Global Grain Trade Implications of the Russia-Ukraine War

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Abstract

This paper provides an ex-post impact assessment of the Russian invasion of Ukraine on international grain and oilseed trade. We use a commodity-level empirical model to assess the counterfactual trade effects and evaluate the region-specific global trade reallocation effects. We find that grain and oilseed imports from Ukraine were 78.2 percent below the counterfactual between February and July 2022. The Russia-Ukraine war caused substantial trade diversion, mainly benefiting countries in North America and Europe. The adjustment of global grain and oilseed trade operates primarily through price adjustments, with considerable heterogeneity across commodity groups. Our ex-ante analysis demonstrates that the Ukraine-Russia war had substantial trade implications for the directly involved countries but only limited ones for the global grain and oilseed markets in terms of traded quantity.

JEL Codes: F14, Q17

Keywords: Russia-Ukraine war, grain and oilseed trade, dynamic treatment effects, commodity heterogeneity

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1. Introduction

The Russian invasion of Ukraine has created immense human suffering, but it is also damaging global trade (Ruta et al., 2022). The World Trade Organization estimated that the global economic prospect has "darkened" considerably since the war started on February 24, 2022, expecting global trade growth to fall from 4.7 percent to between 2.5 percent and 3.4 percent, with the adverse trade effects being concentrated in Europe and Africa (WTO, 2022). Ukraine and Russia are major agricultural commodity exporters that ship most of their crop via sea, and the war limited this mode of transport considerably for Ukraine in particular. This development causes repercussions for agricultural producers all around the globe, inducing a global reallocation of trade flows for some agricultural commodities, such as cereal grains and oilseeds (Bentley et al., 2022; Glauben et al., 2022; Korn and Stemmler, 2022). This paper provides an ex-post assessment of the global trade reallocation effects of the Russia-Ukraine war, drawing on detailed trade data and theory-consistent empirical models to quantify the trade destruction and diversion effects for cereal grains and oilseeds.

A growing literature investigates the economic consequences of the Russian invasion of Ukraine. Areas of inquiry include economic growth (Liadze et al., 2022; Mahlstein et al., 2022), stock market performance (Ahmed et al., 2022; Boungou and Yatié, 2022; Sun and Zhang, 2022), commodity markets (Fang and Shao, 2022; Ihle et al., 2022; Paulson et al., 2022), and food security (Abay et al., 2022; Behnassi and El Haiba, 2022; Carriquiry et al., 2022; Hellegers, 2022). Borin et al. (2022) developed a theoretical framework to assess the economic and trade implications of the Russia-Ukraine war. They argue that the economic effects depend on a country's ability to diversify its supply chain. An ex-ante simulation study by Ruta et al. (2022) estimates that global trade would decrease by 1 percent in 2022, which would lower the global gross domestic product by 0.7

percent and have adverse implications for global supply chains and investment. Several other ex-ante studies simulate the implications of economic sanctions on trade (Allen, 2022; Bergeijk, 2022; Estrade and Koutronas, 2022; von Cramon-Taubadel, 2022), discuss pre-existing grain market trade dependencies (Glauben et al., 2022), and analyze measures to stabilize global wheat supply and ensure food security (Bentley et al., 2022).

We use a flexible, theory-consistent, monthly commodity-level empirical model of bilateral trade to assess the ex-post trade effects of the Russian invasion of Ukraine for cereal grains and oilseeds and evaluate the region-specific global trade reallocation effects. Recent advances in the international trade policy literature, e.g., Arita et al. (2022), Steinbach (2022), Grant et al. (2021), and Carter and Steinbach (2020) guide this empirical analysis. The identification strategy allows us to identify the direct and indirect trade impacts of the Russian invasion of Ukraine. We find that grain and oilseed imports from Ukraine were 78.2 percent below the counterfactual between February and July 2022. The war effect is considerably smaller for Russia, which experienced a 7.4 percent decline in grain and oilseed exports. Meanwhile, imports from non-targeted regions decreased by 2.6 percent, with trade diversion mainly benefiting North America and Europe. The results also provide evidence for considerable positive price effects and heterogeneity across commodity groups, with oilseeds and vegetable oils experiencing the largest adverse trade effects. These findings hold up to a battery of robustness checks and show that the Ukraine-Russia war had considerable trade implications for the directly involved countries but only limited ones for the global grain and oilseed markets in terms of traded quantity. In contrast, we find evidence that the global market adjustment operates mainly through increased prices for grains and oilseeds.

