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Analyzing the Effect of the Unfriendly Countries List of Russia on Global Trade through the Staggered Difference-in-Differences Design in the Gravity Model

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Running title: *The Effect of Russia's UCL on Global Trade*

Abstract

We studied the effect of the Russian Unfriendly Countries List (UCL) on the global trade of sanctioned countries. Applying the staggered Difference-in-Differences in the gravity model to trade data from 48 countries, we found that the UCL has adversely affected sanctioned countries' trade with Russia but has a null effect on the investigated countries' trade with Ukraine. Furthermore, we investigated whether UCL leads to trade diversion, that is, whether UCL countries increase their crude oil imports from other primary exporters.

Keywords: International Trade, Sanctions, Russo-Ukrainian War, Gravity Model, Staggered DiD
JEL classification: F10, F13, F50, F51

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1 Introduction

Since the Russo-Ukrainian War began in March 2014, following the annexation of Crimea, both Western countries and Russia have implemented a series of sanctions and countersanctions against each other's individuals, entities, and international trade. These sanctions are mainly concentrated in the energy and agricultural sectors. For example, Western sanctions prohibited the export of mining machines to Russia. Russia banned the export of agricultural products through counter-sanctions (Bělín & Hanousek, 2021). Previous literature has thoroughly analyzed the impact of earlier sanctions and found that these sanctions were effective policies for reducing trade with Russia (Korhonen et al., 2018; Afesorgbor, 2019; Crozet & Hinz, 2020; Bělín & Hanousek, 2021; Nguyen & Do, 2021; Langot et al., 2022). For example, a 25.25 percent reduction in Russian exports and a 25.92 percent decline in Russian imports were reported after the issuance of sanctions (Nguyen & Do, 2021). Moreover, these sanctions caused exports from Western countries to Russia to be 96 percent less than exports to non-sanctioned countries' embargoed industries and 5.7 percent less than to non-embargoed sectors (Crozet & Hinz, 2020).

The Russo-Ukrainian conflict was exacerbated by the Russian military buildup in early 2021. As a result, more severe sanctions have been issued by both Western countries and Russia. The Russian government introduced the Unfriendly Countries List (UCL) in May 2021, which initially included the United States (US) and the Czech Republic. In March 2022, the UCL expanded to 48 countries, including Ukraine, all EU countries, the UK, Japan, South Korea, Norway, Iceland, Australia, and New Zealand. Multiple trade and payment restrictions were imposed on the listed countries (see Table 1). Unlike sector-specific sanctions, the UCL introduces comprehensive sanctions that affect multiple aspects of economic interactions. Sanctions include requirements for government approval of transactions involving listed countries, restrictions on profit repatriation, prohibitions on certain imports and exports, mandates for ruble-based payments for key commodities, such as natural gas, and limitations on foreign firms' participation in privatization (WTO, 2022; Steinbach, 2023). These cross-sectoral sanctions are intended to reduce Russia's economic dependence on UCL countries and counter Western sanctions imposed on Russia during the 2022 invasion of Ukraine.

Against this background, we study Russia's UCL's effect on global trade for two reasons. First, the previous specific sanctions in Western countries have been shown to have adverse effects on global trade, especially in the energy and agricultural sectors (Korhonen et al., 2018; Afesorgbor, 2019; Crozet & Hinz, 2020; Bělín & Hanousek, 2021; Nguyen & Do, 2021; Langot et al., 2022). Unlike previous sector-specific sanctions, the UCL is a general sanction not restricted to typical industries. Therefore, we wonder whether the list generally affects global trade rather than the sectoral effects of previous sanctions. Second, in event studies on the effects of the Russian invasion in 2022 on global trade, Steinbach (2023), Grant et al. (2023), and Ahn et al. (2023) found that the 2022 Russian invasion affected Ukraine's trade much more seriously than it had influenced Russia's trade. Therefore, we are curious as to whether the UCL has heterogeneous effects on global trade between Russia and Ukraine. Based on our motivations, we propose two specific questions: (1) What is the UCL's effect on Russia's global trade? (2) What is the UCL's effect on Ukraine's global trade?

Furthermore, the evaluation of the direct impact of UCL on trade is not compelling enough. Previous research shows that earlier Russian sanctions hurt Russia's international trade (Crozet & Hinz, 2020; Bělín & Hanousek, 2021; Nguyen & Do, 2021). Unsurprisingly, the UCL would also harm Russian trade. According to Steinbach (2023), the 2022 Russian invasion led to trade diversion; that is, importing countries replaced their trade with Russia with that of other exporters. In the agricultural sector, European countries resorted to imports from the US and other Asian countries. The trade diversion effect triggered by war has also been observed in the energy sector. Germany replaced coal imports from Russia with those from the US, South Africa, and Australia (Liadze et al., 2023). Therefore, we propose the third research question: (3) Does the UCL cause a trade diversion effect for sanctioned countries? If so, which countries benefit from the trade diversion? For our hypotheses, we anticipate trade diversions in the crude oil sector, the most crucial exporting sector for Russia (Orhan, 2022). The main countries exporting crude oil (excluding Russia) are expected to benefit from trade diversion.[1] As the imports of UCL countries from Russia are restricted, other leading exporters are likely to meet their demands for crude oil.

This article comprises 5 more sections. In Section 2, we review previous empirical research. Section 3 provides the theoretical foundation of our project, including the

[1]Specifically, the top five oil exporters (excluding Russia) are Saudi Arabia, Iraq, the US, Canada, and the United Arab Emirates (CEIC, 2024). However, Iraq was not included in the empirical analysis because of limited data availability.

Gravity Model (GM), one of the most common empirical models for studying international trade, as our theoretical basis. The staggered Difference-in-Differences (DiD) method in the context of GM is the most crucial empirical method used in this article. The DiD design and GM are commonly used in research that studies the effects of previous sanctions (Crozet & Hinz, 2020; Bělín & Hanousek, 2021; Nguyen & Do, 2021). However, without innovative staggered DiD estimators, we cannot assess the economic effects of a series of sanctions, and the results suffer from a heterogeneous treatment effect problem (Nagengast & Yotov, 2023; Wooldridge, 2023). Section 4 summarizes and visualizes the dataset. Section 5 focuses on the empirical strategies and results. Section 6 provides robustness checks for the empirical results.

2 Literature Reviews on the Effects of Trade Sanctions

The Russian invasion of Ukraine in 2022 severely disrupted global trade, particularly in the agricultural and energy sectors. The war affected Ukrainian exports the most adversely (Steinbach, 2023; Ahn et al., 2023; Grant et al., 2023). Ukraine's export value decreased by 47 percent in the first six months after the Russian invasion (Steinbach, 2023). From February to July 2022, Ukrainian grain exports declined by 78 percent compared with the expected level (Ahn et al., 2023). In contrast, the war did not significantly affect Russian aggregate exports because Russia benefited from higher crude oil exports in Asia and higher oil prices (Steinbach, 2023). For other countries, such as North American and Western European countries, aggregate exports also increased because of the effect of trade diversion in the crude oil and agricultural sectors; that is, the higher prices of Russian agricultural and crude oil products led importers to purchase these products from other exporting countries (Steinbach, 2023). During 2022-2023, countries with high wheat productivity, such as the US, Canada, Argentina, and Australia, secured a 5-6 percent increase in their cereal exports (Lin et al., 2023). [2]

In the energy sector, Russia supplied 40 percent of the EU's natural gas imports in Mid-2021; however, by 2022, only 8.4 percent of the EU's total energy demand of

[2] Before the Black Sea Grain Initiative (BSGI), an international agreement that protects exports of grains and foodstuffs from the Ukrainian ports from military intervention (Grant et al., 2023) of mid-2022, Ukraine's agricultural exports, particularly of meat, cereals, and oil seeds, suffered a severe decline of 71 percent. However, BSGI effectively mitigated the losses to 34 percent (Grant et al., 2023). By contrast, Russian agricultural exports remained largely unaffected throughout the conflict (Ahn et al., 2023; Grant et al., 2023).

the EU was met by Russian supplies, reflecting a significant reduction in the region's dependence on Russian energy. Reducing the dependence on Russian energy comes with substantial costs for the EU. The EU's energy imports from alternative suppliers are expected to increase by at least 70 percent to compensate for the shortfall in Russian energy (Khudaykulova et al., 2022).

Shifting to a new supplier arises from two key factors. First, transaction costs increase due to the need for new infrastructure, such as natural gas pipelines, to accommodate non-Russian imports (Khudaykulova et al., 2022). Second, Russian trade restrictions have increased oil demand from other exporting countries, causing a sharp spike in global oil prices. The Brent oil prices increased by 56.33 percent between October 2021 and August 2022 (Zhang et al., 2024). Following the Russian invasion, Germany shifted its coal imports from Russia to alternative suppliers, including the US, South Africa, and Australia, to mitigate the impact of Russian trade restrictions (Liadze et al., 2023). This diversion from Russian energy sources has been particularly costly for Germany, whose short-term GDP is expected to decrease by 0.5 percent to 3 percent (Bachmann et al., 2022).

In terms of research methodology, previous studies have widely used the GM as a theoretical foundation and DiD as an estimation method. A DiD with fixed effects is commonly applied in studies of the effects of previous sanctions after the 2014 Crimea conflict (Bělín & Hanousek, 2021; Crozet & Hinz, 2020; Nguyen & Do, 2021). Using a DiD framework within the GM, Korhonen et al. (2018) have demonstrated notable damage to both sectoral and aggregate trade in Russia due to the sanctions imposed by Western countries and countersanctions implemented by Russia during the 2014 Crimean crisis. Crozet and Hinz (2020) used sectoral export data from 40 main countries. They analyzed this effect by separating embargoed goods from non-embargoed goods sectors. The export value from Western countries to Russia is 96 percent lower than that of non-sanctioned countries in embargoed industries and 5.7 percent lower in non-embargoed sectors. Bělín and Hanousek (2021) focused on Russia's import of embargoed goods (mining machines and agricultural products). Russian sanctions on agricultural products reduced Russian imports of the corresponding goods eight times more severely than Western sanctions on mining equipment (Bělín & Hanousek, 2021). At the aggregate level, Nguyen and Do (2021) reported that Russia's trade has suffered significantly. Between 2011 and 2018, Russian exports fell by 25.25 percent, whereas imports declined by 25.92 percent. Finally, Steinbach (2023) reported that the Russia-Ukraine war led to a trade division in Russia.

