decrease from the invasion and then it even increased. In terms of the intensive margin, the overall volume of exported agricultural goods saw a fast increase after a "Grain" deal, which is evident by the 136% and 177% figures in the regression results. The same trend was observed in average export per product. During the latter half of 2022, it was increased by 95% and 117% in the aforementioned categories. And once again the effect was greater than the decrease due to the invasion of 2022. The overall export of agricultural goods has not returned to pre-war level per se, yet it showed considerable speed of recovery. It must be also noted that liberalization of trade, the EU lifting trade tariffs for Ukrainian goods as a whole, played a significant role in softening the effect of the war. It is evident from the results, that the effect of it in Cereal export

was greater than one of the war. All this combined shows that the agricultural sector export was the least affected by the war.

On the other hand, non-agricultural goods were more affected. These goods include Steel, Ore and Machinery, stated according to their share in total exports. Steel required seaports to export, just as much of the agricultural goods. Blockade and the breakup of established supply chains, changed the trade routes, and thus increased costs for both of them. However, for agricultural goods the export by sea was renewed, while for the Steel category it was not. The export of steel had the highest share in 2021, and the effect of war on it became the largest as well. Across all the analysis, Steel and goods of its category showed the highest decrease. In terms of volume, intensive margin, Steel showed 87.9% decrease in the second half of 2022 and had 92.9% decrease from the start of the war. Similar effect of war was in the extensive margin and in average volume. Number of commodities exported in the Steel category decreased by 55.7%, 20% higher than other goods. The average volume per commodity, decreased by 84.1%. The regression results in the case of Steel showed that it was exported least to those countries that did not share a border or colonial past with Ukraine. And even though the liberalization was indeed successful in the case of Steel and showed significant increase, the impact of war was higher, mainly due to the fact that usual markets were not available, which forced the change of supply routes and this increase in cost of transportation.

Another two goods that had large shares in Ukraine's export were Ore and Machinery. The Ore showed similar properties in trade compared to Steel, such as reliance on non-neighbor for export and high decrease due to war. On the other hand, the Machinery was the least affected by the war compared with Steel and Ore, which can be explained by the fact that it is geographically connected with

neighbors, represented by high coefficients for common colonizer and border and the least – for distance.

Therefore, the impact of war was diverse across categories of export and by the markets of destination. Those trading partners which were close in terms of location and those goods that were exported to such countries, had their share increase. Exports became skewed further into raw materials, such as agricultural goods and ores.

In terms of policy advice, it can be noted that Electrical machinery suffered relatively little compared to other major categories. Long-term sustainability and resistance to further shock can be expected from high-added value industries. Categories such as Iron and Steel, and Ore require attention to facilitate their recovery. The research also determined that temporal trade liberalization efforts have made a significant impact on trade and therefore it is necessary to continue them as much as possible. They have greatly helped to mitigate damage done and are required for recovery of export in aforementioned categories. Increasing trade with neighbors is also highly beneficial, though this mainly comes to the integration with the EU. Such trade would require infrastructure which was not present or necessary before the way. With disruption of seafaring through Black Sea, it is a long term sustainability issue to improve the infrastructure with Poland, Romania and Hungary. In this regard, recent problems with Ukrainian exports in the neighboring countries can slow down recovery. Better coordination between Ukraine and the trading partners might be needed to reduce tensions and address the trading partners' concerns to further reduce obstacles for Ukrainian exports.

The research can be further expanded in the future as more information becomes available. The effect of the war can be observed in a larger time-lapse, to discern the effect of state of war and initial shock with higher precision. Furthermore, the service sector of the exports has not been a part of this work and can be studied

later. Considering the scale of the study, the addition of other countries' exports in the regression can be used to discern country specific fixed effects.

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APPENDIX

Appendix contains results for an alternative method of aggregation - HS 1-digit level code, which group goods into 15 categories. This analysis proved to be similar to HS 2-digit, thought it has an inherit value of assessing while export, but only top 6 categories. The results are reported at follows in Table 6,7,8 for intensive, extensive and average volume per category respectively.