The paper offers three distinct contributions to the growing literature on the economic consequences of the Russian invasion of Ukraine. First, the paper is the first to use counterfactual

statistical methods to quantify the direct and indirect implications of the Russia-Ukraine war for global grain and oilseed trade. Insights from this ex-post analysis expand on previous ex-ante studies on the trade effects of economic sanctions and trade blockages (Allen, 2022; Bergeijk, 2022; Estrade and Koutronas, 2022) and concerns about food security (Behnassi and El Haiba, 2022; Carriquiry et al., 2022; Hellegers, 2022). Second, we document the global reallocation dynamics for grains and oilseeds and show how the trade effects of the Russian invasion of Ukraine operate mainly through price effects in non-directly involved markets. These insights represent a significant contribution, as earlier simulation studies cautioned about grain export supply constraints and their implications for food security (Bentley et al., 2022; Glauben et al., 2022). Third, we contribute to the growing literature that assesses the implications of trade shocks using theory-consistent trade models and counterfactual evaluation methods that account for treatment dynamics (Arita et al., 2022; Steinbach, 2022; Grant et al., 2021; Carter and Steinbach, 2020). This paper shows that these methods are well-suited to assess the trade implications of the Russian invasion of Ukraine, which could prove helpful for other studies interested in the counterfactual evaluation of unexpected trade shocks.

2. Methods and Data

2.1. Methods

We rely on a panel event study design to assess the within-year treatment effects of the Russian invasion of Ukraine for cereal grain and oilseed trade. The empirical strategy builds on isomorphic gravity trade models and recent advances in the international trade policy literature to assess the ex-post trade effects of the Russian invasion of Ukraine and evaluate the region-specific global trade reallocation effects (Arita et al., 2022, Steinbach, 2022). The dynamic treatment model includes leads and lags relative to the event of interest and controls for potential unobserved

confounders through high-dimensional fixed effects. The regression framework captures pre-trends and enables us to assess post-treatment dynamics (Freyaldenhoven et al., 2021; Roth and Sant'Anna, 2021; Schmidheiny and Siegloch, 2020). Following Carter et al. (2022), we rely on a non-linear panel regression model for count data:

$$y_{ijst} = \exp\left(\alpha_{ijs,mo} + \alpha_{ijs,yr} + \sum_{k=-5}^{k=5} \beta_k \, r_{ijs,t-k}\right) \eta_{ijst} \,, \tag{1}$$

where we denote the importer with i, the exporter with j, the commodity with s, and the month with t. The outcome of interest is denoted by y_{ijst} and maps into import quantities and prices. We indicate fixed effects at the importer-exporter-commodity-month level with $\alpha_{ijs,mo}$ and at the importer-exporter-commodity-year level with $\alpha_{ijs,yr}$. These variables account for the influence of unobserved factors confounding the relationship of primary interest. We allow the fixed effects to be flexible over time because multiple (unobserved) factors that vary within and across years determine grain and oilseed demand and supply. This specification of the time-fixed effects enables us to account for shocks resulting from unobserved changes in the demand and supply patterns at the importer-exporter-commodity level. For instance, grain and oilseed trade could face pre-existing trends and seasonality patterns in export volumes and prices. The term $\sum_{k=-5}^{k=5} \beta_k \, r_{ijs,t-k}$ measures the dynamic treatment effects of the Russia-Ukraine war. Following standard practice in the event study literature, we use a symmetric event window that extends five months before and after February 2022 (Freyaldenhoven et al., 2021). This approach allows us to account for potential pre-trends and test for leveling off treatment effects.

The empirical model is flexible to some degree, i.e., it allows the treatment effect to be dynamic before and after the event month. The regression specification addresses level differences in export volumes between commodities through the importer-exporter-commodity fixed effects. We deploy

the parsimonious assumption that all latent confounders are invariant at the importer-exporter-commodity-year and importer-exporter-commodity-month levels and thus captured by $\alpha_{ijs,mo}$ and $\alpha_{ijs,yr}$. We use trade data from 2015 to 2019 as the control group to measure the causal treatment effects of the Russian invasion of Ukraine and quantify the trade destruction and diversion effects.[1] Carter et al. (2022) used a similar identification strategy to evaluate the impact of the 2021/22 container shipping disruptions on U.S. agricultural exports. We rely on the Poisson Pseudo Maximum likelihood (PML) estimator to identify the relationship between the count outcome and the treatment variables and account for the high-dimensional fixed effects using a modified version of the iteratively re-weighted least-squares (IRLS) algorithm (Correia et al., 2020; Silva and Tenreyro, 2006). Following standard practice in the trade literature, we cluster the standard errors at the importer-exporter-commodity level (Weidner and Zylkin, 2021; Cameron and Miller, 2015).

2.2. Data

We obtained monthly trade data at the Harmonized System (HS) heading level (HS-4) for grains and oilseeds from the Trade Data Monitor (2022). The final balanced panel dataset consists of monthly commodity-level import quantities and prices for 85 reporting countries and 197 partner countries from August 2015 to July 2022. We rely on mirrored import data because Russia discontinued reporting official trade statistics in February 2022. We use this dataset to construct the event study panel, which enables us to measure the trade destruction and diversion effects caused by the Russian invasion of Ukraine. Lastly, we draw sub-samples for four commodity groups and six regions to assess the heterogeneity in the trade effects for grains and oilseeds. The descriptions

[1] We excluded import data for 2020 and 2021 from this analysis. Because the COVID-19 pandemic started in the Spring of 2020, we are concerned about potential estimation bias induced by using 2020 and 2021 as control groups to construct the counterfactual for evaluating the trade effects of the Russia-Ukraine war (Ahn and Steinbach, 2022).

and HS codes for the commodity groups are listed in **Appendix Table A1**.[2] The final event study panel covers 552,585 unique importer-exporter-commodity pairs imported under 33 HS headings.