Sedrakyan (2022) used the GM to study the spillover effect of sanctions triggered by the Russo-Ukrainian war on trade between transition economies[3] and Russia. The spillover effect refers to the indirect impact of sanctions on countries that are not directly targeted, such as transition economies. The exports of transforming economies to Russia and imports from Russia are negatively affected by sanctions (Sedrakyan, 2022). In addition, Afesorgbor (2019) compared the effects of imposed and threatened sanctions. The threat of possible sanctions is positively and significantly correlated with export flow from sanction issuers to sanction targets. However, the actual imposition of sanctions, regardless of whether issuers threaten them in advance, causes a significant contraction in export flows.

Specifically focusing on the most recent sanctions, Krivko et al. (2023) studied the effect of the UCL on Russia's agricultural imports through GM to compare the impact of the UCL with the previous Russian import ban on agricultural goods. The main conclusion is that the UCL did not significantly reduce agricultural exports to Russia for most of the listed countries, as their exports shrank due to previous sectoral sanctions. However, this approach has some technical limitations.

More specifically, Russian agricultural imports are used as a dependent variable with two dummy variables in the model (Krivko et al., 2023): $Unfriendly_c$, which is equal to one if country c is in the UCL and Ban_c which is one if country c is involved in previous Russian import sanctions. Without interacting with these country-level dummies with time dummies through the DiD setup, the detected effect cannot rule out the initial difference in Russian imports between countries in the treatment and control groups. Taking $Unfriendly_c$ as an example, it simply measures the difference in Russian imports between the countries on the list and those that were not after the issuance of the UCL. However, this difference includes the actual effect of the list and initial Russian import differences between the treated and control countries. Moreover, there is concern that $Unfriendly_c$ and Ban_c could be highly correlated, given the coincidence of UCL countries with those previously sanctioned by the Russian government. According to Wooldridge (2012), multicollinearity inflates the variance of the regression coefficients, leading to

[3]These transition economies are either former Soviet Union countries or eastern and central European countries that are geographically close to Russia.

excessively large standard errors and lower estimate precision.

In summary, the current study on the effect of the UCL on global trade needs to include an internally valid empirical strategy while considering not only sector-specific trade but also aggregate trade with Russia since the UCL targets sanctioned countries as an entity. The spillover effect of UCL on trade between Ukraine and other third countries is also yet to be studied in the literature. Steinbach (2023) studied the disruption of trade caused by the Russia-Ukraine war. However, Steinbach (2023) used the Russo-Ukrainian war as a treatment event. In contrast, we focus on the policy-specific effects of UCL on global trade with Russia and analyze aggregate trade flows between sanctioned countries and Russia. Furthermore, to capture more reliable results, we evaluate the effect of UCL on global trade using the DiD setup in structural GM with fixed effects. We also include a sectoral and general analysis of the effect of UCL on countries' trade with Russia. The spillover effect of the UCL will also be studied by analyzing the trade data of Ukraine and third countries.

3 Theoretical Base

3.1 The Gravity Model

GM is one of the most widely used empirical models for studying international trade (Ciuriak & Kinjo, 2006). The GM suggests that output and transaction costs determine trade flow: larger economies have more trade, and transaction costs hurt trade flow. When Tinbergen (1962) first proposed the GM, it was purely intuitive; however, later, Anderson (1979) offered a theoretical foundation for the GM using Armington's assumptions (Armington, 1969). Despite theoretical developments, several studies suggest that the empirical results of the GM contradict the estimation of the Heckscher-Ohlin (HO) theorem (Krugman, 1979; Helpman & Krugman, 1987; Helpman, 1987). Fortunately, Deardorff (2011) solved this contradiction, suggesting that the GM still holds in the context of the HO model once we add a deviation term related to comparative advantage (CA) and preference.[4]

To include CA in the GM, we introduce a trade specification index (TSI), which is

[4]Deardorff (2011) assumes that consumers' preferences follow the constant elasticity of substitution (CES) under Armington's assumptions. Accordingly, we theoretically assume CES preferences in which the substitution elasticity between goods from different countries remains constant. In the empirical model, the exchange rate serves as a proxy for consumer preferences. Consumers in the home country are more likely to prefer goods from countries with relatively cheaper currencies because a weaker foreign currency makes imported goods more affordable, enhancing their attractiveness under CES preferences.

"net exports (exports minus imports) in a given sector divided by the total two-way trade in that sector" (Ciuriak & Kinjo, 2006, p.190). They perform the following regression: $TSI_{ik} = \beta_1 TSI_{jk} + \epsilon_{ik}$ where TSI_{ik} is the TSI for country i in sector k and TSI_{jk} is the TSI for country j in sector k. β_1 ranges between 1 and -1 given the properties of the TSI. If $\beta_1 = 1$, these two countries have the same TSI values, and should thus be trade competitors. In contrast, $\beta_1 = -1$ means that these countries have opposite values of TSI, indicating that they should be trading partners. Therefore, β_1 measures the degree of substitution and complementarity between countries i and j and thus shows comparative advantages.

3.2 DiD Design in the Context of the GM

We used DiD under the framework of the GM. The articles reviewed in this section guide the conduct of a proper DiD analysis in the context of GM.

Motivations for Using DiD in the GM The GM disentangles the effects of policy interventions on global trade (Nagengast & Yotov, 2023; Silva & Tenreyro, 2006, 2022). Nagengast and Yotov (2023) used regional trade agreements (RTAs) to demonstrate the application of DiD within GM; we adapt the methodology but focus on UCL as the policy intervention.

$$TF_{it} = \exp\big(\lambda_i + \lambda_t + \beta UCL_{it}\big)\epsilon_{it} \tag{1}$$

where TF_{it} denotes the export flow from country i to Russia at time t. The two-way fixed effects are the country fixed effects λ_i and the time fixed effects λ_t. UCL_{it} equals one if country i is listed on the UCL at time t and zero otherwise. The coefficient of interest is denoted by β, and the random error term is denoted by ϵ_{it}. Although the Poisson pseudo-maximum likelihood (PPML) estimation is applied, β suffers from heterogeneous treatment effects (Nagengast & Yotov, 2023). Policy interventions like the UCL are likely to affect trade flows differently across countries and over time, depending on when the treatment begins.

For example, the UCL had two waves: the US and the Czech Republic were sanctioned in May 2021, while other UCL countries, such as Japan, EU members, and Australia, were added in March 2022. Consider the US and Japan in April 2022, both have $UCL_{it} = 1$ at that time. However, the US had already been under sanctions for eleven months, while Japan had only just become subject to the UCL. These countries likely experienced different treatment effects of the UCL on their trade with Russia. However, the model in Equation (1) treats them as if the effect were the same, since the β cannot differentiate them in April 2022. A staggered DiD design addresses this issue by allowing treatment effects to vary by group and period, capturing the dynamic impact of policy implementation (De Chaisemartin & d'Haultfoeuille, 2020).

Staggered DiD Design for the GM There are multiple staggered DiD estimators (De Chaisemartin & d'Haultfoeuille, 2020; Sun & Abraham, 2021; Wooldridge, 2023). For compatibility with the standard GM setup, Nagengast and Yotov (2023) suggested that the staggered DiD method (Wooldridge, 2023) is the most promising approach because Wooldridge (2023) specifically focused on DiD for nonlinear models. In a staggered DiD setup, the original UCL_{it} must be adjusted to the following form:

$$\sum_{g=m}^{T}\sum_{s=g}^{T}\beta_{gs}UCL_{gs} \tag{2}$$

where g represents a group defined by the period in which the country received the UCL treatment. Country i is attributed to group g if it was listed on the UCL exactly at $t = g$. The subscript m represents the period when the first country is listed on the UCL, and s is the post-treatment period. $UCL_{gs} = 1$ if the exporting country i is in group g and the current period is the post-treatment time $t = s$. The coefficient of interest β_{gs} thus captures the treatment effect of the UCL on trade, specifically for group g in post-treatment period s. In this way, we allow for heterogeneous treatment effects of UCL. Using this well-defined staggered DiD estimator, Equation (1) is rewritten in the following form.

$$TF_{it} = \exp\Big(\lambda_i + \lambda_t + \sum_{g=m}^{T}\sum_{s=g}^{T}\beta_{gs}UCL_{gs}\Big)\epsilon_{it} \tag{3}$$

In Equation (3), control variables such as GDP and exchange rates are omitted for theoretical illustration. Two assumptions must be satisfied to ensure a staggered DiD design. The first assumption is the parallel trend assumption, which suggests that the UCL countries and non-UCL countries should have similar trade flows with Russia if the UCL are never implemented. The second assumption is the no-anticipation assumption, which suggests that UCL have no treatment effects on countries' trade with Russia before they become sanctioned (Nagengast & Yotov, 2023; Wooldridge, 2023). In other words, countries should not prepare for UCL by altering their trade behaviors before being listed on the UCL. In Section 5, we test these two assumptions to ensure that our data are appropriate for DiD analysis.

Furthermore, according to Nagengast and Yotov (2023), the average effect of treatment on the treated (ATT) of the UCL should be the weighted sum of the group time-specific treatment estimators β_{gs} in Equation (3).

$$\bar{\beta} = \sum_{g=m}^{T} \sum_{s=g}^{T} \frac{N_{gs}}{N_{Treated}} \hat{\beta}_{gs} \tag{4}$$

where N_{gs} is the number of observations in group g and the post-treatment period s. The total number of treated observations is $N_{Treated} = \sum_{g=m}^{T} \sum_{s=g}^{T} N_{gs}$. The estimated effect of the group time-specific treatment is indicated by $\hat{\beta}_{gs}$. The ATT ($\bar{\beta}$) measures the average change in trade flows between UCL countries and non-UCL countries in their trade with Russia across all post-treatment periods. The standard error of $\bar{\beta}$ is calculated using a weighted linear combination of the covariances of all $\hat{\beta}_{gs}$. Wooldridge (2023) named $\bar{\beta}$ the extended two-way fixed effects (ETWFE) estimator.