Table 6. Intensive margin regression results, HS 1-digit level aggregation

	Intensive margin (log), HS 1-digit aggregation							
	Animal	Vegetable	Foodstuffs	Mineral Products	Chemicals	Plastics Rubbers	Raw Hides	Wood Products
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Distance	-0.56***	-0.917***	-1.013***	-1.551***	-1.387***	-1.345***	-1.50***	-2.211***
	(0.064)	(0.057)	(0.042)	(0.083)	(0.058)	(0.053)	(0.093)	(0.066)
Continuous border	0.795***	-0.178	0.846***	2.338***	1.635***	1.958***	2.269***	0.463***
	(0.152)	(0.179)	(0.107)	(0.190)	(0.124)	(0.092)	(0.223)	(0.102)
Common colonizer	2.096***	0.029	2.661***	1.086***	2.940***	2.641***	1.389***	1.585***
	(0.135)	(0.119)	(0.097)	(0.178)	(0.152)	(0.115)	(0.199)	(0.117)
Log Covid Cases	-0.010	-0.008	0.001	-0.003	0.031***	0.054***	-0.004	0.007
	(0.008)	(0.009)	(0.006)	(0.010)	(0.008)	(0.007)	(0.013)	(0.006)
Liberalization	-0.589	0.171	-0.889***	0.161	-0.418	0.210	-0.175	0.361
	(0.443)	(0.361)	(0.252)	(0.583)	(0.384)	(0.366)	(0.577)	(0.332)
War1	0.345	-0.856***	-0.447***	-1.052***	-0.255	-0.693*	0.269	-0.524*
	(0.255)	(0.291)	(0.171)	(0.396)	(0.259)	(0.360)	(0.436)	(0.288)
War2	0.499***	-0.067	-0.410***	-1.013***	-0.428***	-0.716***	0.204	-0.388***
	(0.163)	(0.177)	(0.140)	(0.285)	(0.165)	(0.168)	(0.307)	(0.144)
IIP_t	0.001	0.003	0.004	0.011	0.006	0.003	0.007	0.014**
	(0.006)	(0.007)	(0.006)	(0.010)	(0.008)	(0.007)	(0.012)	(0.007)
IIP_{t-1}	0.008	0.004	0.003	-0.001	0.009	-0.005	-0.017	0.007
	(0.006)	(0.007)	(0.006)	(0.009)	(0.008)	(0.007)	(0.013)	(0.007)
log GDP	0.430***	0.759***	0.728***	0.979***	0.997***	0.780***	1.019***	0.953***
	(0.023)	(0.026)	(0.019)	(0.039)	(0.030)	(0.028)	(0.058)	(0.027)
Observations	1,758	2,259	2,155	1,819	2,047	2,135	1,258	2,051
R^2	0.316	0.366	0.582	0.494	0.604	0.614	0.436	0.719
Adjusted R^2	0.312	0.363	0.580	0.491	0.602	0.612	0.432	0.718
Residual Std. Error	1.734 (df = 1747)	2.000 (df = 2248)	1.484 (df = 2144)	2.236 (df = 1808)	1.818 (df = 2036)	1.574 (df = 2124)	2.279 (df = 1247)	1.398 (df = 2040)

Note: *p<0.1; **p<0.05; ***p<0.01

Table 6. Intensive margin regression results, HS 1-digit level aggregation (cont.)