3. Results and Discussion

Figure 1 shows event studies estimates for the impact of the Russian invasion of Ukraine on grain and oilseed trade. We compare the import quantity and price effects for Ukraine, Russia, and all other countries. Each sub-figure depicts the dynamic treatment parameters 95 percent confidence intervals and uniform sup-t bands for the event-time of the outcome (Freyaldenhoven et al., 2021). We overlay estimates for a static regression model and report the test statistics for pre-trends and leveling-off treatment effects in the figure notes. We find that grain and oilseed imports from Ukraine were depressed by 78.2 percent from February to July 2022.[3] At the same time, we find no evidence for statistically significant treatment effects for Russia and other countries. The average trade effect for Russia is -7.4 percent and -2.6 percent for all other countries. In contrast, we find evidence for considerable price effects, with grain and oilseed prices being 14.0 percent higher for Ukraine, 13.6 percent for Russia, and 3.9 percent for the remaining countries.[4]

We provide further nuance to the trade destruction and diversion effects of the Russian invasion of Ukraine in **Figure 2**. The figure compares average post-event treatment effects for import quantity and price for four commodity groups and six regions. Regarding trade destruction, we find that

[2] **Appendix Figure A1** shows trends in grain and oilseed trade for Ukraine, Russia, and all other countries by commodity group from January 2015 to July 2022.

[3] We transformed the parameter estimates to trade effects using the formula $\left(\exp(\bar{\beta}_k) - 1\right) * 100$.

[4] **Appendix Figures A2** and **A3** present robustness checks for potential pre-trend effects. We estimate equation (1) under the alternative assumption that the pre-trends would have continued linearly (Dobkin et al., 2018). Apart of imports from Russia, we find no evidence of significant pre-trend effects. Accounting for those trends, the average post-event trade effects for import quantity from Russia is 145.8 percent and -10.4 percent for the import price. Because the quantity effect is considerably larger when controlling for pre-trends, our estimates for Russia likely present the lower bound of the treatment effect range.

Africa's grain and vegetable oil imports were 99.5 percent and 92.6 percent below the counterfactual, while Europe faced the largest adverse trade effects for oilseeds (-98.3 percent). These considerable trade effects are accompanied by average price increases of 2.0 to 7.3 percent that vary considerably across export destinations. For instance, the average price of grain imports from Ukraine was 60.0 percent above the counterfactual for Africa and 24.6 percent for Asia, pointing toward substantial import price adjustments in many food-insecure countries.

We find evidence for considerable trade diversion to other grains and oilseed producers, as shown in **Figure 2**, implying that affected commodities from Ukraine were replaced by imports of similar *varieties* from other regions. Global grain imports from Europe and North America increased by 10.5 percent and 22.1 percent, respectively, while Asia and South America benefitted from trade diversion for milled grains. We utilized the trade elasticity estimates to assess the direct and indirect global grain and oilseed market effects in **Table 1**. We find that export losses for Ukraine concentrate on grains, while we find only minor quantity effects for milled grains, oilseeds, and vegetable oils. Between February and July 2022, grain imports from Ukraine were 12.9 million tons below the counterfactual. At the same time, Russia experienced limited trade diversion, increasing its grain and oilseed exports by 0.4 million tons. Although the trade destruction effects for Ukraine were considerable, grain imports from other countries compensated for those losses, increasing by 8.6 million tons above the counterfactual. A similar replacement effect is observable for milled grains. At the same time, grain and oilseed import prices for Ukraine and Russia increased considerably, while they increased far less for all other countries. This pattern implies that the price effects for directly involved countries outweigh those for other countries, pointing toward import prices being the main pathway of trade adjustments.

4. Conclusion

This paper provides an initial ex-post assessment of the global trade reallocation effects of the Russia-Ukraine war for cereal grains and oilseeds, drawing on detailed trade data and theory-consistent empirical models. Using counterfactual evaluation methods, we find that grain and oilseed exports from Ukraine were 78.2 percent below the counterfactual between February and July 2022, while the war effect is considerably smaller for Russia. The Russia-Ukraine war caused substantial trade diversion, mainly benefiting countries in North America and Europe. We find that the adjustment of global grain and oilseed markets operates primarily through price effects, with considerable heterogeneity across commodity groups. Our ex-ante analysis proves that the Ukraine-Russia war had substantial trade implications for the directly involved countries but only limited ones for the global grain and oilseed markets in terms of traded quantity.

