Russia's Invasion of Ukraine: An Initial Assessment of Export Volumes, Prices, and Policy Actions

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Abstract

Russia's invasion of Ukraine has major implications for global grains, vegetable oil, meal, and seed, and fertilizer and energy supplies. Less is known, however, as to the size of the war's effects on Ukraine and Russia's key agricultural exports to more than 170 markets they historically serve. Using monthly bilateral trade data, this article provides one of the first assessments of the war's impact on observed trade flows and predicted export volumes that have been unable to reach the global market.

JEL Codes: Q11, Q17, Q18

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Introduction

As of this writing, ten months have passed since Russian forces launched an unprovoked attack on Ukraine on February 24th, 2022. Beyond the serious humanitarian impacts (UN 2022), including more than 7 million Ukrainians that were initially displaced by the war, Russia's invasion of Ukraine is having far-reaching economic implications including disruptions to the availability of key staple commodities, exacerbating already soaring food inflation not seen since the early 1980s, further bottlenecking international supply chains, and reducing incomes and purchasing power in some of the world's poorest net food importing countries. There are few certainties right now as to when and how this war ends. What is clear is that Russia's war against Ukraine could have long lasting geopolitical and economic consequences.

International institutions and world leaders have sounded the alarm (FAO 2022). The International Monetary Fund (IMF) warned the global economy faces its "biggest test" since the second world war (Financial Times 2022). The World Bank's recent Commodity Markets Outlook Report suggests "the war in Ukraine has dealt a major shock to commodity markets, altering global patterns of trade, production, and consumption in ways that will keep prices at historically high levels through the end of 2024" (World Bank 2022). OECD chief economist Laurence Boone said "The war could spark starvation. It could cause social unrest and political turmoil" (Associated Press 2022). More bluntly, World Food Programme Director, David Beasley warned that "failure to open the ports in Ukraine will be a declaration of war on global food security" (World Food Programme 2022).

Russia and Ukraine are significant exporters of key staple grains, vegetable oil, meal and seed, and fertilizer and energy products (Paulson et al. 2022; Glauber and Laborde 2022). Many

lower income economies depend on Russia and Ukraine for grains and oilseeds. As a result, the world finds itself grappling with a tight global supply situation and questions about food availability for the over 1 billion people that reside in vulnerable net food importing countries.

For example, USDA's July 2022 World Agricultural Supply and Demand Estimate (USDA, 2022) projected that Ukraine will export 10 million metric tons (mmts) in the 2022/23 marketing year, nearly half its historical export totals. Global ending stocks of wheat are expected to fall by 12.6 mmts in 2022-23 to 267.5 mmt. This could be the third consecutive decline in stocks and would represent the largest year-over-year drop in global wheat stocks since 2012. April and May are also key planting months in Ukraine for corn, spring wheat, oilseeds and pulse crops, and Ukraine's larger winter wheat crop is planted in the fall for harvest in June of the following year (Westhoff et al. 2022 this issue; Smith 2022 this issue).

Russia's invasion of Ukraine is having major implications for global agricultural markets. However, some important questions remain including:

i. How significant has Russia's invasion impacted Ukraine's agricultural exports?

ii. How severe is the war's impact on low-income countries most dependent on grain and oilseed imports for subsistence consumption? And,

iii. What has been the impact of the war on Russia's agriculture and fertilizer exports? Specifically, has Russia's policy of restricting trade, currency, and diplomatic ties with 'unfriendly' countries altered the pattern of its agricultural and fertilizer trade?

A related question is the role of Western sanctions against Russia. Russia has claimed that sanctions have impaired global food supply contributing to global food insecurity. The United States and EU have denounced such claims, stating that agriculture and fertilizer products

are specifically exempt (Reuters 2022a; Politico 2022). The U.S. Department of the Treasury issued a fact sheet to clarify that the United States has not imposed sanctions on the export of agricultural or fertilizer products from, to, transiting, or related to Russia, and these sanctions do not prohibit transactions involving insurance and reinsurance services in transportation (The U.S. Department of the Treasury 2022). The EU has issued a similar fact sheet. Despite these exemptions, however, some news reports have suggested certain banks and trading firms may still avoid transactions with Russian companies due to general uncertainty or other factors (sometimes referred to as "self-sanctioning") (Reuters 2022b). While this study does not attempt to unpack all potential indirect effects of Western sanctions against Russia, we do provide some early empirical evidence of the *de facto* impact of the war on Russia's agricultural and fertilizer exports and differential impacts on trade with its 'friendly' and 'unfriendly' partner countries.

This article provides an initial econometric assessment of the impacts of the war on key food and agricultural exports by Ukraine and Russia to 51 partner countries using the latest available monthly bilateral trade data (January 2017 through June 2022). We control for product seasonality of commodity exports, product-specific historical trade relationships, import dependence, and export restrictions recently legislated by some countries. Additionally, as of this writing, Ukraine has reported its export statistics through August 2022 (6 full months since the war began), which allows us to identify some preliminary impacts on food insecure countries it serves (e.g., Egypt, Somalia, Lebanon, Bangladesh, and others). To our knowledge, this study is one of the first to provide an early *ex post* empirical assessment as to how Russia's invasion of Ukraine has altered agricultural commodity exports from these regions.

The Importance of Agricultural Exports from Russia and Ukraine

Russia and Ukraine produce and export several staple agricultural products (Abay et al. 2022; Glauber, Laborde and Mamun 2022; FAO 2022). Table 1 illustrates key export totals and the share of Russia and Ukraine exports in world exports for calendar year 2021 (CY2021). Ukraine and Russia supply 10% and 18% of global wheat exports by value, respectively, with a combined share of over one-quarter of global wheat exports. Ukraine is also responsible for 13% of corn exports and Russia and Ukraine each account for 14% of global barley exports, or 28% combined. Ukraine, and to a lesser extent Russia, is also an important exporter of vegetable oils (namely sunflower oil). Vegetable oils are used worldwide from cooking oil to dairy spreads, to the making of soaps, perfumes, and hydraulic fluid. Its co-product, vegetable meal is an important protein ingredient for livestock feed and pet food. While Ukraine and Russia account for 73% and 81% of global sunflower oil and meal exports, respectively, their contribution to the larger overall vegetable oil and meal market is smaller at 7% (Table 1).