In addition to the ATT ($\bar{\beta}$), Nagengast and Yotov (2023) introduce two additional estimators. The first is the group-specific treatment effect estimator ($\bar{\beta}_g$):

$$\bar{\beta}_g = \sum_{s=g}^{T} \frac{N_{gs}}{N_g} \hat{\beta}_{gs} \tag{5}$$

where N_g denotes the total number of observations in group g.[5] The group-specific treatment effect, $\bar{\beta}_g$, measures the average effect of the UCL on countries that entered the UCL exactly in period $t = g$.

The second extra estimator is the time-specific treatment effect estimator ($\bar{\beta}_s$).

$$\bar{\beta}_s = \sum_{g=m}^{T} \frac{N_{gs}}{N_s} \hat{\beta}_{gs} \tag{6}$$

where N_s denotes the total number of observations in the post-treatment period ($t = s$). The time-specific treatment effect ($\bar{\beta}_s$) measures the average treatment effects of UCL on the trade with Russia for all UCL countries in period $t = s$.

[5]By definition, all observations in group g receive treatment beginning in period $t = g$.

4 Data

We selected 48 countries for analysis based on these three criteria. First, each continent required at least one representative country to ensure global coverage. Second, developed countries were prioritized to achieve greater sectoral trade diversity. Third, the selected countries collectively accounted for at least 80 percent of global trade, providing sufficient data coverage. By 2021, these countries represented 86.58 percent of world exports and 86.97 percent of world imports, as summarized in Table 2. These countries were classified into three groups according to treatment status. Countries in Group 0 were never included in the Russian UCL. Group 1 is the treatment group included in the list for May 2021. Group 2 is the treatment group included in the UCL group in March 2022. (See Table 3 for a detailed group categorization.)

We collected monthly export and import data from January 2014 to May 2024 following UN Comtrade (2024). We indexed these periods for further analysis. May 2021 was indexed with the period $t = 0$ when the Russian UCL was first introduced. Thus, the first period (January 2014) was indexed as $t = -88$. In March 2022, when most of the treated countries were included in the UCL, it was indexed to $t = 10$, and the last period (September 2023) was indexed to $t = 36$.

To assess the impact of the UCL, we summarized the trade flows for the 48 countries before and after the issuance of the UCL and tested the significance of the differences using unpaired t-tests of two samples. The results shown in Table 4 indicate that Group 0 countries experienced a significant increase in exports and imports with Russia after the UCL was issued. In contrast, Group 1 countries, such as the US and the Czech Republic, experienced substantially lower trade with Russia but significantly higher trade with Ukraine. The countries in Group 2, which were later included in the list, also recorded notable reductions in trade with Russia and increased trade flows with Ukraine.

Sectoral trade data covering 97 sectors were collected at the HS 2-digit level. Although comprehensive, the HS 2-digit classification can complicate analysis when introducing sectoral dummies. To resolve this issue, we adopted an alternative classification system, the Principal Commodity Code (P.C. Code), provided by the Japan Ministry of Finance (Ministry of Finance Japan, 2023). This system aggregates trade data into eight main sectors, making it easier to interpret the sectoral effects.

We gathered additional data relevant to GM to incorporate economic and trade cost factors into the analysis. Economic mass was measured using the GDP of 48 countries, as provided by Valev et al. (2024). Trade costs were estimated using geographical variables, including distance, common language, colonial ties, and the surrounding geographical characteristics obtained from CEPII (2023). Real exchange rates were calculated using nominal exchange rates and CPI data to account for currency fluctuations.[6] Finally, the CA measurement was estimated using the method in Ciuriak and Kinjo (2006).

Trade flows were visualized to assess whether the data aligned with the GM predictions and to identify trade changes after the UCL. According to the GM, trade flows were positively correlated with GDP and negatively correlated with distance (Pal & Kar, 2021). Figures 1 and 2 illustrate Russian trade flows in 2018, before the UCL, and in 2022, after its issuance. In 2018, higher trade flows were concentrated between countries with larger GDPs and shorter distances to Russia, such as China, Germany, and Japan. By 2022, significant reductions in trade flows were observed for UCL countries such as Germany and the US. For example, the thick dark trade curves representing Germany's trade with Russia in 2018 became thinner and lighter by 2022. In contrast, Group 0 countries such as India showed increased trade flows with Russia during the same period.

5 Empirical Strategy

5.1 Tests for the DiD Assumptions

Tests for the Parallel Trend Assumption According to Wooldridge (2021), the parallel trend assumption can be tested using a pooled regression in which the treatment indicator interacts with all possible time indicators. The pooled regression is presented in Equation (7).

$$TF_{it} = \exp\Big(\lambda_i + \lambda_t + \gamma X + \sum_{t=-88}^{9} \beta_t^{pre} UCL_i * Time_t + \sum_{t=10}^{28} \beta_t^{post} UCL_i * Time_t\Big)\epsilon_{it} \quad (7)$$

where TF_{it} represents the trade flows (exports or imports) between country i and Russia in the period t. X denotes the matrix of covariates, including GDP (GDP_{it}), real exchange rates ($REXR_{it}$), and the comparative advantage index (CA_{it}). γ is the vector of parameters corresponding to the control variables. $Time_t$ equals one if the observation

[6] We first collected the nominal exchange rate and CPI data for the investigated countries. The real exchange rate q was calculated using the formula $q = \frac{EP^*}{P}$, where E is the nominal exchange rate, P^* is the foreign CPI, and P is the home CPI. We collect the CPI data from Valev et al. (2024).

belongs to period t and zero otherwise. UCL_i equals one if country i is in the UCL and zero otherwise. In addition, λ_i is the country-fixed effect, and λ_t is the time-fixed effect. The coefficients of interest are classified as pre-treatment (β_t^{pre}) and post-treatment (β_t^{post}).[7] If this assumption holds, then all pre-treatment coefficients β_t^{pre} must be insignificant. Wooldridge (2021) recommended the Wald test for the joint significance of β_t^{pre}. The null hypothesis for the Wald test is $H_0 : \beta_t^{pre} = 0, \forall t < 10$, and the alternative hypothesis is that H_1 : at least one of β_t^{pre} is not zero. In the export model, a significantly negative β_t^{pre} was detected. The Wald test rejected H_0 with a Wald statistic of 2.11 and $p = 1.61 \times 10^{-11}$, indicating a violation of the assumption of a parallel trend.

To address this violation, we relaxed this assumption by adjusting the covariates following Wooldridge (2021): We added the interaction terms of the covariates with time and individual fixed effects to the model. Specifically, we finalized the set of covariates using a linear combination of $X * Time_t$, $X * UCL_i$, and X. γ_1, γ_2, and γ_3 are parameters corresponding to the control variables. According to Wooldridge (2021), these interaction terms absorb the unobserved effect that caused preexisting trend differences in the treatment and control groups. In the relaxed model presented in Equation (8), the pretreatment coefficients became largely insignificant at the 95 percent confidence level. Figure 3 visualizes the coefficients, showing that 96 out of 99 pretreatment estimates are statistically insignificant. The Wald statistic decreased to 1.06 with a p-value of 0.08[8] This finding suggests that the relaxed parallel-trend assumption holds reasonably well. Although the three coefficients (at $t = -62$, $t = -16$, and $t = 8$) remained marginally significant, they appear in isolation and do not belong to any broader temporal trends or clusters. In the staggered DiD framework, a small number of significant pre-treatment coefficients does not necessarily imply failure of the identification strategy, particularly when the majority of estimates are insignificant. In support of this, Callaway and Sant'Anna (2021) suggested that minor deviations in pretreatment tests are not uncommon in applied settings and emphasized the importance of evaluating overall pretreatment trends rather than overemphasizing isolated estimates. Given the substantial improvement in the pre-trend balance and guidance provided by Wooldridge (2021), the export data are considered

[7] The pre-treatment group are the coefficients β_t^{pre} for time $t < 10$, which is before March 2022. The post-treatment group is the coefficient β_t^{post} for time $t \geq 10$; that is, after March 2022. In March 2022, the treated countries, excluding the US and Czech Republic, were listed on the UCL. The US and Czech Republic were listed in May 2021; however, according to Section 5.2, the UCL was not found to be effective in the trade of countries with Russia until March 2022.

[8] Periods $t = -62$, $t = -16$, and $t = 8$ are excluded from the test.

sufficiently valid for a staggered DiD analysis. More importantly, the same set of covariates must be included in the main DiD estimation to preserve the adjusted identification strategy.

$$TF_{it} = \exp\Big(\lambda_i + \lambda_t + \gamma_1 X + \gamma_2 X * Times_t + \gamma_3 X * UCL_i + \sum_{t=-88}^{9} \beta_t^{pre} UCL_i * Time_t + \sum_{t=10}^{28} \beta_t^{post} UCL_i * Time_t\Big)\epsilon_{it} \quad (8)$$

For the import model, we found no significant β_t^{pre} in the original test of Equation (7). The Wald statistic was 1.18, with $p = 0.13$, which supports the assumption of a parallel trend. The coefficients of the import test are visualized in Figure 4. Although not necessary, a relaxed test was conducted for consistency and similarly confirmed that there was no violation of parallel trends (Wald's statistic was 1.12, with $p = 0.20$).

Parallel trend tests were conducted using Ukrainian trade data. We again used Equation (7) and adjusted the dependent variables to reflect the exports and imports of the investigated countries with Ukraine. Both the export and import data for Ukraine passed the parallel trend tests.[9] The Wald statistic was 1.23 in export data, with the corresponding $p = 0.11$. In the imported data, the Wald statistic was 1.24, with $p = 0.08$. Ukraine's export and import data passed the parallel trend test without significant β_t^{pre} detected.