	Intensive margin (log), HS 1-digit aggregation						
	Textiles	Footwear Headgear	Stone Glass	Metals	Machinery Electrical	Transporation	Misc
	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Distance	-2.182***	-1.820***	-2.117***	-1.409***	-1.435***	-1.405***	-1.888***
	(0.060)	(0.133)	(0.065)	(0.081)	(0.038)	(0.081)	(0.042)
Continuous border	0.741***	2.465***	1.215***	0.617***	1.966***	1.113***	0.453***
	(0.129)	(0.201)	(0.095)	(0.117)	(0.121)	(0.131)	(0.089)
Common colonizer	1.973***	0.924***	2.104***	0.422***	2.328***	1.240***	1.705***
	(0.125)	(0.274)	(0.125)	(0.137)	(0.107)	(0.172)	(0.096)
Log Covid Cases	0.023***	0.004	0.022***	0.009	-0.005	0.006	0.008
	(0.008)	(0.015)	(0.008)	(0.009)	(0.006)	(0.009)	(0.006)
Liberalization	0.358	0.061	-0.167	1.380***	0.062	0.111	0.590**
	(0.393)	(0.439)	(0.483)	(0.421)	(0.258)	(0.331)	(0.296)
War1	-0.117	0.172	-0.332	-2.673***		0.263	-0.428**
	(0.330)	(0.325)	(0.427)	(0.389)		(0.301)	(0.215)
War2	-0.024	0.206	-0.549***	-2.262***	-0.468***	-0.098	-0.261**
	(0.164)	(0.285)	(0.182)	(0.232)	(0.127)	(0.200)	(0.131)
IIP_t	-0.003	-0.009	0.006	-0.009	0.004	-0.013*	0.010*
	(0.008)	(0.012)	(0.007)	(0.008)	(0.006)	(0.008)	(0.005)
IIP_{t-1}	0.003	0.012	-0.001	0.014	-0.001	0.007	-0.012**
	(0.008)	(0.013)	(0.007)	(0.009)	(0.006)	(0.008)	(0.005)
log GDP	1.082***	0.516***	0.833***	0.755***	0.925***	0.669***	0.930***
	(0.034)	(0.060)	(0.034)	(0.040)	(0.020)	(0.043)	(0.020)
Observations	1,864	1,073	1,759	2,260	2,346	1,598	2,216
R^2	0.659	0.481	0.671	0.420	0.719	0.453	0.707
Adjusted R^2	0.658	0.476	0.669	0.417	0.718	0.449	0.706
Residual Std. Error	1.723 (df = 1853)	1.936 (df = 1062)	1.572 (df = 1748)	2.051 (df = 2249)	1.390 (df = 2336)	1.806 (df = 1587)	1.454 (df = 2205)

Note: *p<0.1; **p<0.05; ***p<0.01

Table 7. Extensive margin regression results, HS 1-digit aggregation

	Extensive margin (log), HS 1-digit aggregation							
	Animal	Vegetable	Foodstuffs	Mineral Products	Chemicals	Plastics Rubbers	Raw Hides	Wood Products
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Distance	-0.453***	-0.764***	-0.724***	-0.453***	-0.557***	-0.719***	-0.358***	-1.030***
	(0.033)	(0.027)	(0.031)	(0.023)	(0.026)	(0.017)	(0.023)	(0.019)
Continuous border	0.098	0.461***	0.347***	1.407***	1.153***	0.999***	0.633***	0.567***
	(0.095)	(0.062)	(0.062)	(0.048)	(0.056)	(0.035)	(0.079)	(0.047)
Common colonizer	0.746***	0.793***	1.714***	0.712***	2.270***	1.460***	0.515***	1.154***
	(0.083)	(0.056)	(0.061)	(0.043)	(0.058)	(0.043)	(0.061)	(0.047)
Log Covid Cases	-0.006	-0.002	0.005	-0.003	0.016***	0.010***	0.026***	0.012***
	(0.005)	(0.003)	(0.004)	(0.002)	(0.004)	(0.002)	(0.003)	(0.003)
Liberalization	-0.247	0.054	-0.084	-0.263*	0.095	0.334**	0.190	0.233
	(0.220)	(0.156)	(0.200)	(0.137)	(0.183)	(0.146)	(0.159)	(0.148)
War1	-0.428***	-0.506***	-0.283**	-0.321***	-0.383***	-0.412***	-0.344***	-0.322***
	(0.153)	(0.098)	(0.133)	(0.060)	(0.118)	(0.125)	(0.133)	(0.116)
War2	-0.015	-0.046	-0.041	-0.205***	-0.075	-0.034	0.094	-0.099
	(0.098)	(0.067)	(0.096)	(0.060)	(0.080)	(0.062)	(0.094)	(0.072)
IIP_t	0.003	0.002	0.003	0.003*	0.004	0.004*	0.001	0.006***
	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)
IIP_{t-1}	0.001	-0.003	-0.003	-0.0001	0.002	-0.001	-0.005*	0.001
	(0.004)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)
log GDP	0.205***	0.369***	0.337***	0.252***	0.403***	0.349***	0.234***	0.400***
	(0.013)	(0.009)	(0.013)	(0.008)	(0.013)	(0.009)	(0.016)	(0.011)
Observations	1,758	2,259	2,155	1,819	2,047	2,135	1,258	2,051
R^2	0.280	0.654	0.557	0.733	0.672	0.780	0.441	0.777
Adjusted R^2	0.276	0.653	0.555	0.732	0.670	0.779	0.436	0.776
Residual Std. Error	0.969 (df = 1747)	0.718 (df = 2248)	0.910 (df = 2144)	0.473 (df = 1808)	0.846 (df = 2036)	0.552 (df = 2124)	0.587 (df = 1247)	0.630 (df = 2040)