Table 1. Key Russia and Ukraine Exports and Global Market Shares, CY2021

	Ukraine	Russia	Russia-Ukraine Combined	World Trade	Ukraine Share	Russia Share	Russia-Ukraine Combined Share
	$ Billion				*Share (%)*		
Wheat	5.1	9	14.1	51.1	10%	18%	28%
Corn	6	1.1	7.1	45.2	13%	2%	16%
Barley	1.27	1.26	2.5	8.9	14%	14%	28%
Sunflower Oil	6.5	4	10.5	14.3	45%	28%	73%
Sunflower Meal	1.2	0.5	1.7	2.1	57%	24%	81%
All Veg. Meals (soy, rape, palm, etc)	1.54	1.07	2.61	35.4	4%	3%	7%
Fertilizer (N, P, K)	0.43	4.71	5.14	24.9	2%	19%	21%
Oil, Natural Gas	0.084	120	120.1	776	0%	15%	15%

Source: Authors calculations from Trade Data Monitor

Finally, Russia is a major producer of all three fertilizer nutrient blends: nitrogen, phosphate, and potassium (note: Ukraine is not a significant exporter of fertilizer). Forty-four

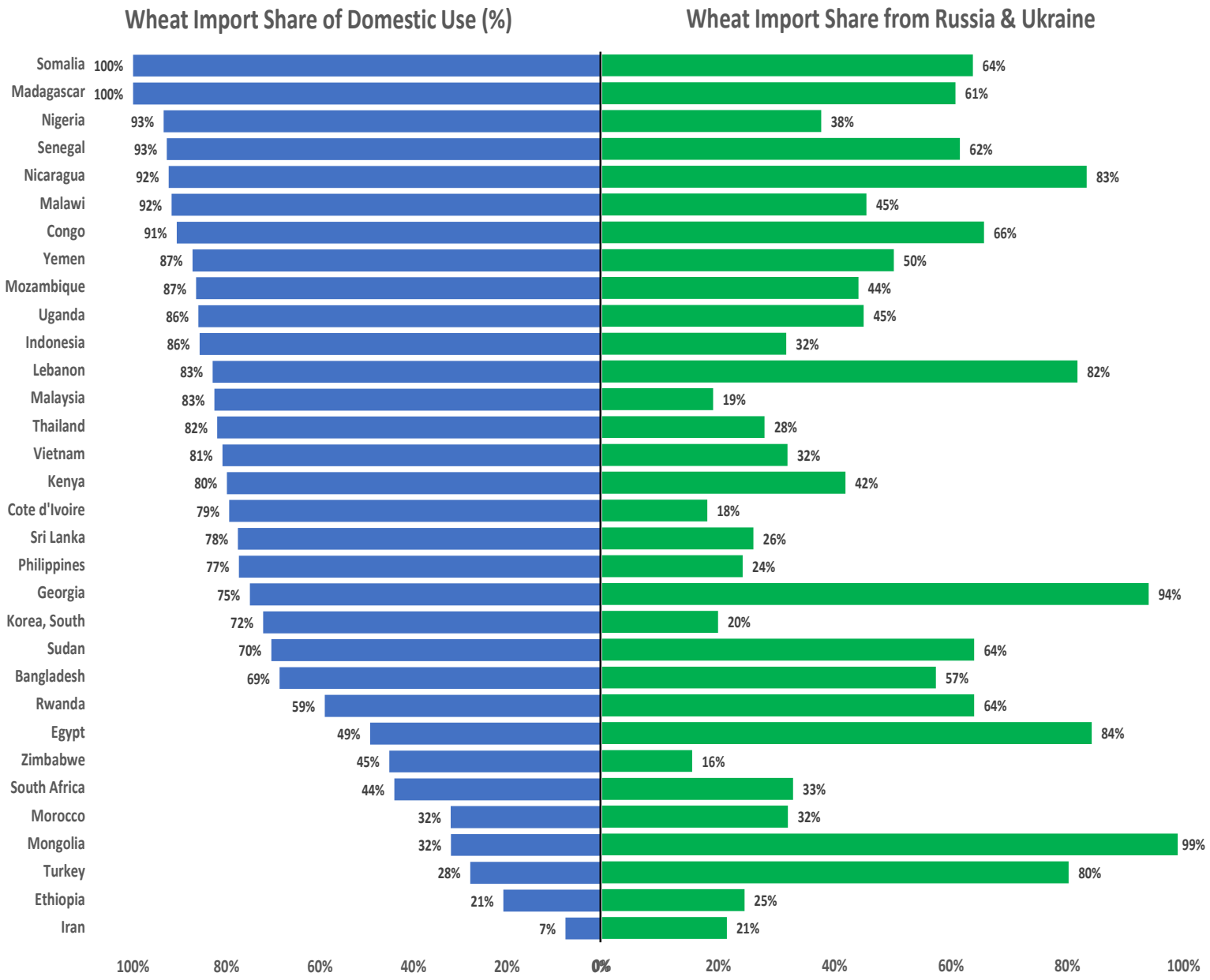
percent of global production of fertilizers are exported (FAS/USDA 2022; Myers and Nigh 2021). Russia is the largest nitrogen exporter, supplying 23% of ammonia and 14% of urea exports in 2021 and the third-largest phosphate and potash (potassium) exporter accounting for 9% and 16% of global exports, respectively. Combined, Russia and Belarus account for more than 40% of potash exports. Belarus is a close ally of Russia. In 2021, several countries, including the EU and the United States, imposed sanctions on imports of potash fertilizer from Belarus in response to a ongoing political repression and corruption actions by the Belarussian government.

Import Reliance on Russia and Ukraine: The Case of Wheat

According to the FAO (2022), nearly 50 countries depend on Russia or Ukraine for more than 30% of wheat imports. Figure 1 combines data from USDA's Production, Supply and Distribution tables (PSD, Left Panel) and historical (2017-2021) bilateral trade from CEPII's BACI international trade database for 32 (mostly) low to middle income economies in which wheat imports account for over 20% of total use. Iran is also included because over 20% of Iran's wheat imports are sourced from Russia and Ukraine. Countries are sorted largest to smallest in terms of their reliance on wheat imports to satisfy domestic use (Left Panel).