Parallel trend tests were also conducted on the data to measure the trade diversion effect in the crude sector. Equation (9) presents the pooled regression for these trade-diversion data. TF_{ijt} were the imports of j from the main crude exporter i. Country-pair fixed effects (λ_{ij}) were newly included. For the control variables, GDP, $REXR$, and CA of the investigated countries and major oil exporters. For the Wald test,[10] We have a Wald statistic of 1.17 with $p = 0.18$, which supports the assumption of a parallel trend.

$$TF_{ijt} = \exp\Big(\lambda_{ij} + \lambda_t + \gamma X + \sum_{t=-88}^{9} \beta_t^{pre} UCL_j * Time_t + \sum_{t=10}^{28} \beta_t^{post} UCL_j * Time_t\Big)\epsilon_{ijt} \quad (9)$$

Tests for the No Anticipation Assumption The no-anticipation assumption requires that countries maintain consistent trade behavior with Russia prior to their inclusion in the UCL. To test this, we performed a placebo test, as suggested by Borusyak et al. (2021), assuming that placebo treatment occurred one year before the actual inclusion. The

[9] Relaxed tests were not performed on the Ukrainian data because the data successfully passed the original tests.

[10] The degree of freedom was 16854.

pretreatment data were used separately for Groups 1 and 2, with Group 1 data excluded from the Group 2 control data to avoid contamination. We present the regression model for the test shown in Equation (10).

$$TF_{it} = \exp\Big(\lambda_i + \lambda_t + \gamma X + \ \beta^{Placebo} Group_i * Placebo_t\Big)\epsilon_{it} \tag{10}$$

The new variable $Placebo_t$ equals one if the observation is from the placebo period and zero otherwise. In Group 1, $Group_i$ equals one if country i is in Group 1 and zero otherwise; similarly, in the Group 2 models, $Group_i$ equals one if country i is in Group 2. For this assumption to hold, $\beta^{Placebo}$ should be indifferent to zero. The results in Table 5 confirm that the placebo treatment does not have significant effects on export and import data, indicating that Russia's trade data satisfy the assumption of no anticipation.

Similar no-anticipation tests were performed on the trade data with Ukraine, substituting the dependent variables with the investigated countries' exports and imports from Ukraine. In Table 6, we again do not detect any significant $\beta^{Placebo}$ in either the export or import data for Groups 1 and 2. UCL countries did not alter their trade with Ukraine in anticipation of the UCL.

No anticipation tests were conducted on the imports of the four main oil exporters. The identification of the model is presented in Equation (11). The test results are presented in Table 7. No significant $\beta^{Placebo}$ was detected at the 0.05 percent critical level. The assumption of no anticipation holds for import flows from four major oil exporters other than Russia.

$$TF_{ijt} = \exp\Big(\lambda_{ij} + \lambda_t + \gamma X + \beta^{Placebo} Group_j * Placebo_t\Big)\epsilon_{it} \tag{11}$$

5.2 Global Trade with Russia

In this subsection, we analyzed Russia's trade data using a staggered DiD model to address the first research question: What is the effect of the UCL on Russia's global trade? We used the model in Equation (12) to capture the effect of UCL on the import values of the 48 countries from Russia. This equation becomes the export model when the dependent variable (TF_{jt}) is replaced with TF_{it}, the exports of country i to Russia.

$$TF_{jt} = \exp\Big(\lambda_j + \lambda_t + \gamma_1 X + \gamma_2 X * Times_t + \gamma_3 X * Group_g + + \sum_{g=m}^{T}\sum_{s=g}^{T} \beta_{gs} UCL_{gs}\Big)\epsilon_{jt} \tag{12}$$

where TF_{jt} (TF_{it}) is the import (export) flows of importer j (exporter i) from Russia during period t. The subscript g represents the treatment groups, as defined in Table 3. Group 0 countries were used as the control group. $UCL_{gs} = 1$ if importing country j (exporting country i) is in group g in the current period $t = s$, and $UCL_{gs} = 0$ otherwise. β_{gs} captures the effect of the UCL on imports for group g in period s. The covariates (X) include GDP, $REXR$, CA, and their interactions with the time indicators ($Time_t$) and group indicators ($Group_g$). Following Nagengast and Yotov (2023), the ATT effect $\bar{\beta} = \sum_{g=m}^{T} \sum_{s=g}^{T} \frac{N_{gs}}{N_{Treated}} \hat{\beta}_{gs}$, the group-specific effect $\bar{\beta}_g = \sum_{s=g}^{T} \frac{N_{gs}}{N_g} \hat{\beta}_{gs}$ and the period-specific effect $\bar{\beta}_s = \sum_{g=m}^{T} \frac{N_{gs}}{N_s} \hat{\beta}_{gs}$ are estimated. ATT and group-specific results are reported in Table 8. The time-specific effects are visualized in Figures 5 and 6.

The ATT effects of the UCL on countries' exports and imports from Russia were negative and significant after updating the covariates. Specifically, the UCL countries were expected to import USD 2.51 billion less from Russia than non-UCL countries after the inclusion of UCL. UCL countries are predicted to decrease their exports to Russia by USD 1.00 billion after the onset of treatment. The group-specific effects of UCL were adverse and significant for both Groups 1 and 2. In terms of imports, Group 1 countries are expected to decrease imports from Russia by USD 7.79 billion and Group 2 countries by USD 1.92 billion. Regarding exports, Group 1 countries reduced their exports to Russia by USD 4.75 billion and Group 2 countries by 1.34 billion. The time-specific effects in Figures 5 confirm that the adverse impact of the UCL on sanctioned countries' imports to Russia was triggered after the expansion of the UCL (second wave) in March 2022. In Figures 6, the adverse effects of the UCL on exports are present at the onset of the UCL in May 2021 and become even more harmful after the UCL expansion in March 2022.

By integrating import and export data analyses, we presented crucial findings regarding the impact of the UCL on the international trade of the countries investigated with Russia. First, UCL adversely affected these countries' imports from Russia and their exports to Russia. UCL countries are expected to decrease their monthly imports from Russia by USD 2.51 billion and their exports to Russia by USD 1.00 billion compared with non-UCL countries. These adverse effects are consistent with those found in previous research on Russian sanctions. For example, Nguyen and Do (2021) claimed that earlier sanctions reduced exports to sanctioned countries by 25.25 percent and imports by 25.92 percent in sanctioned sectors.

Regarding the magnitude of the impact, UCL is more detrimental to the imports of Russian countries than to their exports. There are two potential interpretations for the gap between the effects of the UCL on imports and exports. First, according to Bělín and Hanousek (2021), previous Russian export sanctions jeopardized eight times more than Western export sanctions. Note that UCL countries have also issued sanctions against Russia.[11] Consequently, the export sanctions of these listed countries are captured in the ATT effect of the export model.[12] Meanwhile, the ATT effect of the import model should capture the impact of Russia's export restrictions on UCL countries. The more severe effect of UCL on the import model can be regarded as confirmation that Russian export sanctions are more severe than Western export sanctions. The second interpretation is the UCL's solid negative impact on Russia's imports may result from a combination of Russian sanctions targeting the UCL and Western import sanctions. In February 2022, the US and Canada imposed import sanctions on Russia's oil sector, prohibiting the purchase of Russian oil (Khudaykulova et al., 2022). Thus, the notable effect of the UCL on imports from Russia can be attributed to both Russian export sanctions against the UCL and import sanctions enacted by certain UCL countries.

Furthermore, in terms of group-specific effects, Group 1 countries experienced a more significant decline in imports and exports with Russia due to the UCL than Group 2 countries. Consequently, among all the sanctioned countries, Group 1 countries (the US and the Czech Republic) experienced the most significant reduction in their trade with Russia after the implementation of the UCL.

Therefore, we confirm the first question on the effectiveness of the UCL on Russia's global trade. The UCL significantly reduced Russia's imports and exports from the sanctioned countries, with a more substantial impact on imports than on exports. Additionally, the impact varies by country group, with Group 1 countries (the US and the Czech Republic) experiencing more severe trade reductions than Group 2 countries. These findings contribute to and refine the existing literature on trade disruptions caused by war and sanctions. We support previous evidence of trade declines due to sectoral sanctions (Crozet & Hinz, 2020; Bělín & Hanousek, 2021; Nguyen & Do, 2021; Krivko et al., 2023) but extend this evidence to the aggregate level under a comprehensive sanction regime

[11] In the 2022 Russia Invasion, Western sanctions on Russia concentrated on February 2022, which is represented by the blue dashed line in Figures.

[12] The export sanctions from the Western countries include the prohibition of exporting mining machines to Russia (Bělín & Hanousek, 2021).

(the UCL). Furthermore, consistent with Steinbach (2023) that highlights the broad trade impacts of the Russo-Ukrainian war, particularly the decline in Ukrainian exports and the resilience of the Russian energy trade, our results show that the UCL specifically caused significant trade reductions between Russia and sanctioned countries.

5.3 Global Trade with Ukraine

Ukraine's exports suffered dramatically after the Russian invasion in 2022, whereas the exports of Russia and third countries were not seriously affected by the war (Steinbach, 2023; Ahn et al., 2023). However, previous studies on UCL have focused only on its impact on Russia (Krivko et al., 2023; Langot et al., 2022). In this subsection, we focused on the second research question: What is the effect of the UCL on Ukraine's global trade? Using Equation (13) with Ukrainian data, we analyzed the effect of the UCL on the import values of the investigated countries from Ukraine. The dependent variables are adjusted for the imported and exported products of the investigated countries with Ukraine. The interaction terms of the control variables were omitted from the Ukrainian model because the data passed the parallel trend tests without them. Table 9 shows the effect of ATT and the group-specific effects of the UCL on the trade of the countries with Ukraine. Figures 7 and 8 capture the time-specific effects of the UCL on Ukraine's imports to the investigated countries. As before, this equation becomes the export model when the dependent variable (TF_{jt}) is replaced with TF_{it}.

$$TF_{jt} = \exp\Big(\lambda_j + \lambda_t + \gamma GDP_{jt} + \sum_{g=m}^{T} \sum_{s=g}^{T} \beta_{gs} UCL_{gs}\Big)\epsilon_{jt} \tag{13}$$

The empirical results for Ukrainian models are thought-provoking. The UCL has insignificant ATT effects on both imports and exports to Ukraine. UCL also did not have a heterogeneous treatment effect on countries' trade with Ukraine. After the issuance of the UCL, Groups 1 and 2 remained the same as Group 0 regarding exports and imports to Ukraine. Regarding the time-specific effects in Figures 7 and 8, no significant differences in imports or exports were found between the treated and control countries after May 2021. Ukraine's international trade was severely affected by the Russian invasion in 2022 (Steinbach, 2023). However, empirical evidence does not support the idea that the countries included in the UCL increased their trade with Ukraine. To clarify, the insignificant effects of the UCL on the sanctioned countries' trade with Ukraine do not imply that UCL countries did not support Ukraine during the war. The US has provided over USD 44 billion to Ukraine as military assistance since the Russian invasion of 2022 (US Department of State, 2024). Our results suggest that in addition to military aid, UCL countries should also consider increasing their trade with Ukraine to save Ukraine's damaged export sectors.