The Black Sea Grain Initiative likely eased some quantity constraints and price pressure after July 2022 by pushing an additional 10 million tons of grains and oilseeds out of Ukraine (WTO, 2022). Most of these additional grain exports went to developed countries, such as Spain, Turkey, and Italy. In contrast, considerably fewer exports were destined for developing countries in the Middle East and North Africa region, which experienced the sharpest reduction in grain imports from Ukraine due to the Russia-Ukraine war. This pattern raises the question of who benefited from the Black Sea Grain Initiative. Before the Russian invasion of Ukraine, a significant share of Ukraine's grain and oilseed exports was sent to those vulnerable food-importing countries. As we show, affected *varieties* produced in Ukraine were replaced by exports of similar *varieties* from other regions not impacted by the disruption, implying that the grain deal could have benefited some developed countries more than vulnerable developing countries.

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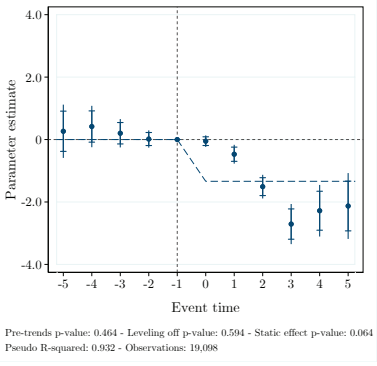
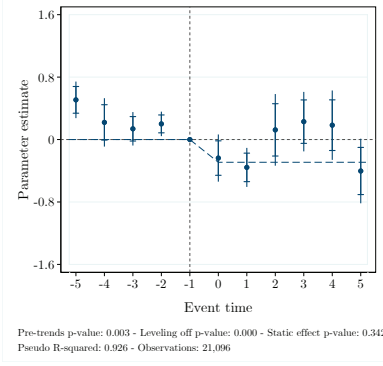
Figures and Tables

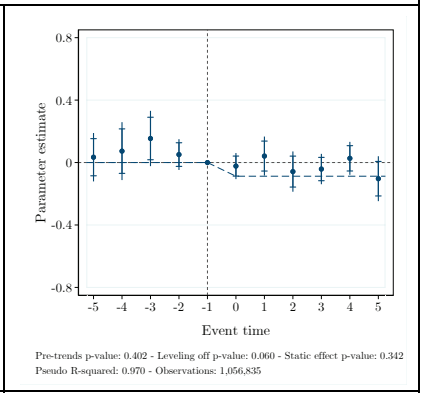
Figure 1. Event Studies for the Impact of the Russian Invasion of Ukraine on Grain and Oilseed Imports from Ukraine, Russia, and Other Countries.



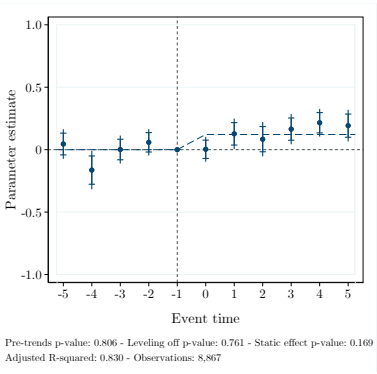
Panel (A): Import Quantity from Ukraine



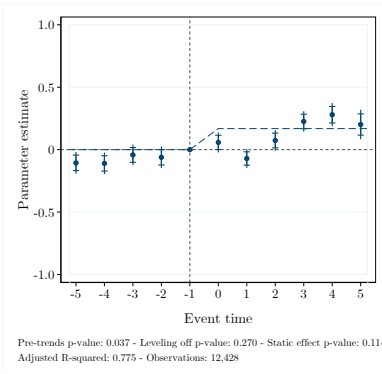
Panel (B): Import Quantity from Russia



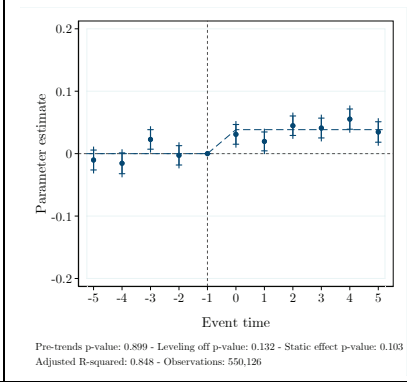
Panel (C): Import Quantity from Other Countries