At the top of the list, Somalia, Madagascar, Nigeria, Senegal, Nicaragua, Malawi, and Congo are 90%-100% reliant on wheat imports to satisfy subsistence consumption. For Somalia, Madagascar, Senegal, and Nicaragua over 60% of these imports are sourced from Russia and Ukraine (Right Panel). Other countries in which imports make up a large share of domestic use and a high dependence on Russia and Ukraine include Lebanon (82%), Georgia (94%) and Egypt (84%). Conversely, Nigeria, Indonesia, Malaysia, Thailand, Vietnam, Cote d'Ivoire and South Korea have import shares of domestic use greater than 70%, but a relatively smaller share of

Figure 1. Import Reliance: A Ranking of Wheat Import Shares of Domestic Use and the Share of Wheat Imports Sourced from Russia and Ukraine



Source: Author's calculations from USDA's Production, Supply and Distribution (PSD) database available at: https://apps.fas.usda.gov/psdonline/app/index.html#/app/home and BACI International Trade Database: http://www.cepii.fr/CEPII/en/bdd_modele/bdd_modele_item.asp?id=37); Notes: Domestic use includes wheat for feed, food, seed and industrial use. Historical import shares from Russia and Ukraine are an average over calendar years 2017-2021. Not all countries have available domestic production and use data (i.e., Laos).

those imports (<40%) are dependent on Russia and Ukraine. At the other extreme, Mongolia is only 32% reliant on imports for domestic use but sources 99% of its wheat imports from Russia.

Seasonality of Ukraine's Agricultural Exports

When evaluating the impact of Russia's war in Ukraine, an important consideration in the estimation of counterfactual trade losses is the seasonality of exports. Grant et al. (2021) and Grant et al. (2019) illustrate that a large share of the estimated trade damage to U.S. exports during the 2018/19 U.S.-China trade dispute occurred during the U.S.'s peak export months (fall season). Figure 2 plots Ukraine's total monthly wheat, corn, vegetable oil and meal exports from January 2018 through August 2022. Several important trends are worth mentioning.

First, Ukraine's peak wheat exports occur in August-October (months 8-10, Figure 2). Historically, Ukraine's in-season wheat exports averaged close to 4 mmt/month, compared to its offseason exports (January-July), which averaged close to 1 mmt per month. A similar seasonal pattern exists for Russian wheat exports (not shown to save space).

Second, Ukraine's monthly corn exports are counter-seasonal to its wheat exports, and peak (in-season) in the months December through May following the later corn harvest. Up to 30% of Ukraine's $4.8-$5.8 billion worth of annual corn exports (roughly 25-30 million metric tons) since 2019 are exported to China. Other key destination markets include the EU, Egypt, Turkey, Iran, Tunisia and South Korea. In-season Ukrainian corn exports averaged 3-4 mmt per month and are exported to over 100 countries, compared to less than 1 mmt in the offseason months (May-September). Note, Russia is not a significant producer or exporter of corn.

Third, Ukraine is also an important exporter of vegetable oil and meal (predominantly sunflower but also rapeseed- and soy) with peak exports between 400 and 600 thousand mt/month and serving over 170 countries (Figure 2). With the exception of September each year, Ukraine's vegetable oil and meal exports exhibit less seasonality.

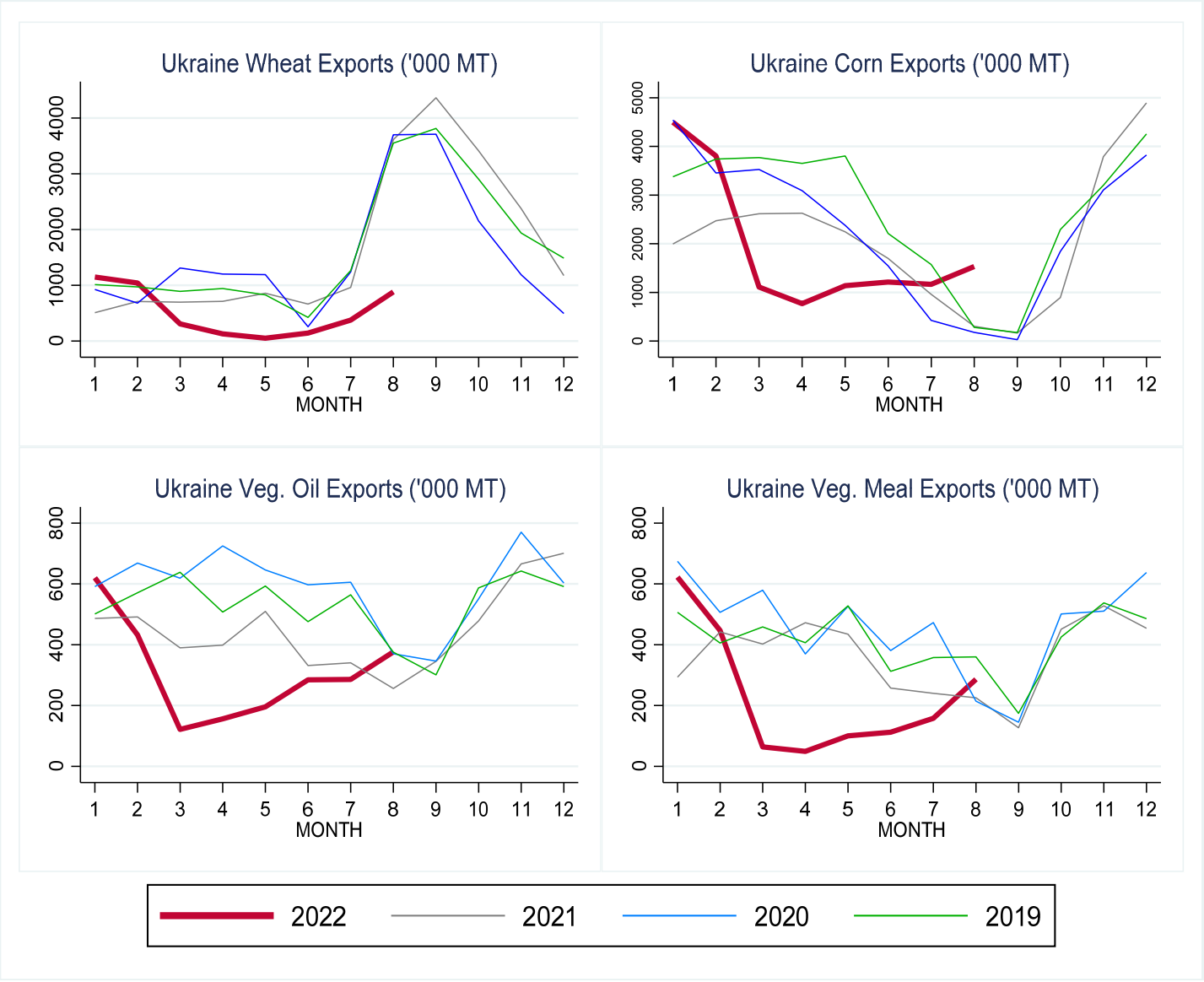
Finally, the heavier red line in Figure 2 traces Ukraine's exports in the first six months of 2022 and provides a first look at the economic toll of Russia's invasion. Since March 2022, Ukraine's out-of-season wheat shipments are down by 75% or more, with total losses of 750,000 mt/month; corn exports declined 75% or more in the initial months March-April, 2022, from an average of 4 mmt/month to approximately 1 mmt/month or less, but have since recovered to the out-of-season trend in June-August, 2022; vegetable oil exports dropped from 600,000 mt to less than 200,000 mt in March-May of 2022 but show some signs of recovery in May and June 2022; and vegetable meal exports are down from 500,000 mt/month to less than 100,000 mt/month and remain weak through June 2022.