Note: *p<0.1; **p<0.05; ***p<0.01

Table 7. Extensive margin regression results, HS 1-digit aggregation (cont.)

	Extensive margin (log), HS 1-digit aggregation						
	Textiles	Footwear Headgear	Stone Glass	Metals	Machinery Electrical	Transporation	Misc
	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Distance	-0.941***	-0.316***	-0.644***	-0.843***	-0.751***	-0.403***	-0.836***
	(0.029)	(0.025)	(0.021)	(0.019)	(0.019)	(0.029)	(0.018)
Continuous border	1.125***	1.148***	1.095***	0.938***	1.169***	1.025***	0.788***
	(0.066)	(0.064)	(0.046)	(0.037)	(0.047)	(0.061)	(0.039)
Common colonizer	1.405***	0.920***	1.407***	1.377***	1.884***	1.197***	1.294***
	(0.061)	(0.057)	(0.044)	(0.047)	(0.050)	(0.063)	(0.045)
Log Covid Cases	0.017***	0.009**	0.019***	0.012***	0.007**	0.010**	0.010***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
Liberalization	0.494**	0.324**	0.179	0.500***	0.228	0.269	0.218
	(0.215)	(0.138)	(0.167)	(0.167)	(0.163)	(0.187)	(0.140)
War1	-0.305**	-0.177	-0.379***	-0.686***	-0.338***	-0.233*	-0.185*
	(0.150)	(0.130)	(0.127)	(0.125)	(0.121)	(0.133)	(0.097)
War2	0.167*	0.196*	-0.086	-0.339***		0.056	0.061
	(0.088)	(0.104)	(0.074)	(0.085)		(0.088)	(0.058)
IIP_t	0.003	-0.001	0.005**	0.001	0.002	0.004	0.004*
	(0.004)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
IIP_{t-1}	-0.005	-0.005	-0.004	-0.0002	0.00002	-0.003	-0.003
	(0.004)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)
log GDP	0.536***	0.162***	0.307***	0.412***	0.484***	0.239***	0.419***
	(0.017)	(0.013)	(0.013)	(0.010)	(0.009)	(0.015)	(0.009)
Observations	1,864	1,073	1,759	2,260	2,346	1,598	2,216
R^2	0.669	0.552	0.713	0.768	0.788	0.521	0.770
Adjusted R^2	0.668	0.548	0.711	0.767	0.787	0.518	0.769
Residual Std. Error	0.938 (df = 1853)	0.591 (df = 1062)	0.639 (df = 1748)	0.635 (df = 2249)	0.649 (df = 2336)	0.721 (df = 1587)	0.633 (df = 2205)