These results provide an answer to our second research question related to the effectiveness of the UCL on Ukraine's global trade. In short, the analysis found no statistically significant impact of the UCL on the sanctioned countries' exports to or imports from Ukraine, indicating that UCL countries did not increase their trade with Ukraine after being included in the list.

5.4 Trade Diversion Effects of the UCL

Regarding the trade diversion analysis, the following model was used to address the third research question: Does the UCL cause a trade diversion effect for sanctioned countries?

$$TF_{ijt} = \exp\Big(\lambda_{ij} + \lambda_t + \gamma_1 GDP_{it} + \gamma_2 GDP_{jt} + \sum_{g=m}^{T}\sum_{s=g}^{T} \beta_{gs} UCL_{gs}\Big)\epsilon_{ijt} \qquad (14)$$

The crude Import data of 48 countries from the four primary crude exporters (Saudi Arabia, Iraq, the US, Canada, and the United Arab Emirates) were analyzed using Equation (14). TF_{ijt} represents the crude imports of examined country j from primary crude exporter i. The average treatment effect (ATT) of β_{gs} indicates a trade diversion. Suppose that the ATT of β_{gs} is positive and statistically significant. Then, the UCL countries increased their imports from other primary crude exporters after the inclusion of the UCL compared to the control group, indicating a trade diversion. ATT and group-specific effects are presented in Table 10, and the time-specific effects are illustrated in Figure 9.

An insignificant ATT effect was observed for UCL-listed countries, indicating that the imports of a sanctioned country from the four major oil exporters are expected to be similar to those of a non-UCL country, holding the other factors constant. For Group 1 countries, imports from the four main oil exporters are projected to decline by USD 4.03 billion compared with Group 0 after UCL issuance. Group 1 includes only the US and the Czech Republic. As a major oil exporter, the US is likely to have lower foreign crude demand than other UCL countries, which may explain the negative group-specific effects in Group

1. By contrast, Group 2 showed no significant difference from Group 0 with regard to oil imports. The time-specific effects in Figure 9 further indicate no significant difference in oil imports between the treatment and control importers, suggesting that inclusion in the UCL does not significantly affect imports from other major oil exporters. These results do not support UCL's trade diversion effect. Specifically, UCL countries did not increase their imports from the four main oil exporters other than Russia after restricting Russian oil imports. Although earlier studies (Khudaykulova et al., 2022; Liadze et al., 2023) observed an increase in energy imports from non-Russian sources by EU countries, our findings suggest that this increase is not unique to UCL countries. Since UCL and non-UCL countries exhibited indifferent oil import patterns from major exporters after the UCL was issued, we can conclude that both UCL and non-UCL countries increased their oil imports from alternative sources besides Russia. However, the current analysis of a complete sample may not be sufficiently representative. Overall, oil-exporting countries such as the US, Canada, Saudi Arabia, and Qatar have a low demand for Russian oil imports in the first place. A subsample analysis was conducted to make the sample more representative and further disentangle the existence of trade diversion.

The subsample analysis focuses on countries that increased their oil imports from four alternative oil exporters after the onset of the UCL. Table 14 compares each country's pre- and post-treatment oil imports from the four exporters. Except for five countries (Brazil, Israel, New Zealand, Portugal, and Qatar), all other countries investigated increased their trade with four alternative oil exporters. The subsample was constructed by dropping observations from the five countries. We then conducted an identical analysis on this subsample using the model specification in (14). The ATT and group-specific ATT effects are presented in Table 11, and the time-specific ATT effects are illustrated in Figure 10. Even within the filtered sample, in which all remaining countries increased their oil imports from alternative exporters after the issuance of the UCL, there was still no observed effect of the UCL on oil imports in these countries. The subsample analysis found no significant ATT, group-specific ATT, or time-specific ATT effects, indicating no trade diversion effects.

In the filtered dataset, all countries increased their oil imports from alternative oil exporters. However, the UCL had an insignificant impact on imports from the four oil exporters, indicating that both UCL and non-UCL countries chose to trade more with alternative suppliers following UCL issuance. The purpose of the UCL was to restrict the trade of sanctioned countries with Russia and force them to source oil from alternative suppliers. If the UCL had solely favored Russia, it would have only limited the sanctioned countries' oil imports without affecting non-UCL countries' imports. However, the UCL prompted non-UCL countries to increase their trade with alternative suppliers, which was unfavorable from Russia's perspective. Table 15 in the Appendix shows that all the countries examined, except for the UAE, increased their oil imports after Russia's invasion in 2022. During a period of high global oil demand, the UCL raised the opportunity cost of Russian oil for both UCL and non-UCL countries, benefiting alternative suppliers by offering substitutes for Russian oil.

These results complement those of Steinbach (2023), who observed trade diversion in the crude oil sector after the Russo-Ukrainian war, as importers shifted away from Russian oil due to rising prices. Instead of directly using the war as the treatment event, our analysis focuses on whether the UCL, as a targeted sanction policy, caused a similar diversion effect. It follows that although countries increased imports from non-Russian crude exporters, this pattern was not unique to UCL countries. Interestingly, both UCL and non-UCL countries exhibited similar import behavior, indicating that trade diversion in the crude sector was a universal market response to the war, rather than a phenomenon directly attributable to the UCL.

A potential concern regarding Table 15 is that pre-UCL oil imports may have been too low due to the reduction in productivity triggered by COVID-19. The results in the Appendix are controlled for oil prices to mitigate this issue. Additionally, we included REXR as a control variable in the empirical models to measure countries' productivity. Therefore, these concerns do not undermine our empirical results on trade diversion in the crude sector. Table 16 further supports the claim that the UCL hindered non-UCL countries from importing Russian oil. The list of countries that reduced their Russian oil imports following UCL issuance, as presented in Table 16, primarily includes UCL countries but also features seven non-sanctioned countries: Argentina, Chile, Israel, Mexico, Qatar, Vietnam, and Thailand. Based on the subset analysis, we can determine the overall performance of UCL. From Russia's perspective, UCL negatively affected trade between UCL countries and Russia, as demonstrated in Section 5.2. However, it also poses an unfavorable threat to non-UCL countries.

6 Robustness Checks

6.1 Alternative Control Groups

According to Nagengast and Yotov (2023), a robustness check in a staggered DiD setup changes the control group from countries that have not been treated in all periods to those that have not yet been treated. Therefore, in our original model, the control groups were always the countries in Group 0, which were not included in the Russian UCL in all the investigated periods. This section changes the control group to include countries not yet included in UCL.

In Table 12, the three key findings from the original models in Section 5.2 are still available. First, the UCL adversely affected imports and exports between the sanctioned countries and Russia after the onset of the treatment. Second, the group-specific effect shows that the UCL impacts the countries in Group 1 more severely than those in Group 2 with respect to trade with Russia. Third, comparing the export and import models, UCL exerts a more pronounced negative effect on imports from Russia than on exports to Russia, regardless of the inclusion of additional control variables. These findings confirm that the conclusions of Section 5.2 are robust even when the control group is redefined.

6.2 Alternative Staggered DiD Method

Sun and Abraham (2021) proposed an alternative staggered DiD estimator to capture the heterogeneous treatment effects (see Appendix 2). To ensure the validity of our empirical results based on the estimator in Wooldridge (2023), we analyzed an alternative staggered DiD method from Sun and Abraham (2021). Equation (15) represents the regression model of Sun and Abraham (2021) used to capture the effect of the UCL on imports. We can capture the UCL effect on exports when the dependent variable (TF_{jt}) is replaced by TF_{it}.

$$TF_{jt} = \exp\big(\lambda_j + \lambda_t + \gamma X + \sum_l b_l 1\{t - G_j = l\}\big)\epsilon_{jt} \tag{15}$$

The newly introduced subscript l represents the time difference between current time t and time G_j when importer j receives the UCL treatment. The treatment indicator $1\{t - G_j = l\}$ is defined as whether the current time t is l periods away from the treatment (Sun & Abraham, 2021). Where b_l denotes estimated coefficients. The effects of the

CATT and ATT were then estimated. The results in Table 13 are consistent with those in Table 8. First, the UCL adversely affected the imports and exports between the countries investigated and Russia. Regarding the ATT effects of Sun and Abraham (2021), the UCL countries decreased their monthly imports from Russia by USD 0.98 billion and exports to Russia by USD 0.89 billion compared to the non-UCL countries. These results confirm the second key finding that the UCL is more detrimental to Russia's imports than exports. For the CATT effects, the Group 1 countries experienced more negative CATT effects on imports and exports than other UCL countries in Group 2, which confirms the previous finding that the Group 1 countries are the most influenced by the UCL. In addition, the DiD plots again suggest that the effects of the UCL became negative and significant only after the UCL expansion in March 2022. In summary, the empirical results and conclusions remained valid after applying the alternative staggered DiD method.

7 Conclusion

We investigated the impact of Russia's UCL on global trade and made two key contributions. First, unlike previous research focusing mainly on sectoral trade (Crozet & Hinz, 2020; Bělín & Hanousek, 2021; Nguyen & Do, 2021), this study examined the effects of the UCL on aggregate trade flows, providing a broader understanding of its economic impact. Second, we analyzed the spillover effects of the UCL, which refers to the indirect impact on sanctioned countries' trade with nations other than Russia, offering a comprehensive assessment of the performance of the UCL. The analysis revealed that while the UCL effectively reduced trade between Russia and sanctioned countries as intended, it also produced unfavorable spillover effects from the Russian perspective. The UCL prompted nonsanctioned countries to redirect crude imports to alternative oil exporters. Using a staggered DiD approach within the GM framework, we ensured reliable inference regarding the economic consequences of UCL sanctions.