Empirical Methods and Data

We conducted a short-run, four-month, *ex-post econometric* evaluation of the Russia-Ukraine conflict on key agricultural exports by the two countries. The model includes controls for seasonality (within-year dimension), country-pair-product specific effects capturing historical trade relationships and import dependencies, and export restrictions recently legislated by some countries on certain food and fertilizer exports (Laborde 2022). The impact on exports of Ukraine and Russia's exposure to the war are specified as indicator variables equal to one for Ukraine and separately for Russian exports beginning in March 2022 and extending through June 2022 relative to monthly historical exports in these same months in 2017-2021.

High-frequency monthly bilateral trade volumes are retrieved from Trade Data Monitor (accessed at: https://tradedatamonitor.com/). The initial analysis is constrained to "early reporters"– a set of 51 countries that have reported HS6-digit bilateral imports from and exports to their partner countries through June 2022. In April 2022, the Federal Customs Service of Russia suspended its national statistics until further notice. In May 2022, Belarus followed. Thus,

Figure 2. Ukraine Global Exports of Wheat, Corn, Vegetable Oil and Meal, through August, 2022



Source: Authors calculations from Trade Data Monitor.
Notes: Volumes illustrated are based on Ukraine's reported export statistics.

to capture the potential trade impacts of the war on Russia's exports, we rely on 51 countries' reported imports. These countries are grouped regionally in Appendix Table A along with other lower-income countries using Ukraine's reported export statistics. Appendix Table B lists the product sectors included in the empirical analyses.

A Look at the Destructive Trade Impacts of the War in Ukraine

To what extent has Russia's war in Ukraine impacted key agricultural exports? Table 3 presents the results across six categories: Ukraine's top agricultural export sectors combined (cereal grains, oilseeds and co-products, and meat products), and individually for cereal grains, oilseed, meat, fertilizer and a combined category of Russia and Ukraine's top non-agricultural exports (see appendix Table B). We focus on two econometric coefficients in the model: (i) 51 countries' imports from Ukraine given the war; and (ii) the same 51 countries' imports from Russia given the latter's claims of (indirect) sanction effects.

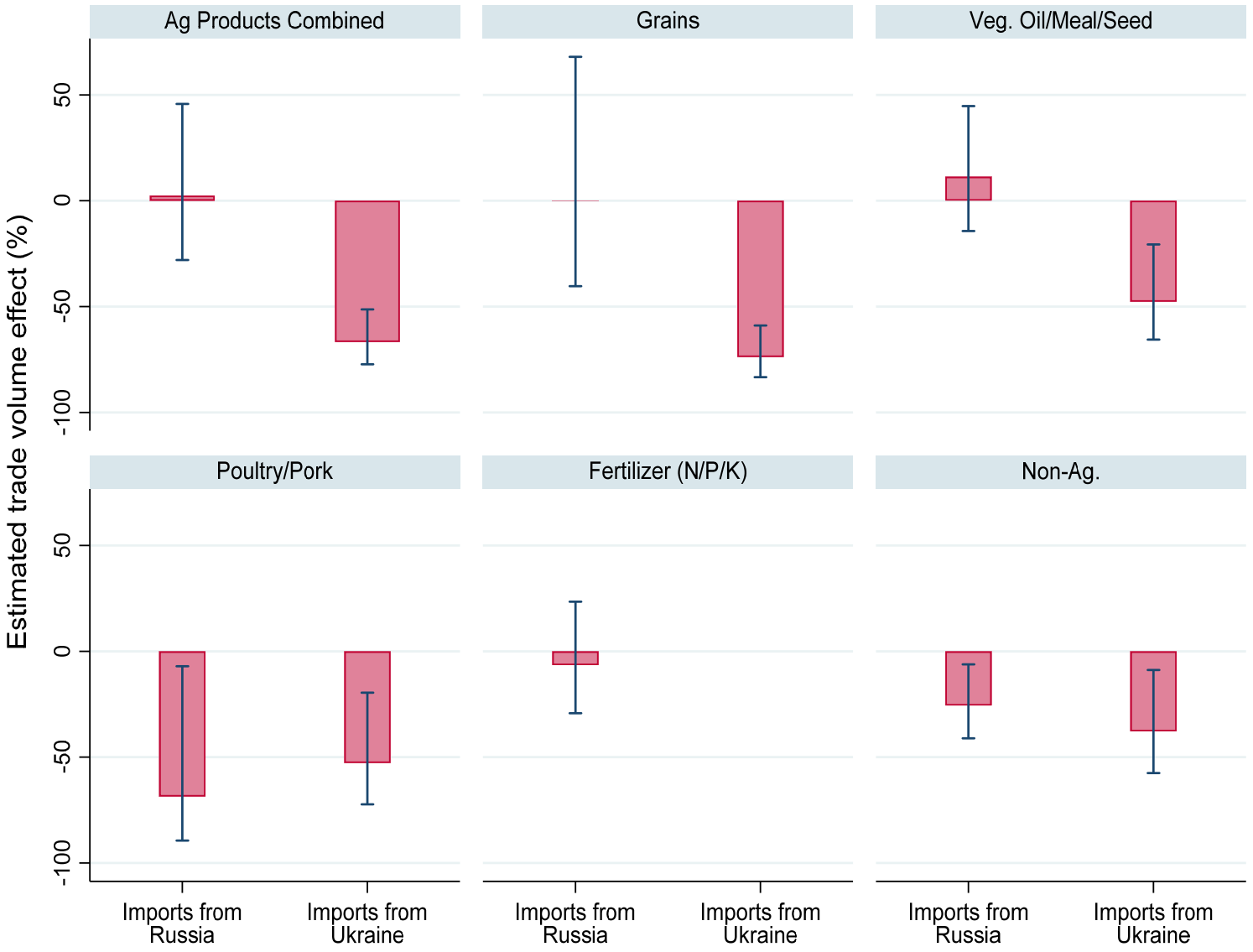
Table 2. Econometrically Estimated Trade Impacts of Russia's Invasion of Ukraine