Panel (D): Import Price from Ukraine



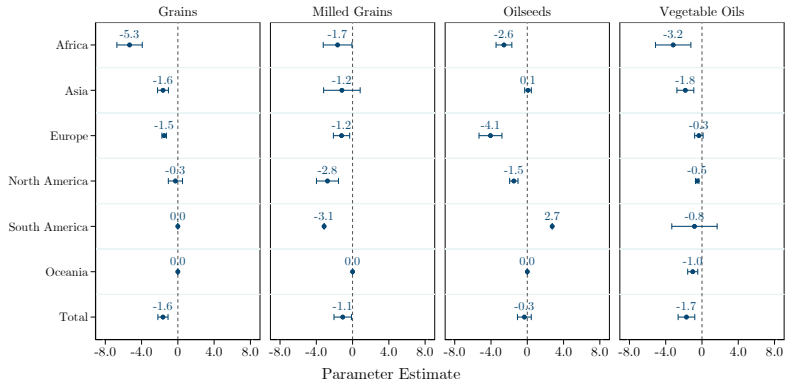
Panel (E): Import Price from Russia



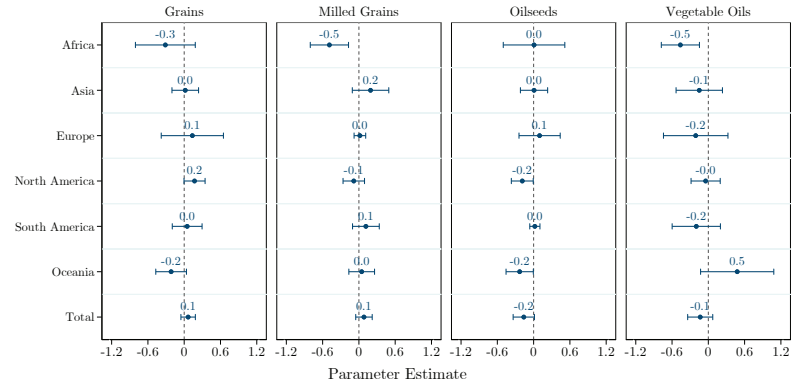
Panel (F): Import Price from Other Countries

Note. The figure presents event study estimates for the impact of the Russian invasion of Ukraine on grain and oilseed import quantities and prices for Ukraine, Russia, and all other countries. The event time is measured in months relative to February 2022. Each sub-figure depicts the dynamic treatment parameters 95 percent confidence intervals and uniform sup-t bands for the event-time of the outcome. We overlay estimates for a static regression model and report Wald test statistics for pre-trends and leveling-off treatment effects in the figure notes. Standard errors are adjusted for within-cluster correlation at the importer-exporter-commodity level.

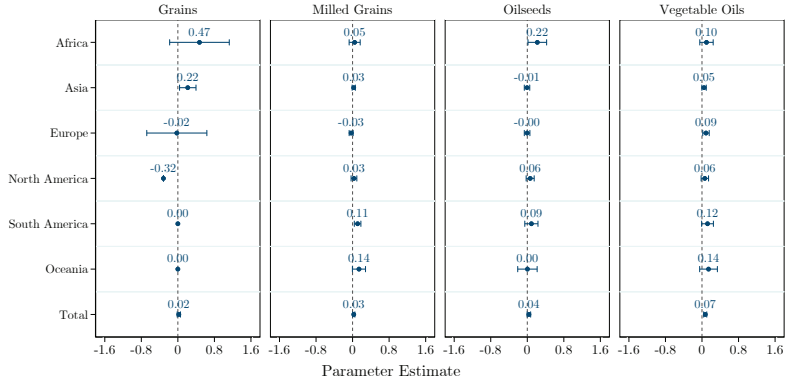
Figure 2. Average Post-Event Treatment Effects by Commodity Group and Region.



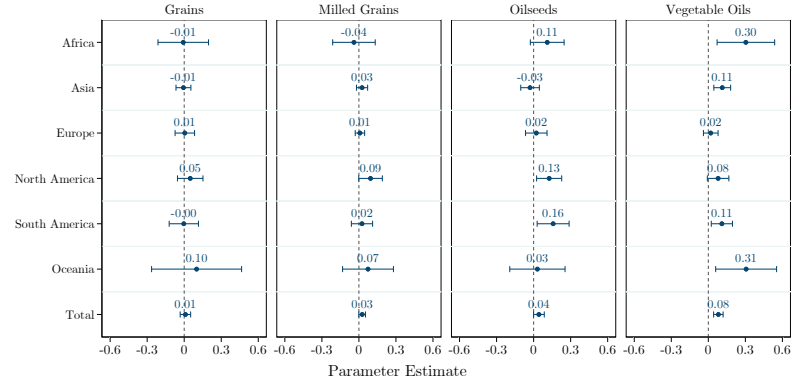
Panel (A): Import Quantity from Ukraine



Panel (B): Import Quantity from Other Countries



Panel (C): Import Price from Ukraine



Panel (D): Import Price from Other Countries

Note. The figure shows the average post-event treatment effects and corresponding confidence intervals by commodity group and region. The subgroup all others includes all countries apart from Ukraine and Russia. The average post-event treatment effects were calculated following Chaisemartin and D'Haultfœuille (2020).