Our findings have several important implications. First, UCL is a more extensive and powerful tool than previous sector-specific sanctions, such as those following the 2014 Crimea crisis. While earlier sanctions predominantly targeted specific industries, the UCL imposed a more comprehensive economic constraint on the sanctioned countries' total trade with Russia. However, in terms of the spillover effect, both UCL and non-UCL countries chose to trade more with alternative oil suppliers following UCL issuance. The

UCL prompted non-UCL countries that Russia did not impose sanctions to increase their oil imports with alternative suppliers, which was unfavorable from Russia's perspective. From Russia's perspective, the UCL effectively restricted trade between its own countries and Russia. However, it also posed an unfavorable threat to non-UCL countries. Furthermore, Ukraine's international trade was severely sabotaged by the Russian invasion of 2022 (Steinbach, 2023; Ahn et al., 2023), and the UCL countries have not increased their trade with Ukraine since March 2022. Although UCL countries, especially the US,[13] provided considerable military aid to Ukraine (US Department of State, 2024), our results suggest that UCL countries should also consider increasing their trade with Ukraine to save damaged Ukrainian export sectors.

[13]The US has offered over USD 44 billion to Ukraine as military assistance since March 2022 (US Department of State, 2024).

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Tables and Figures

Sanction Type	**Details**
Payment & Trade Restrictions	Debt payments must be made in rubles. New corporate deals require government approval. Energy exports (gas) must be paid in rubles.
Export Bans	Banned exports of inert gases.
Foreign Investment Restrictions	UCL investors are banned from key Russian businesses. Companies from UCL countries were required to sell their Russian assets at a 50% discount to Russian buyers.
Intellectual Property Penalties	No compensation required for patents from UCL countries.
Financial Penalties	UCL countries must pay 10% exit tax on sales of Russian shares. Suspension of the tax treaties for the UCL countries

Table 1: Russian Sanctions Imposed on UCL Countries

Characteristic	**N = 48**
Percentage of World Export	
Sum	86.58
Mean (SD)	1.92 (2.49)
Median (IQR)	1.10 (0.49, 2.52)
Range	0.04, 13.20
Percentage of World Import	
Sum	86.97
Mean (SD)	1.93 (2.63)
Median (IQR)	1.06 (0.51, 2.40)
Range	0.04, 13.04

Note: In the parentheses, SD is the standard deviation, and IQR is the Interquartile range.

Table 2: Percentage Share of 48 Selected Countries in World Trade

Group Code	Treatment Status	Countries
Group 0	Never Treated	Argentina, Brazil, Bangladesh, Chile, China, Colombia, Egypt, India, Indonesia, Israel, Malaysia, Mexico, Philippines, Qatar, Saudi Arabia, South Africa, Thailand, Turkey, UAE, Vietnam
Group 1	Treated in May 2021	USA, Czech
Group 2	Treated in March 2022	Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, South Korea, Singapore, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland, UK

Note: The treatment stands for the inclusion of the UCL of Russia. Group 1 was included in the UCL in May 2021, and Group 2 in March 2022. Group 0 has never been included in the list.

Table 3: Group Categorization of the 48 Selected Countries

Export from Investigated Countries to Russia

Group	Pre-Treatment Mean	Pre-Treatment SE	Pre-Treatment Observations	Post-treatment Mean	Post-Treatment SE	Post-Treatment Observations	Difference(Post-Pre)	p-value
Group 0	0.27	0.88	1662	0.61	1.96	355	0.34***	0.001
Group 1	0.45	0.19	175	0.16	0.17	74	-0.29***	<0.001
Group 2	0.31	0.50	2591	0.14	0.21	663	-0.17***	<0.001

Import of Investigated Countries from Russia

Group	Pre-Treatment Mean	Pre-Treatment SE	Pre-Treatment Observations	Post-treatment Mean	Post-Treatment SE	Post-Treatment Observations	Difference(Post-Pre)	p-value
Group 0	0.45	1.06	1667	1.41	2.78	372	0.96***	<0.001
Group 1	1.02	0.71	175	0.87	0.84	74	-0.15	0.18
Group 2	0.57	0.65	2555	0.34	0.55	688	-0.23***	<0.001

Export from Investigated Countries to Ukraine

Group	Pre-Treatment Mean	Pre-Treatment SE	Pre-Treatment Observations	Post-treatment Mean	Post-Treatment SE	Post-Treatment Observations	Difference(Post-Pre)	p-value
Group 0	0.043	0.13	1646	0.038	0.09	328	-0.005	0.40
Group 1	0.12	0.05	175	0.14	0.06	74	0.02**	0.013
Group 2	0.07	0.11	2591	0.10	0.21	678	0.03***	¡0.001

Import of Investigated Countries from Ukraine

Group	Pre-Treatment Mean	Pre-Treatment SE	Pre-Treatment Observations	Post-treatment Mean	Post-Treatment SE	Post-Treatment Observations	Difference(Post-Pre)	p-value
Group 0	0.07	0.13	1667	0.06	0.13	372	-0.01	0.18
Group 1	0.09	0.03	175	0.13	0.04	74	0.04***	<0.0001
Group 2	0.06	0.08	2555	0.07	0.11	688	0.01**	0.03

Note: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$
The mean trade flows are measured in billions of USD. The pre-treatment period is the one before the countries are included in the UCL of Russia. The post-treatment period is after the countries are included in the UCL. Countries in Group 0 are not in the UCL and thus have not been treated. To make a fair control group, we summarize the trade flows of Group 0 before and after March 2022, when most treated countries are included in the UCL.

Table 4: Trade Flow Data Summarized by Groups

Placebo Test: Export Data							
Response	*Variable*	*Group 1 Results*			*Group 2 Results*		
		Estimate	SE	p-value	Estimate	SE	p-value
Export	Placebo*Group	-0.105	0.127	0.412	-0.080	0.071	0.261
Export	GDP_EX	0.432***	0.155	0.005	0.473***	0.165	0.004
Export	REXR	-0.011***	0.004	0.008	-0.007*	0.004	0.094
Export	CA	-0.573*	0.309	0.063	-0.543*	0.307	0.077
Model Description							
		Group 1 Model			*Group 2 Model*		
Exporting Country Fixed Effects		Yes			Yes		
Time Fixed Effects		Yes			Yes		
Observations		3,981			4,228		
Pseudo R^2		0.385			0.418		
BIC		4,186.3			4,382.2		

Placebo Test: Import Data							
Response	*Variable*	*Group 1 Results*			*Group 2 Results*		
		Estimate	SE	p-value	Estimate	SE	p-value
Import	Placebo*Group	0.088	0.107	0.412	-0.084	0.061	0.171
Import	GDP_IM	0.191	0.195	0.327	0.060	0.173	0.728
Import	REXR	-0.011	0.006	0.093	-0.007	0.005	0.182
Import	CA	-0.425**	0.198	0.032	-0.444**	0.197	0.024
Model Description							
		Group 1 Model			*Group 2 Model*		
Importing Country Fixed Effects		Yes			Yes		
Time Fixed Effects		Yes			Yes		
Observations		3,950			4,197		
Pseudo R^2		0.375			0.397		
BIC		5,493.9			5,807.7		

Note: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$ For the export model, the dependent variable is the export flow from the investigated countries to Russia in billions of USD. Correspondingly, the import model's dependent variable is the import flow of the investigated countries from Russia in billions of USD. Groups 1 and 2 are the previously defined groups based on countries' treatment status. Placebo is the indicator for the periods after the placebo treatment is assigned. For the control variables, GDP_EX is the GDP of the exporting country in billions of USD. GDP_IM is the GDP of the importing country in billions of USD. REXR is the real exchange rate of the investigated countries' currency versus the Russian ruble. CA is the comparative advantage index between the investigated countries and Russia.

Table 5: Placebo Test for the Assumption of No Anticipation: Russia Data

Placebo Test: Export Data (Ukraine)							
Response	*Variable*	*Group 1 Results*			*Group 2 Results*		
		Estimate	SE	p-value	Estimate	SE	p-value
Export	Placebo*Group	0.008	0.058	0.895	-0.042	0.049	0.393
Export	GDP_EX	0.231**	0.114	0.043	0.207*	0.113	0.067
Export	REXR	0.005	0.003	0.137	0.005**	0.002	0.033
Export	CA	-0.263**	0.113	0.020	-0.348***	0.127	0.006
Model Description							
		Group 1 Model			*Group 2 Model*		
Exporting Country Fixed Effects		Yes			Yes		
Time Fixed Effects		Yes			Yes		
Observations		3,966			4,212		
Pseudo R^2		0.119			0.148		
BIC		2,266.5			2,387.2		

Placebo Test: Import Data (Ukraine)							
Response	*Variable*	*Group 1 Results*			*Group 2 Results*		
		Estimate	SE	p-value	Estimate	SE	p-value
Import	Placebo*Group	0.131	0.122	0.283	0.020	0.133	0.877
Import	GDP_IM	0.467	0.343	0.174	0.399	0.315	0.205
Import	REXR	-0.014***	0.003	<0.001	-0.014***	0.005	0.004
Import	CA	-0.488*	0.261	0.061	-0.557**	0.261	0.033
Model Description							
		Group 1 Model			*Group 2 Model*		
Importing Country Fixed Effects		Yes			Yes		
Time Fixed Effects		Yes			Yes		
Observations		3,950			4,197		
Pseudo R^2		0.048			0.081		
BIC		2,396.4			2,567.1		

Note: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$ For the export model, the dependent variable is the export flow from Ukraine to Russia in billions of USD. Correspondingly, the import model's dependent variable is the import flow of Ukraine from Russia in billions of USD. Groups 1 and 2 are the previously defined groups based on countries' treatment status. Placebo is the indicator for the periods after the placebo treatment is assigned. For the control variables, GDP_EX is the GDP of the exporting country in billions of USD. GDP_IM is the GDP of the importing country in billions of USD. REXR is the real exchange rate of the investigated countries' currency versus the Russian ruble, and CA is the comparative advantage index between the investigated countries and Russia.