	Top Ag. Sectors Combined	Cereal Grains	Oilseeds and Co-Products	Meat (Poultry and Pork)	Fertilizers	Top Non-Ag Sectors Combined
Mar. - June 2022 Trade Impacts						
Imports from Ukraine (Mar-June 2022)	-1.11***	-1.34***	-0.67**	-0.74**	----	-0.47***
Std. err.	[0.19]	[0.23]	[0.21]	[0.27]	----	[0.14]
Imports from Russia (Mar-June 2022)	0.02	0	0.08	-1.14*	-0.07	-0.30**
Std. err.	[0.18]	[0.26]	[0.13]	[0.55]	[0.14]	[0.09]
Implied % Trade Effects						
Ukraine	*-67%*	*-74%*	*-49%*	*-52%*	----	*-37%*
Russia	----	----	----	*-68%*	----	*-26%*
Pseudo-R^2	0.94	0.91	0.96	0.98	0.91	0.86
N	557,906	179,581	314,580	63,285	209,273	1,176,582

Notes: Sample period runs from 2017M1-2022M6 and includes 51 countries' reported bilateral import volumes as well as Ukraine's reported export volumes to 19 low-income countries. Dep. var. is the volume (converted to metric tons) of bilateral trade converted to common units (metric tons). All models are estimated by Poisson Pseudo-Maximum Likelihood estimation with high-dimensional fixed effects. *, **, and *** denote statistical significance at the ten, five and one percent levels, respectively. Implied percentage trade impacts are computed as the exponential of the estimated coefficient minus one multiplied by 100.

The results in Table 2 are suggestive of a large, negative, and statistically significant trade volume effect across most product categories exported by Ukraine and underscores the significant economic toll of the war on its staple food exports. For example, from March through June 2022, model results suggest that Russia's invasion has reduced Ukraine's top agricultural exports by 67%, on average. Across individual sectors, Ukraine's cereal grain exports show the

Figure 3. Model Estimated Percentage Trade Effects of Russia's Invasion of Ukraine for March-June, 2022 Relative to Historical



Notes: implied trade estimates are derived from econometric model results in Table 3. Upper and lower 95% confidence intervals are included to illustrate the range and precision of the exponentially transformed estimates.

largest percentage trade reductions at 74%. Oilseeds and co-products, and Ukraine's poultry and pork meat exports experienced a relatively smaller but still economically significant trade volume reductions of 49% and 52%, respectively. With the exception of meat and non-

agricultural exports, none of the coefficients for Russia's cereal grains, oilseeds or fertilizer exports are economically or statistically significant. This suggests that Russia's exports have been little impacted by its invasion of Ukraine relative to the same product-month exports in the historical period (2017-2021). Figure 3 plots the model implied percentage trade effects of the March-May 2022 model specification.

We also evaluated results from a model that incorporates month-specific conflict coefficients for each month during March-June 2022. This scenario allows us to examine whether Ukraine's exports have shown any improvements in the spring and early summer months (May and June 2022). With the exception of poultry, vegetable oils, and non-agricultural products, the results (not shown to save space) for Ukraine's cereal grains and oilseeds exports suggest very little improvement through June 2022. The month-specific results for Russia's exports are again statistically insignificant. This finding is consistent with the exemptions for agriculture and fertilizers from sanctions, and may also suggest some indirect effects whereby countries not enforcing any type of sanctions, or that have more neutral or allied relations with Russia, could be absorbing additional Russian exports. In the next section we try to unpack some of these results.

Russian Exports to 'Friendly vs Unfriendly' Countries

Russia has made several announcements threatening to restrict or halt exports of agricultural and fertilizer products to so-called 'unfriendly' nations, which have applied sanctions or otherwise supported the use of sanctions against Russia. In April 2021, nearly a year prior to the invasion, Russia published an 'unfriendly list' of countries as a means to introduce countermeasures, including currency and trade restrictions. Initially the list included the United States and Czech Republic over diplomatic rifts that preceded Russia's invasion of Ukraine (The Economist 2021).

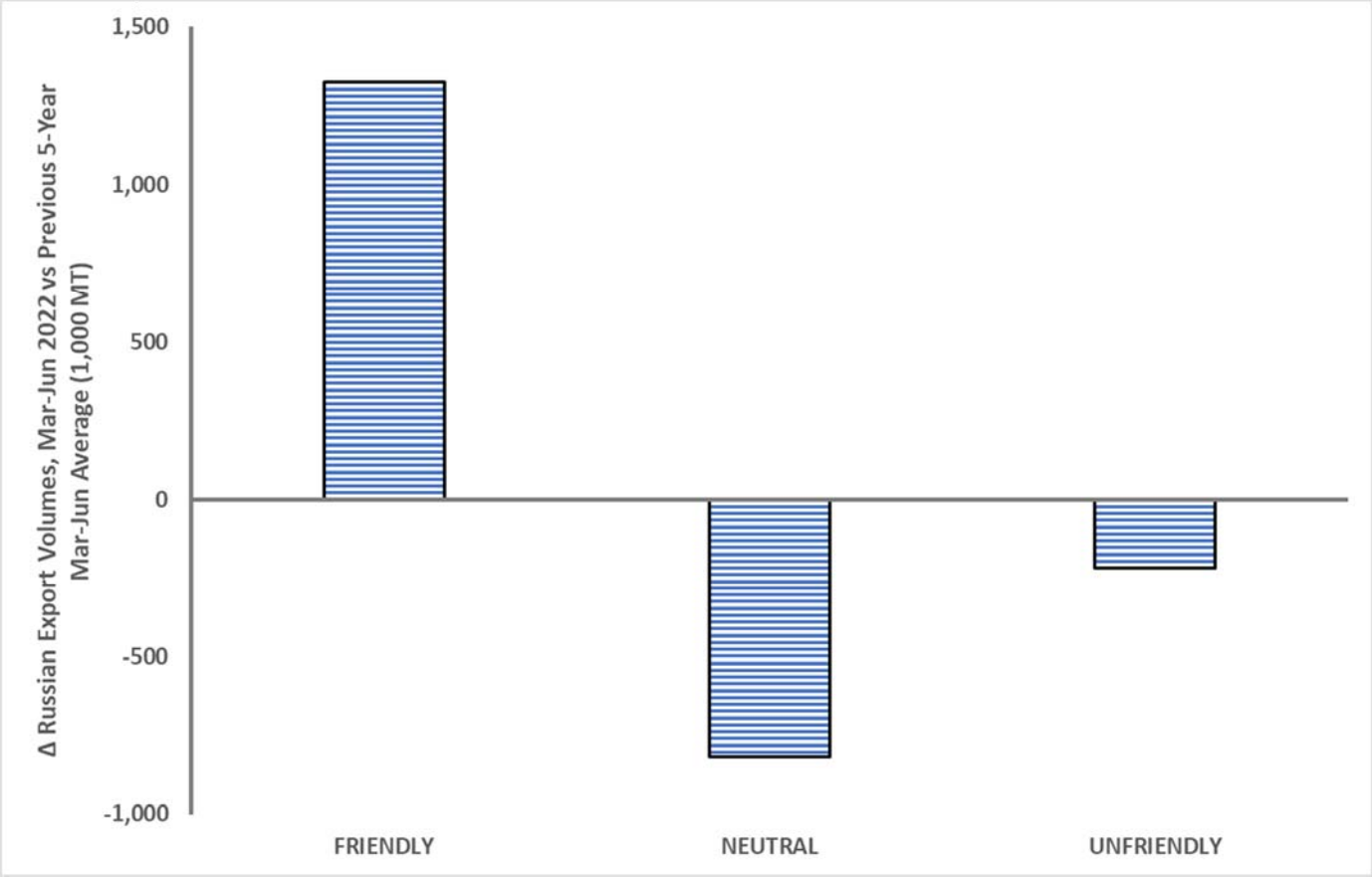
Following its invasion of Ukraine and in response to countries imposing sanctions, by March 2022 Russia's 'unfriendly list' of countries increased to 48.