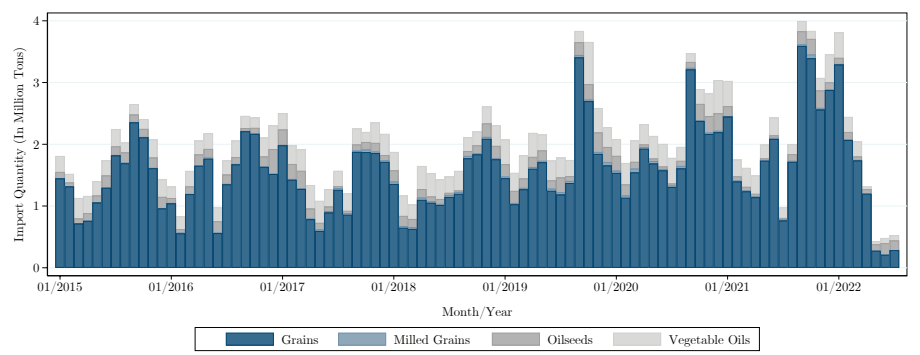
Table 1. Counterfactual Trade Effects for Grain and Oilseed Quantities and Prices.				
	Commodity Group	Ukraine	Russia	All Others
Import Quantity (in Million Tons)	Grains	-12.88	0.16	8.57
	Milled Grains	-0.04	-0.33	1.06
	Oilseeds	-0.11	0.23	-11.66
	Vegetable Oils	-1.78	-0.33	-1.10
Import Unit Value (in USD per Ton)	Grains	68.48	106.43	3.88
	Milled Grains	47.90	27.83	13.97
	Oilseeds	51.08	57.88	29.97
	Vegetable Oils	37.83	315.39	128.29
Note. The table shows the counterfactual trade volume and price changes for grains and oilseeds from February to July 2022. We summed the import quantity and calculated the average import price based on the counterfactual dynamic treatment effect estimates at the commodity level.				

Online Appendix

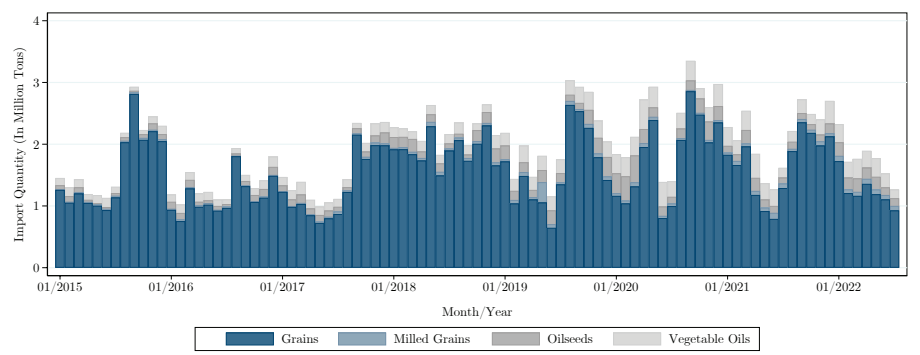
The Impact of the Russian Invasion of Ukraine on Grain and Oilseed Trade

Soojung Ahn, Dongin Kim and Sandro Steinbach

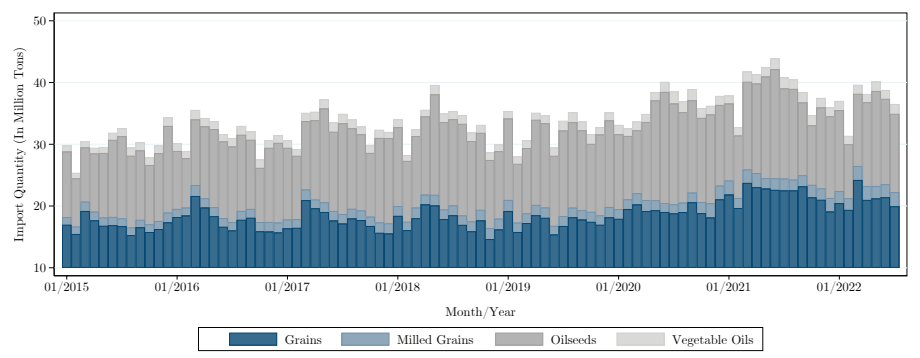
Figure A1. Trends in Grain and Oilseed Import Volumes from January 2015 to July 2022.



Panel (A): Import Quantity from Ukraine



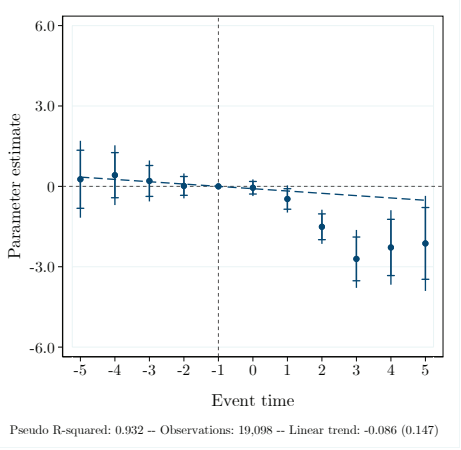
Panel (B): Import Quantity from Russia



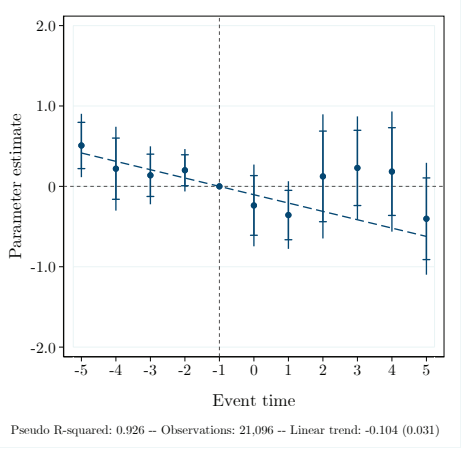
Panel (C): Import Quantity from Other Countries

Note. The table shows trends in grain and oilseed import volumes from January 2015 to July 2022. We stacked the data by commodity group and report them for Ukraine, Russia, and other countries.