Table 6: Placebo Test for the Assumption of No Anticipation: Ukraine Data

Placebo Test: Import Data from Major Oil Exporters							
Response	*Variable*	*Group 1 Results*			*Group 2 Results*		
		Estimate	SE	p-value	Estimate	SE	p-value
Import	Placebo*Group	-0.168*	0.094	0.075	-0.030	0.127	0.815
Import	GDP_IM	0.174	0.363	0.633	0.658***	0.224	0.003
Import	GDP_EX	0.183	0.117	0.116	0.433***	0.074	<0.001
Import	REXR	-0.012	0.017	0.456	-0.010	0.011	0.374
Import	REXR_EX	79.016	108.464	0.466	387.684***	39.670	<0.001
Import	CA	0.841	0.527	0.111	0.273	0.401	0.496
Model Description							
		Group 1 Model			*Group 2 Model*		
Importing Country Fixed Effects		Yes			Yes		
Time Fixed Effects		Yes			Yes		
Observations		12,311			13,179		
Pseudo R^2		0.387			0.384		
BIC		11,465.6			10,417.6		

Note: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$ The dependent variable is the import flow of the investigated countries from the four major oil exporters. Group 1 and Group 2 are the previously defined groups based on countries' treatment status. Placebo equals one if the current period is after the placebo treatment is assigned for each respective group and zero otherwise. Control variables include GDP_IM (GDP of the importing country), GDP_EX (GDP of the exporting country), REXR (real exchange rate of the investigated countries' currency versus Russia Ruble), REXR_EX (real exchange rate of the investigated countries' currency versus Russia Ruble), and CA (comparative advantage index between the investigated countries and the oil exporters).

Table 7: Placebo Test for the Assumption of No Anticipation with Additional Control Variables for Imports from Major Oil Exporters

Models for Trade with Russia: Interactions of Covariates

Import Model

Response	*Differences*	*Estimate*	*SE*	*p-value*
ATT Effect				
Import	mean(Treatment) - mean(Control)	-2.51***	0.06	<0.001
Group-specific Effects				
Import	mean(Group 1) - mean(Group 0)	-7.79***	0.12	<0.001
Import	mean(Group 2) - mean(Group 0)	-1.92***	0.06	<0.001
Control Variables				
Import	GDP	0.74***	0.34	0.03
Import	REXR	-0.08	0.09	0.37
Import	CA	-0.09	0.20	0.66

Export Model

Response	*Differences*	*Estimate*	*SE*	*p-value*
ATT Effect				
Export	mean(Treatment) - mean(Control)	-1.00***	0.09	<0.001
Group-specific Effects				
Export	mean(Group 1) - mean(Group 0)	-4.75***	0.14	<0.001
Export	mean(Group 2) - mean(Group 0)	-1.34**	0.14	<0.001
Control Variables				
Export	GDP	1.00***	0.34	<0.001
Export	REXR	-0.08	0.06	0.16
Export	CA	0.04	0.13	0.74

Model Description

	Imports Model	*Exports Model*
Country Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
Observations	5325	5319
Squared Correlation	0.78	0.88
Adjusted R^2	0.14	0.10
BIC	17904.6	14943.6

Note: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$
In the import model, the dependent variable is the import flow of the investigated countries from Russia in billions of USD. Correspondingly, the export model's dependent variable is the export of the investigated countries to Russia in billions of USD. The Estimate column captures the corresponding ATT effect and the group-specific effects. The Difference column specifies the mean difference the corresponding estimate is measuring. Treatment stands for the countries that are included in the UCL. Control stands for the countries not included in the UCL by May 2024. Group 1, Group 2, and Group 0 are the previously defined groups based on countries' treatment status. For the control variables, GDP is the GDP of the investigated country in billions of USD. REXR is the real exchange rate of the investigated countries' currency versus the Russian ruble. CA is the comparative advantage index between the investigated countries and Russia. All control variables are standardized.

Table 8: Effect of UCL on the International Trade Among the Investigated Countries and Russia with Interactions in the Covariates

Models for Trade with Ukraine				
Import Model				
ATT Effect				
Response	*Differences*	*Estimate*	*SE*	*p-value*
Import	mean(Treatment) - mean(Control)	0.010	0.021	0.624
Group-specific Effects				
Import	mean(Group 1) - mean(Group 0)	0.020	0.061	0.775
Import	mean(Group 2) - mean(Group 0)	0.016	0.032	0.619
Control Variable				
Import	GDP	0.494	0.375	0.188
Export Model				
ATT Effect				
Response	*Differences*	*Estimate*	*SE*	*p-value*
Export	mean(Treatment) - mean(Control)	-0.001	0.031	0.977
Group-specific Effects				
Export	mean(Group 1) - mean(Group 0)	-0.046	0.083	0.583
Export	mean(Group 2) - mean(Group 0)	0.002	0.046	0.965
Control Variable				
Export	GDP	0.792***	0.253	0.002

Model Description		
	Imports Model	*Exports Model*
Country Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
Observations	5526	5487
Squared Correlation	0.398	0.348
Adjusted R^2	-0.534	-0.491
BIC	8684.8	8567.8

Note: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$
In the import model, the dependent variable is the import flow of the investigated countries from Ukraine in billions of USD. Correspondingly, the export model's dependent variable is the export of the investigated countries to Ukraine in billions of USD. The Estimate column captures the corresponding ATT effect and the group-specific effects. The Difference column specifies the mean difference the corresponding estimate is measuring. Treatment stands for the countries that are included in the UCL. Control stands for the countries not included in the UCL by September 2023. Group 1, Group 2, and Group 0 are the previously defined groups based on countries' treatment status. For the control variable, GDP is the GDP of the investigated country in billions of USD.

Table 9: Effect of UCL on the International Trade Among the Investigated Countries and Ukraine

Models for Trade Diversion				
Import Model				
ATT Effect				
Response	*Differences*	*Estimate*	*SE*	*p-value*
Import	mean(Treatment) - mean(Control)	-0.180	0.137	0.190
Group-specific Effects				
Import	mean(Group 1) - mean(Group 0)	-5.370***	1.950	0.006
Import	mean(Group 2) - mean(Group 0)	0.041	0.126	0.742
Control Variables				
Import	GDP_IM	0.661**	0.273	0.016
Import	GDP_EX	-0.030	0.221	0.893

Model Description	
	Imports Model
Country Fixed Effects	Yes
Time Fixed Effects	Yes
Observations	17158
Squared Correlation	0.713
Adjusted Pseudo R^2	0.296
BIC	28356.8

Note: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$
In the general model, the dependent variable is the import flow of the investigated countries from the four major crude exporters (the US, Canada, Saudi Arabia, and UAE) in billions of USD. The Estimate column captures the corresponding ATT effect and the group-specific effects. The Difference column specifies the mean difference the corresponding estimate is measuring. Treatment stands for the countries that are included in the UCL. Control stands for the countries not included in the UCL by May 2024. Group 1, Group 2, and Group 0 are the previously defined groups based on countries' treatment status. For the control variables, GDP_IM is the GDP of the investigated country in billions of USD, and GDP_EX is the GDP of the exporting country.

Table 10: Effect of UCL on the International Import of the Investigated Countries from Four Major Crude Exporters

Models for Trade Diversion

Import Model

ATT Effect				
Response	*Differences*	*Estimate*	*SE*	*p-value*
Import	mean(Treatment) - mean(Control)	-0.083	0.201	0.678
Group-specific Effects				
Import	mean(Group 0) - mean(Group 0)	-2.684	2.584	0.299
Import	mean(Group 10) - mean(Group 0)	0.055	0.158	0.728
Control Variables				
Import	LGDP	0.845**	0.370	0.022
Import	LGDPEX	0.085	0.234	0.717

Model Description

	Imports Model
Country Fixed Effects	Yes
Time Fixed Effects	Yes
Observations	14882
Squared Correlation	0.721
Adjusted Pseudo R^2	0.296
BIC	26,775.7

Note: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$
In the general model, the dependent variable is the import flow of the investigated countries from the four major crude exporters (the US, Canada, Saudi Arabia, and UAE) in billions of USD. The Estimate column captures the corresponding ATT effect and the group-specific effects. The Difference column specifies the mean difference the corresponding estimate is measuring. Treatment stands for the countries that are included in the UCL. Control stands for the countries not included in the UCL by May 2024. Group 1, Group 2, and Group 0 are the previously defined groups based on countries' treatment status. For the control variables, LGDP is the logarithm of the GDP of the investigated country, and LGDPEX is the logarithm of the GDP of the exporting country.

Table 11: Effect of UCL on the International Import of the Investigated Countries from Four Major Crude Exporters: Subset of Countries Who Increased Crude Imports from the Four Oil Exporters After UCL Onset

Russia Models, Alternative Control Group, Extra Covariates				

Import Model

ATT Effect				
Response	*Differences*	*Estimate*	*SE*	*p-value*
Import	mean(Treatment) - mean(Control)	-2.79***	0.05	<0.001
Group-specific Effects				
Import	mean(Group 1) - mean(Group 0)	-11.00***	0.10	<0.001
Import	mean(Group 2) - mean(Group 0)	-1.90***	0.05	<0.001
Control Variables				
Import	GDP	1.01***	0.12	<0.001
Import	REXR	-0.13**	0.06	0.02
Import	CA	-0.12	0.14	0.40

Export Model

ATT Effect				
Response	*Differences*	*Estimate*	*SE*	*p-value*
Export	mean(Treatment) - mean(Control)	-1.1***	0.03	<0.001
Group-specific Effects				
Export	mean(Group 1) - mean(Group 0)	-2.04***	0.02	<0.001
Export	mean(Group 2) - mean(Group 0)	-0.99***	0.03	<0.001
Control Variables				
Export	GDP	1.58***	0.17	<0.001
Export	REXR	-0.13	0.08	0.11
Export	CA	0.05	0.13	0.73

Model Description

	Imports Model	*Exports Model*
Country Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
Observations	5325	5319
Squared Correlation	0.77	0.87
Adjusted Pseudo R^2	0.23	0.24
BIC	13145.5	10175.9

Note: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$
In the general model, the dependent variable is the import/export flow of the investigated countries from Russia in billions of USD. The Estimate column captures the corresponding ATT effect and the group-specific effects. The Difference column specifies the mean difference the corresponding estimate is measuring. Treatment stands for the countries that are included in the UCL. Control stands for the countries that are not yet treated. Group 1, Group 2, and Group 0 are the previously defined groups based on countries' treatment status. For the control variables, GDP is the GDP of the investigated country, REXR is the real exchange rate, and CA is the comparative advantage index. All control variables are standardized.