The role of this 'unfriendly list' and potential impacts on Russia's export patterns is not clear. For instance, while Russia has brought attention to using its food exports as a geopolitical instrument, making several announcements that it "will not supply our products and agricultural products to [its] enemies" and "will supply food and crops only to [its] friends" (Politico 2022b), it has also repeatedly accused Western sanctions for impairing its agricultural exports and the global food security crisis. Setting aside Russia's contradicting statements as well as the specific exemption of agriculture and fertilizer items from Western sanctions, a private importer from a Western or other 'unfriendly' country may still engage in "self-sanctioning" of Russian products either voluntarily or because of logistical, shipping, finance, and insurance challenges currently affecting trade transactions with Russia (Bloomberg, 2022a).

While it is difficult to disentangle the various dimensions of these geopolitical effects, Figures 4 and 5 below illustrate Russia's exports to 'friendly' and 'unfriendly' partner countries for cereal grains (Figure 4) and potassium, nitrogen and phosphate fertilizer (Figure 5). 'friendly' countries include countries that have provided some level of public support for Russia, have not publicly condemned Russia's attack on Ukraine, or have not participated in Western sanctions. This includes Brazil, India, China, South Africa (BRICS countries) plus Iran, Saudi Arabia, and the United Arab Emirates. Neutral countries are defined as all other countries not explicitly on the 'friendly' or 'unfriendly' lists.

Figure 4 reports the change (Δ) in the volume of Russia's March-Jun 2022 cereal grain exports (using importers' reported import volumes from Russia, 1,000 MT) relative to the March-June average in the previous five years to friendly,

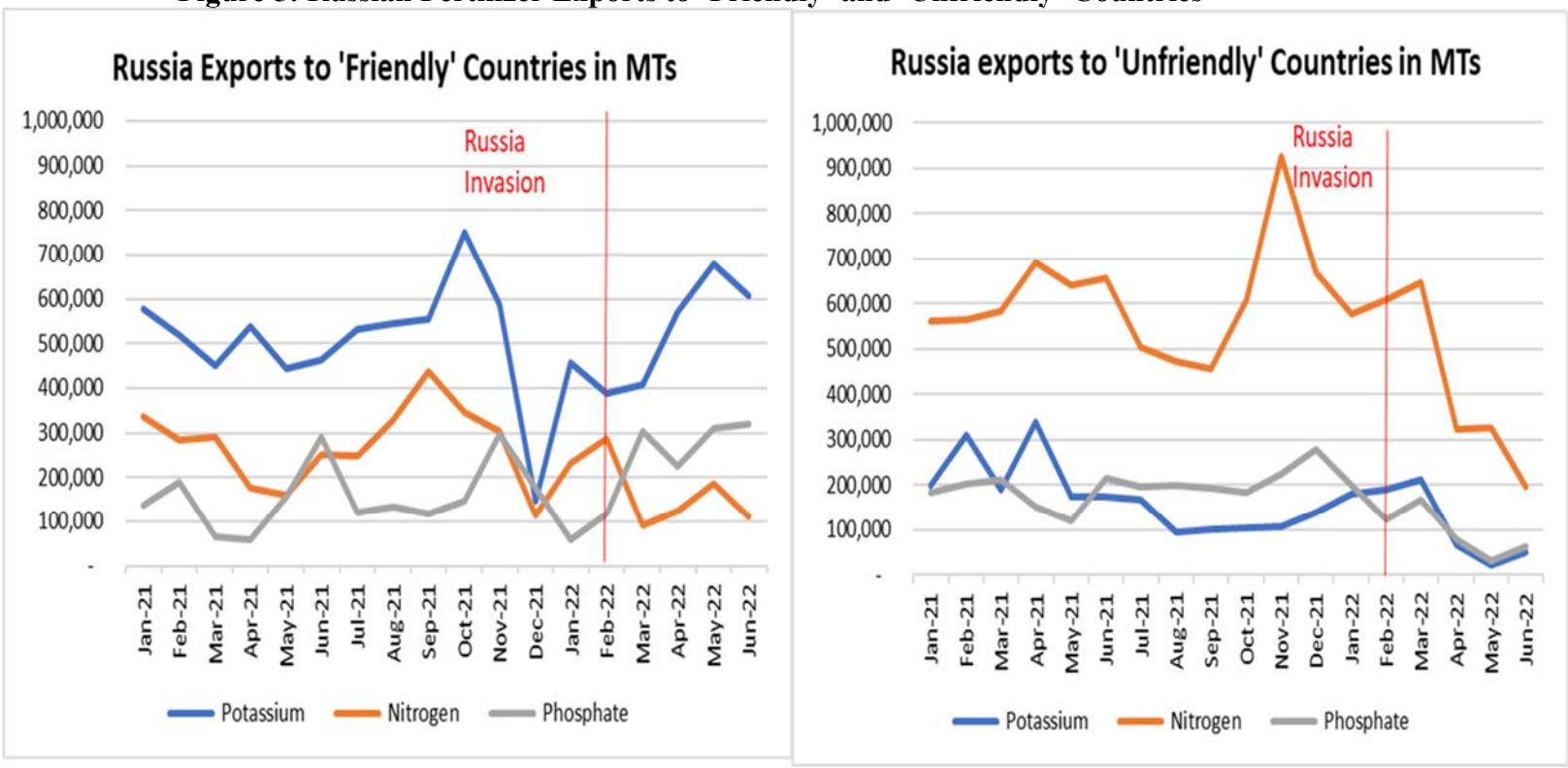
Figure 4: Trade Volume Changes of Russia's Cereal Grain Exports to Friendly, Unfriendly and Neutral Countries.