Note: *p<0.1; **p<0.05; ***p<0.01

Table 8. Average volume per category regression results, HS 1-digit

	Average volume per category (log), HS 1-digit aggregation							
	Animal	Vegetable	Foodstuffs	Mineral Products	Chemicals	Plastics Rubbers	Raw Hides	Wood Products
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Distance	-0.183***	-0.086*	-0.269***	-1.010***	-0.854***	-0.658***	-1.158***	-0.927***
	(0.055)	(0.051)	(0.038)	(0.069)	(0.053)	(0.046)	(0.081)	(0.053)
Continuous border	0.493***	-0.512***	0.537***	1.084***	0.534***	0.969***	1.609***	0.143**
	(0.156)	(0.150)	(0.083)	(0.168)	(0.095)	(0.074)	(0.188)	(0.060)
Common colonizer	1.142***	-0.522***	0.926***	0.442***	0.597***	1.218***	0.876***	0.252***
	(0.136)	(0.107)	(0.073)	(0.155)	(0.123)	(0.092)	(0.171)	(0.072)
Log Covid Cases	-0.007	-0.012	-0.006	0.001	0.011	0.040***	-0.030***	-0.007
	(0.007)	(0.009)	(0.006)	(0.009)	(0.007)	(0.006)	(0.011)	(0.005)
Liberalization	0.021	0.095	-0.734***	0.411	-0.497*	0.108	-0.270	-0.047
	(0.374)	(0.312)	(0.244)	(0.507)	(0.278)	(0.291)	(0.519)	(0.213)
War1	0.666***	-0.190	-0.153	-0.690**	0.202	-0.367	0.459	-0.004
	(0.251)	(0.252)	(0.163)	(0.331)	(0.225)	(0.293)	(0.405)	(0.197)
War2	0.467***	0.063	-0.337***	-0.800***	-0.352**	-0.620***	-0.005	-0.326***
	(0.161)	(0.157)	(0.115)	(0.246)	(0.139)	(0.144)	(0.271)	(0.087)
IIP_t	-0.001	0.005	0.005	0.008	0.002	-0.001	0.007	0.009
	(0.006)	(0.006)	(0.005)	(0.008)	(0.006)	(0.007)	(0.011)	(0.005)
IIP_{t-1}	0.006	0.003	0.004	-0.0003	0.009	-0.005	-0.011	0.008
	(0.006)	(0.007)	(0.005)	(0.008)	(0.006)	(0.007)	(0.012)	(0.006)
log GDP	0.199***	0.438***	0.367***	0.723***	0.562***	0.419***	0.797***	0.444***
	(0.022)	(0.027)	(0.018)	(0.033)	(0.027)	(0.025)	(0.048)	(0.021)
Observations	1,758	2,259	2,155	1,819	2,047	2,135	1,258	2,051
R^2	0.113	0.162	0.256	0.360	0.368	0.369	0.373	0.485
Adjusted R^2	0.108	0.158	0.253	0.357	0.365	0.366	0.368	0.482
Residual Std. Error	1.675 (df = 1747)	1.890 (df = 2248)	1.254 (df = 2144)	1.898 (df = 1808)	1.509 (df = 2036)	1.284 (df = 2124)	1.973 (df = 1247)	0.990 (df = 2040)

Note: *p<0.1; **p<0.05; ***p<0.01

Table 8. Average volume per category regression results, HS 1-digit (cont.)