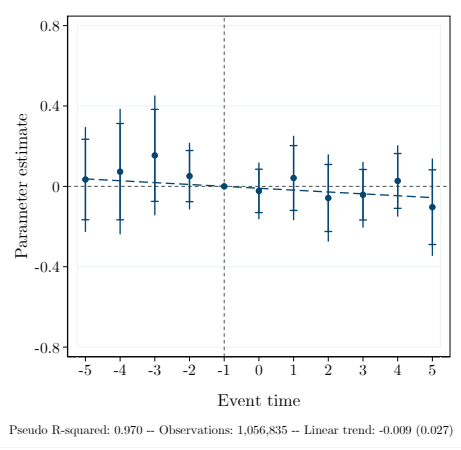
Figure A2. Robustness Checks for Linear Pre-Trends.



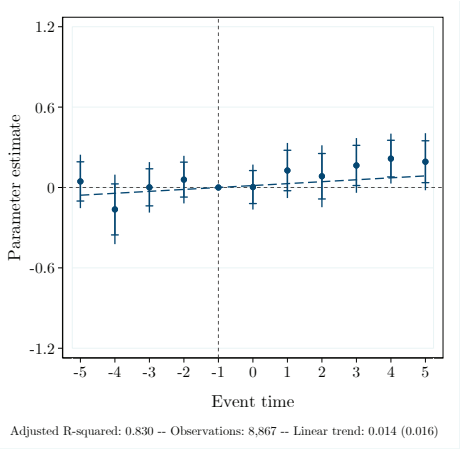
Panel (A): Import Quantity from Ukraine, Extrapolated Trend



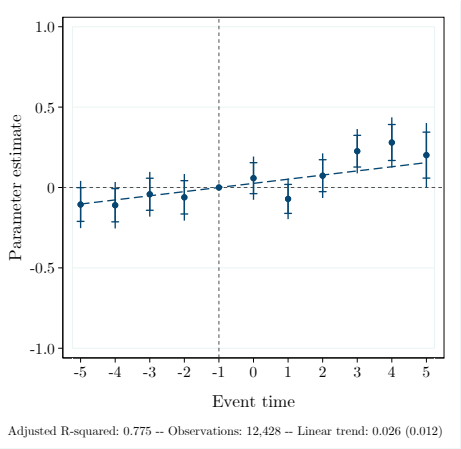
Panel (B): Import Quantity from Russia, Extrapolated Trend



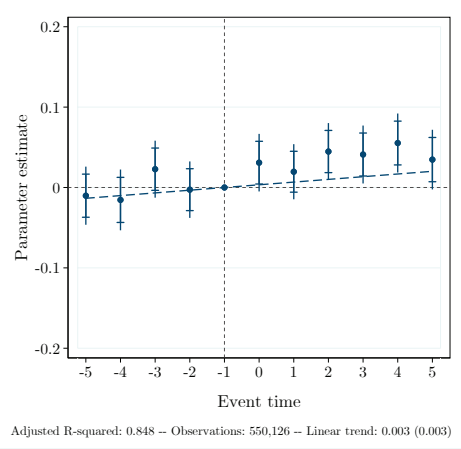
Panel (C): Import Quantity from Other Countries, Extrapolated Trend



Panel (D): Import Unit Value from Ukraine, Extrapolated Trend



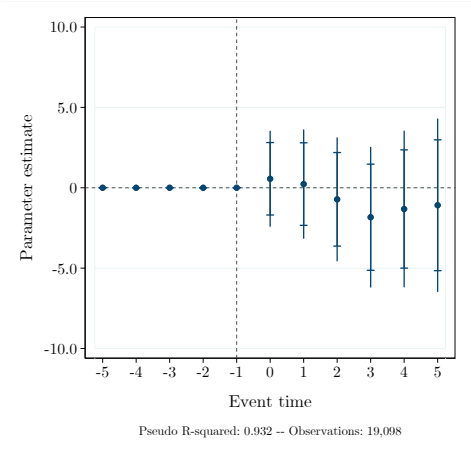
Panel (E): Import Unit Value from Russia, Extrapolated Trend



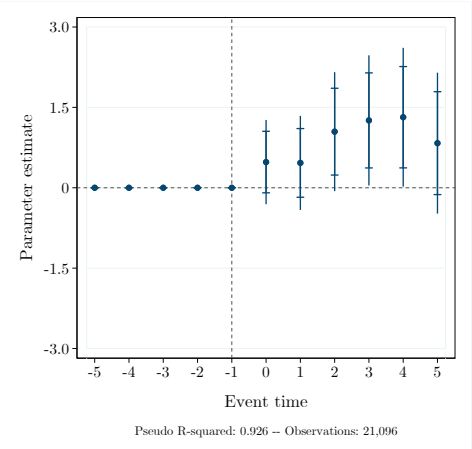
Panel (F): Import Unit Value from Others Countries, Extrapolated Trend

Note. The figure presents the robustness checks for linear pre-trends. We estimate equation (1) under the alternative assumption that the pre-trends would have continued linearly. The dashed lines represent linear pre-trends for import quantity and price for Ukraine, Russia, and other countries.