Source: Authors calculations from Trade Data Monitor

neutral, and unfriendly countries. The figure illustrates a clear reorientation of Russia's cereal grain trade since the start its war in Ukraine. Russian exports of cereal grains to "neutral" and 'unfriendly' countries have fallen significantly, by almost 819 and 217 thousand MTs relative to the pre-war period; while its exports of cereal grains to 'friendly' countries are up by 1.3 mmts. The effects are also notable for Russia's fertilizer exports in Figure 5 which breaks out fertilizer exports by nutrient components across 'friendly' vs 'unfriendly' countries. Russia's potash exports are up significantly to 'friendly' countries, and more than makes up for the decline in potash exports to 'unfriendly' countries. Conversely, nitrogen exports to both 'friendly' and 'unfriendly' countries declined, whereas phosphate exports are up slightly for friendly and

Figure 5: Russian Fertilizer Exports to 'Friendly' and 'Unfriendly' Countries



Source: Authors calculations from Trade Data Monitor

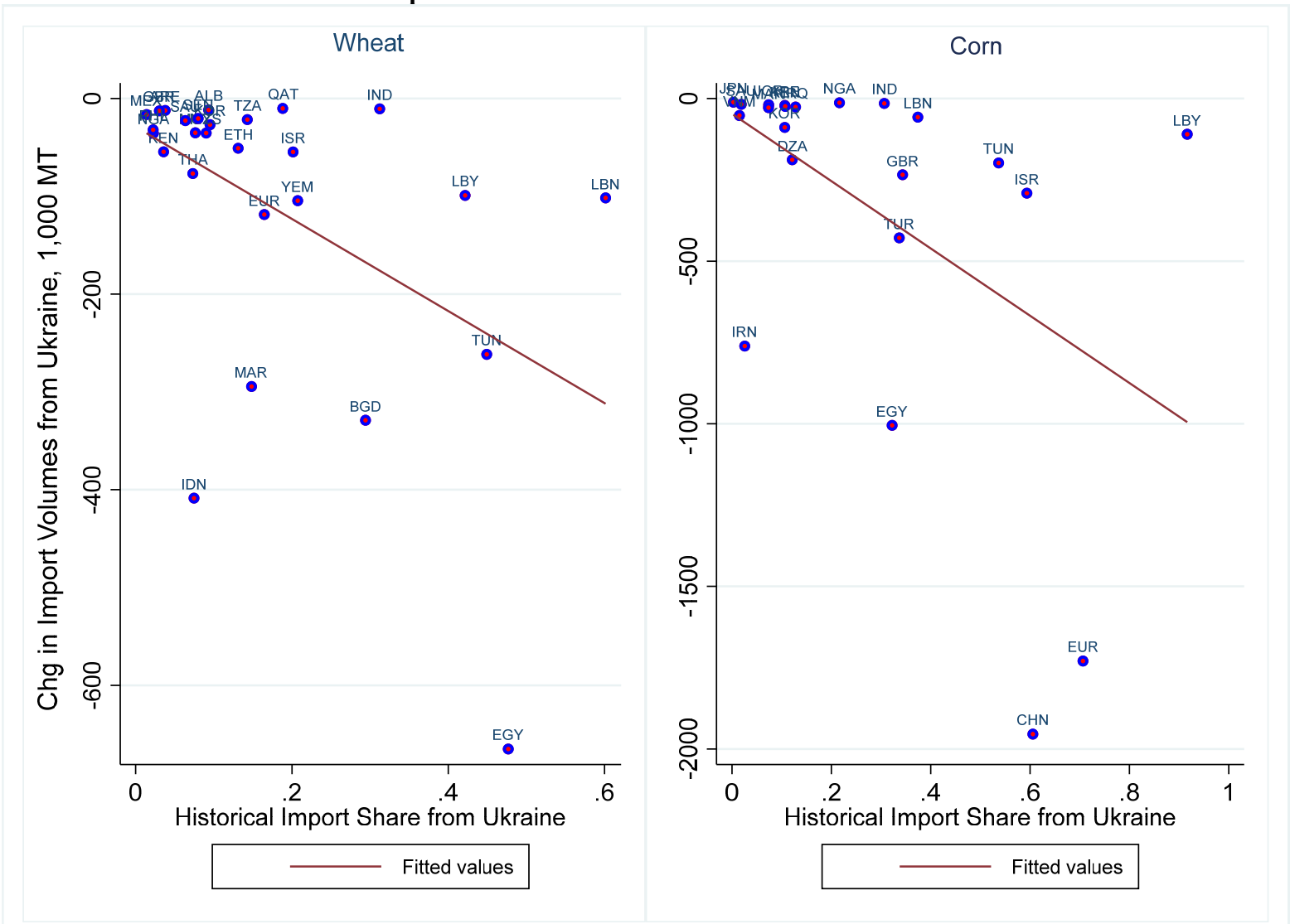
down for unfriendly countries. One reason for the significant increase of Russian potash exports may be that prior to the war, 'friendly' countries were the key destination markets (accounting for two-thirds of Russian potash exports). The opposite is true for Russia's nitrogen exports, where unfriendly countries were the primary markets (also accounting for two-thirds of Russian exports prior to the war). Thus, 'friendly' markets may have more capacity to absorb additional Russian potash exports relative to nitrogen exports. In efforts to assist its domestic farmers, Russia also extended its quotas on nitrogen fertilizer exports (Reuters 2022c). At the time of this writing the level of Russia's nitrogen fertilizer exports have yet to reach the quota levels.

Are the Trade Effects Worse for Lower-Income Countries More Reliant on Ukraine?

In this final sub-section, we return to an important question raised by the many international organizations: are the trade losses from Russia's invasion of Ukraine more severe for lower-income countries? Using wheat and corn as a case study, we illustrate this relationship in Figure 6. This chart plots the change in countries' March-June 2022 cumulative wheat and corn import volumes from Ukraine (relative to the average of the same months in the previous five years) on the vertical axis against each country's average historical March-June (2017-2021) share of wheat and corn imports sourced from Ukraine.