	Average volume per category (log), HS 1-digit aggregation, (cont.)						
	Textiles	Footwear Headgear	Stone Glass	Metals	Machinery Electrical	Transportation	Misc
	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Distance	-1.252***	-1.464***	-1.384***	-0.396***	-0.660***	-0.994***	-0.986***
	(0.057)	(0.122)	(0.061)	(0.087)	(0.029)	(0.071)	(0.033)
Continuous border	-0.280***	1.450***	0.241***	-0.061	0.869***	0.186	-0.194***
	(0.105)	(0.195)	(0.083)	(0.107)	(0.092)	(0.127)	(0.070)
Common colonizer	0.511***	0.115	0.729***	-0.851***	0.510***	0.221	0.444***
	(0.110)	(0.244)	(0.107)	(0.111)	(0.081)	(0.139)	(0.073)
Log Covid Cases	0.003	-0.007	0.001	-0.007	-0.011**	-0.001	-0.006
	(0.007)	(0.013)	(0.007)	(0.008)	(0.004)	(0.008)	(0.004)
Liberalization	0.012	-0.256	-0.444	1.227***	0.223	-0.039	0.377*
	(0.291)	(0.391)	(0.395)	(0.370)	(0.243)	(0.300)	(0.221)
War1	0.090	0.348	0.202	-2.209***	-0.175	0.435	-0.235
	(0.276)	(0.318)	(0.350)	(0.366)	(0.184)	(0.303)	(0.172)
War2	-0.227	-0.078	-0.550***	-1.859***	-0.445***	-0.180	-0.301***
	(0.143)	(0.252)	(0.159)	(0.196)	(0.098)	(0.182)	(0.098)
IIP_t	-0.0001	-0.010	-0.0002	-0.009	0.002	-0.017**	0.005
	(0.009)	(0.012)	(0.006)	(0.008)	(0.005)	(0.008)	(0.004)
IIP_{t-1}	0.005	0.020	0.004	0.013	0.0001	0.011	-0.005
	(0.010)	(0.012)	(0.006)	(0.008)	(0.005)	(0.008)	(0.004)
log GDP	0.512***	0.364***	0.512***	0.323***	0.463***	0.457***	0.503***
	(0.027)	(0.054)	(0.028)	(0.038)	(0.018)	(0.034)	(0.017)
Observations	1,864	1,073	1,759	2,260	2,346	1,598	2,216
R^2	0.412	0.368	0.503	0.178	0.476	0.287	0.521
Adjusted R^2	0.409	0.362	0.501	0.174	0.474	0.282	0.519
Residual Std. Error	1.352 (df = 1853)	1.765 (df = 1062)	1.285 (df = 1748)	1.764 (df = 2249)	1.050 (df = 2335)	1.684 (df = 1587)	1.051 (df = 2205)

Note: *p<0.1; **p<0.05; ***p<0.01

Table 9. Summary statistics

	Average volume per category	Extensive margin	Intensive margin
	HS 2-digit	HS 2-digit	HS 2-digit
Distance	-0.663***	-0.218***	-0.912***
	(0.014)	(0.004)	(0.016)
Continuous border	0.463***	0.449***	0.911***
	(0.035)	(0.011)	(0.039)
Common colonizer	0.520***	0.432***	0.997***
	(0.034)	(0.011)	(0.038)
Log Covid Cases	0.001	0.003***	0.005**
	(0.002)	(0.001)	(0.002)
Liberalization	-0.032	-0.015	-0.059
	(0.087)	(0.027)	(0.097)
War1	-0.021	-0.104***	-0.121
	(0.067)	(0.021)	(0.075)
War2	-0.227***	0.082***	-0.137***
	(0.039)	(0.012)	(0.043)
IIP_t	3.821***	-1.533***	1.677***
	(0.228)	(0.070)	(0.255)
IIP_{t-1}	0.002	0.001*	0.003*
	(0.002)	(0.0005)	(0.002)
Log GDP Ukraine	0.005***	-0.001**	0.004**
	(0.002)	(0.001)	(0.002)
Log GDP Partner	0.346***	0.095***	0.455***
	(0.006)	(0.002)	(0.007)
Observations	80,365	80,365	80,367
R^2	0.077	0.159	0.124
Adjusted R^2	0.077	0.159	0.124
Residual Std. Error	2.831 (df = 80353)	0.886 (df = 80353)	3.179 (df = 80355)

Note: *p<0.1; **p<0.05; ***p<0.01