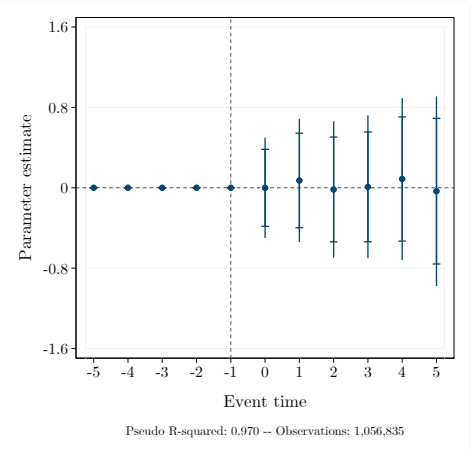
Figure A3. Event Studies with Subtracted Linear Pre-Trends.



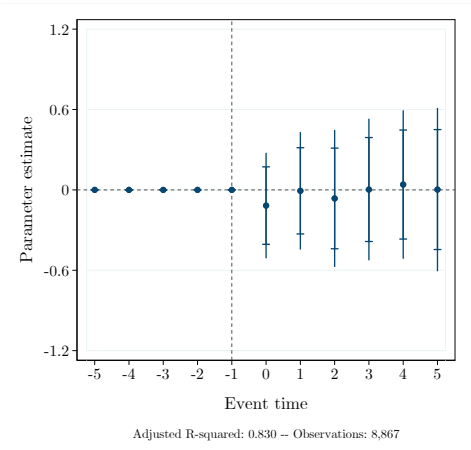
Panel (A): Import Quantity from Ukraine, Subtracted Trend



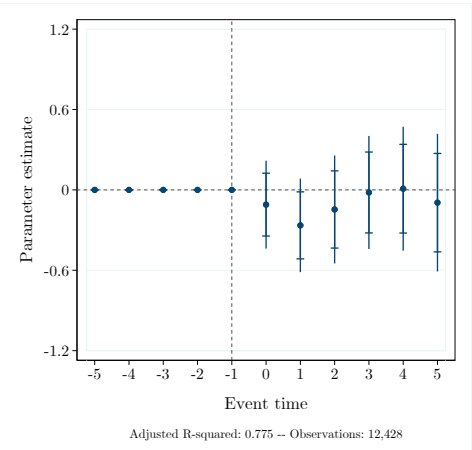
Panel (B): Import Quantity from Russia, Subtracted Trend



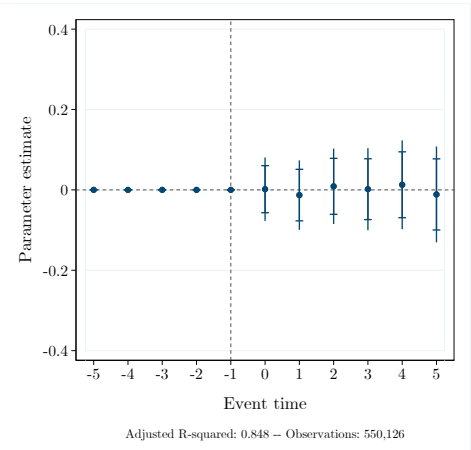
Panel (C): Import Quantity from Other Countries, Subtracted Trend



Panel (D): Import Unit Value from Ukraine, Subtracted Trend



Panel (E): Import Unit Value from Russia, Subtracted Trend



Panel (F): Import Unit Value from Other Countries, Subtracted Trend

Note. The figure shows event studies with subtracted linear pre-trends. We estimate equation (1) under the alternative assumption that the pre-trends would have continued linearly and subtracted the linear pre-trends from the event study estimates following Dobkin et al. (2018).

Table A1. Commodity Groups.		
Commodity Group	HS-4 Digit	Commodity Description
Grains	1001-1008	Wheat and meslin, rye, barely, oats, maize, rice, grain sorghum, buckwheat, millet and canary seeds, other cereals
Milled Grains	1101-1108	Wheat and meslin flour, maize flour, buckwheat flour, rice flour, rye flour, cereal groats, meal and pellets, cereal grains worked, flour, meal, and powder of the dried leguminous vegetables, etc.
Oilseeds	1201-1211, 1213,1214	Soybeans, peanuts, copra, flaxseed, rape or colza seeds, sunflower seeds, other oilseeds, flours, and meals of oilseeds
Vegetable Oils	1507, 1512, 1514, 1517	Soybean oil, sunflower-seed, safflower or cottonseed oil, rapeseed, colza or mustard oil, margarine, etc.