The further down and to the right the scatterplots are (i.e., moving southeast) in the Figure 6, the greater is the reduction in import volumes from, and historical reliance on, Ukraine for wheat and corn imports. Although the relationship is not as tight as presumed, the results underscore a general trend: the line of best fit slopes downward indicating that the negative trade volume effects of the war are increasing, in absolute value, for countries that are historically more reliant on imports from Ukraine. Egypt is an example of a country with a historically large import reliance on Ukraine for wheat and corn imports of 48% and 32%, respectively, and has experienced a decline of over 600,000 mt of wheat and over 1 mmt of corn in March-June 2022, compared to Egypt's 2017-2021 average in these same months. Other lower-income countries with relatively high import dependence and larger trade volume reductions include Bangladesh (-300,000 mt; 30% import reliance on Ukraine), Tunisia (-262,000 mt; 45%), Morocco (-295,000 mt; 15%), Yemen (-104,000 mt; 21%), Libya (-99,000 mt; 42%) and Lebanon (-102,000 mt; 60%). Indonesian wheat, and China and EU corn imports are examples of upper-middle and high-income markets that have been similarly impacted by the war.

Figure 6. March-June Trade Flow Changes Relative to 5-year Previous Average vs. Historical March-June Imports Sourced from Ukraine



Notes: Authors calculations from Trade Data Monitor. EUR denotes European Union. Line of best fit included. Country codes in Appendix A.

Conclusions and Global Implications

This article provided one of the first looks at the potential agricultural trade impacts of Russia's invasion of Ukraine. We found sharp and immediate effects: Russia's war has reduced Ukraine's grain and oilseed exports by an average of 74% and 49%, respectively, during the first 4 months of this conflict (March-June 2022). This is equivalent to restricting over 11 mmts of

Ukrainian cereal grains (wheat, corn and barley) and an additional 2.4 mmts of vegetable oil, meal and seed from the global market. These amounts represent nearly one-quarter (24%) and 15% of Ukraine's annual global exports in these two sectors, respectively. These trade volume impacts occurred on top of *fob* export price discounts due to the war.

Our estimated effects on most Russian agricultural and fertilizer exports were not significant. However, we find a significant geographical reorientation of Russian agricultural and fertilizer exports away from 'unfriendly' and towards 'friendly' countries – at least in the early months of this conflict. This is likely leading to shifts in the relative costliness of imported agricultural and fertilizer commodities that may negatively impacting some countries while benefiting others. However, we leave this analysis to future research.

At the time of this writing, Russia and Ukraine recently signed an agreement with the U.N and Tukey to restart Ukrainian grain exports from three ports: Odessa, Yuzhny, and Chernomorsk (Bloomberg 2022b; Washington Post 2022). While positive, this has been the only diplomatic breakthrough since the war began and initial shipments following the deal have been slow. Nevertheless, the agreement hinges upon both sides living up to the agreement. Even if the deal is honored, it will take time to rebuild port capacity and for traders and inspection officials to kick-start trade flows. Ukraine faces the task of clearing a pathway in mined seas, finding enough ships to carry the backlogged grain, re-routing trains and trucks that are now being used elsewhere, and rebuilding storage capacity at these ports. What this means for the many lower-income countries dependent on Ukrainian food exports remains unclear. Much will depend on how easily these markets can source product from other exporters in North and South America. We leave this and many other important questions for further research.

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Appendix Table A. List of 51 Early Reporting Countries in Sample and their ISO-3 Digit Country Codes

Africa	Middle East	Asia	Europe	Oceania	North America	Central/South America & Caribbean
Senegal* (SEN)	Iran* (IRN)	China (CHN)	Switzerland (CHE)	Australia (AUS)	Canada (CAN)[a]	Argentina (ARG)
Madagascar* (MDG)	Qatar (QAT)	Japan (JPN)	Norway (NOR)	New Zealand (NZL)	United States (USA)[a]	Brazil (BRA)
Cote d'Ivoire* (CIV)	Saudi Arabia (SAU)	Singapore (SGP)	Serbia (SRB)		Mexico (MEX)	Chile (CHL)
Ethiopia* (ETH)	Israel (ISR)	South Korea (KOR)	Georgia (GEO)			Dominican Rep. (DOM)
South Africa (ZAF)		Sri Lanka* (LKA)	Uzbekistan* (UZB)			Uruguay (URY)
Kenya* (KEN)		Indonesia (IDN)	Turkey (TUR)			Peru (PER)
Morocco* (MAR)		Thailand (THA)	United Kingdom (GBR)			Costa Rica (CRI)
Namibia* (NAM)		Malaysia (MYS)	Albania (ALB)			
Mozambique* (MOZ)		India* (IND)	Bosnia & Herz. (BIH)			
Nigeria* (NGA)		Taiwan (TWN)	EU (EUR)			
Zimbabwe* (ZWE)		Philippines (PHL)	North Macedonia (MKD)			
			Kazakhstan (KAZ)			
			Montenegro (MNE)			
TOTAL: 11	*4*	*11*	*13*	*2*	*3*	*7*

----------Additional Lower-Income Countries Included in the Sample Using Ukraine's Reported Exports----------

Algeria, Egypt, Jordan, Lebanon, Tunisia, Libya, South Sudan, Iraq, Pakistan, Bangladesh, Somalia, Yemen, Vietnam, Nepal, Myanmar, Ghana, Tanzania, United Arab Emirates, Nicaragua

Note: Total = 51 countries. Sample excludes Hong Kong, Bolivia, Paraguay, El Salvador, Paraguay, Bahrain, Iceland, and Panama. These countries have very little historical agricultural trade with Russia or Ukraine (< $1.0 mil. annually). * denotes low-income or lower-middle income economies according to the World Bank Country Classification for current 2022 fiscal year. Some countries only report monthly trade values (i.e., Dominican Republic and Israel). In these cases, we approximated monthly volumes from the value data using average unit value prices for the same product and month of the nearest neighboring countries, where trade volume = trade value / unit value price.

Appendix Table B. Product Sectors Included in the Analysis

Top Agricultural Sectors			Non-Agriculture Sectors	Fertilizer
Cereal Grains & Pulses	*Oilseeds and Co-Products*	*Meat products*		
Corn	Oilseeds (Sunflower, Rapeseed and Soybeans)	Poultry	Ferrous Metals (Iron/Steel)	Nitrogen
Wheat	Vegetable Oils (Sunflower, soy and rapeseed Oil)	Pork	Electrical Equipment	Phosphate
Coarse grains	Vegetable Meal (Sunflower, soy an rapseed meal)		Non-Ferrous metals	Potassium
Pulses			Chemicals	
			Mineral Extractions	
			Coal	
			Oil	
			Petroleum	