Table 12: Effect of UCL on the International Trade Among the Investigated Countries and Russia Alternative Control Group and Extra Controls

Models for Trade with Russia: Alternative DiD Estimators

Import Model

Response	*Differences*	*Estimate*	*SE*	*p-value*
ATT Effect				
Import	mean(Treatment) - mean(Control)	-0.98***	0.12	<0.001
Cohort ATT Effects				
Import	mean(Group 1) - mean(Group 0)	-1.25***	0.16	<0.001
Import	mean(Group 2) - mean(Group 0)	-0.96***	0.13	<0.001
Control Variables				
Import	GDP	0.08	0.09	0.36
Import	REXR	-0.03	0.03	0.35
Import	CA	-0.02	0.02	0.35

Export Model

Response	*Differences*	*Estimate*	*SE*	*p-value*
ATT Effect				
Export	mean(Treatment) - mean(Control)	-0.89***	0.06	<0.001
Cohort ATT Effects				
Export	mean(Group 1) - mean(Group 0)	-1.66***	0.07	<0.001
Export	mean(Group 2) - mean(Group 0)	-0.83***	0.06	<0.001
Control Variables				
Export	GDP	0.53***	0.07	<0.001
Export	REXR	-0.05***	0.02	0.009
Export	CA	-0.16***	0.02	<0.001

Model Description

	Imports Model	*Exports Model*
Country Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
Observations	5325	5319
Squared Correlation	0.94	0.99
Adjusted R^2	0.40	0.39
BIC	9599.8	7467.6

Note: ***: $p < 0.01$, **: $p < 0.05$, *: $p < 0.1$
In the import model, the dependent variable is the import flow of the investigated countries from Russia in billions of USD. Correspondingly, the export model's dependent variable is the export of the investigated countries to Russia in billions of USD. The Estimate column captures the corresponding ATT effect and the group-specific effects. The Difference column specifies the mean difference the corresponding estimate is measuring. Treatment stands for the countries that are included in the UCL. Control stands for the countries not included in the UCL by May 2024. Group 1, Group 2, and Group 0 are the previously defined groups based on countries' treatment status. For the control variables, GDP is the GDP of the investigated country in billions of USD. REXR is the real exchange rate of the investigated countries' currency versus the Russian ruble. CA is the comparative advantage index between the investigated countries and Russia.

Table 13: Effect of UCL on the International Trade Among the Investigated Countries and Russia: Sun and Abraham Staggered DiD

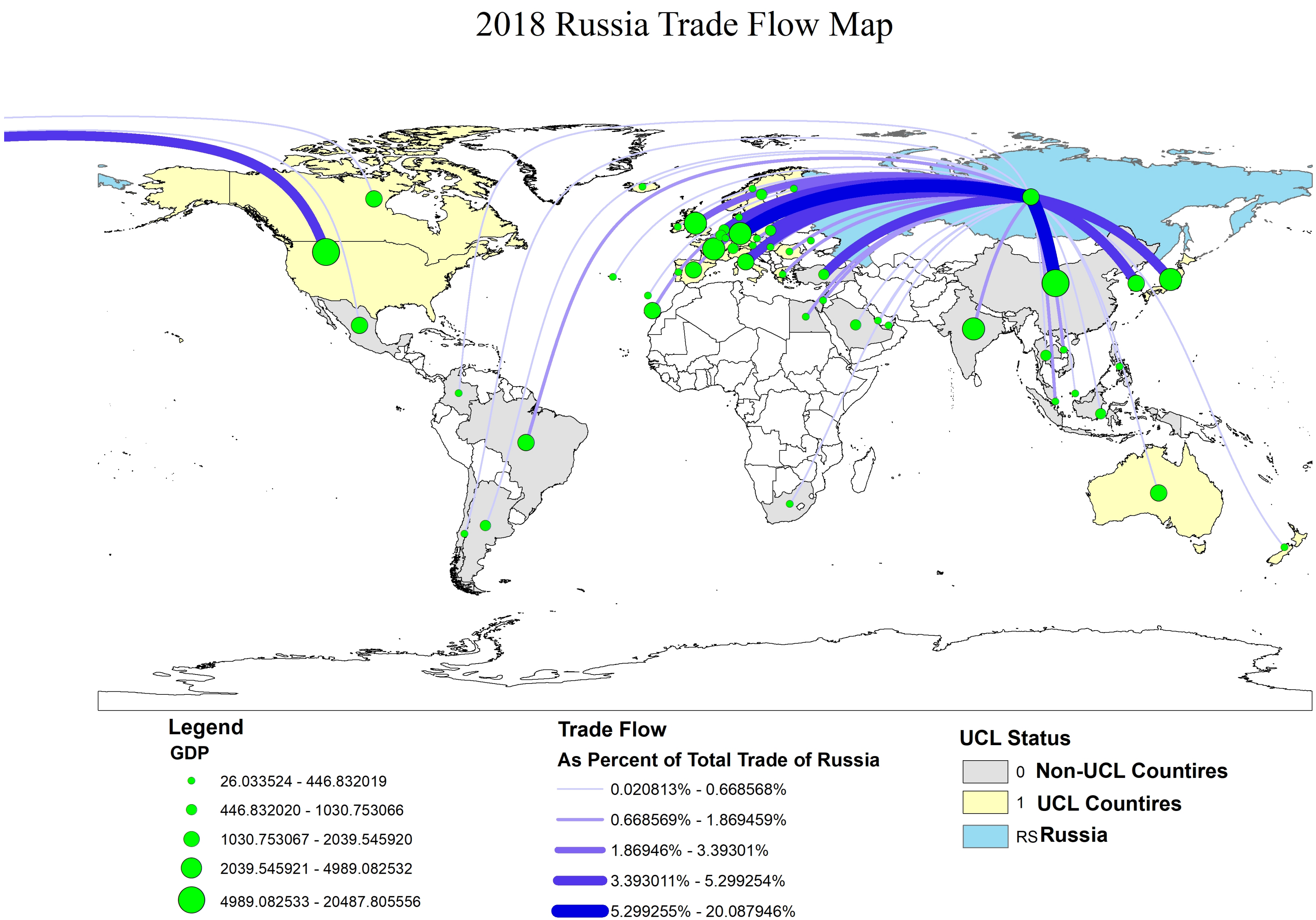


Figure 1: Russia Trade Flow Map 2018

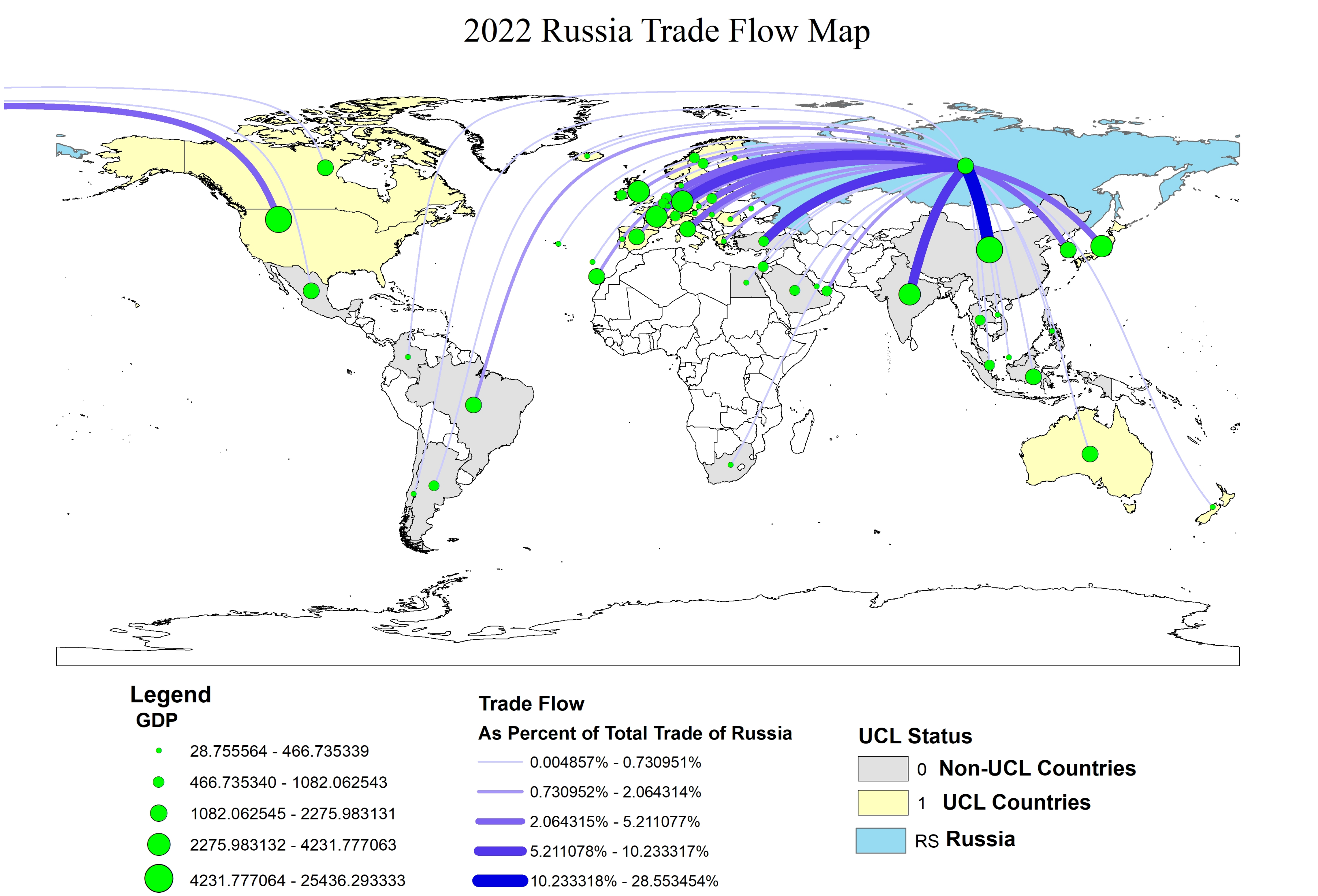
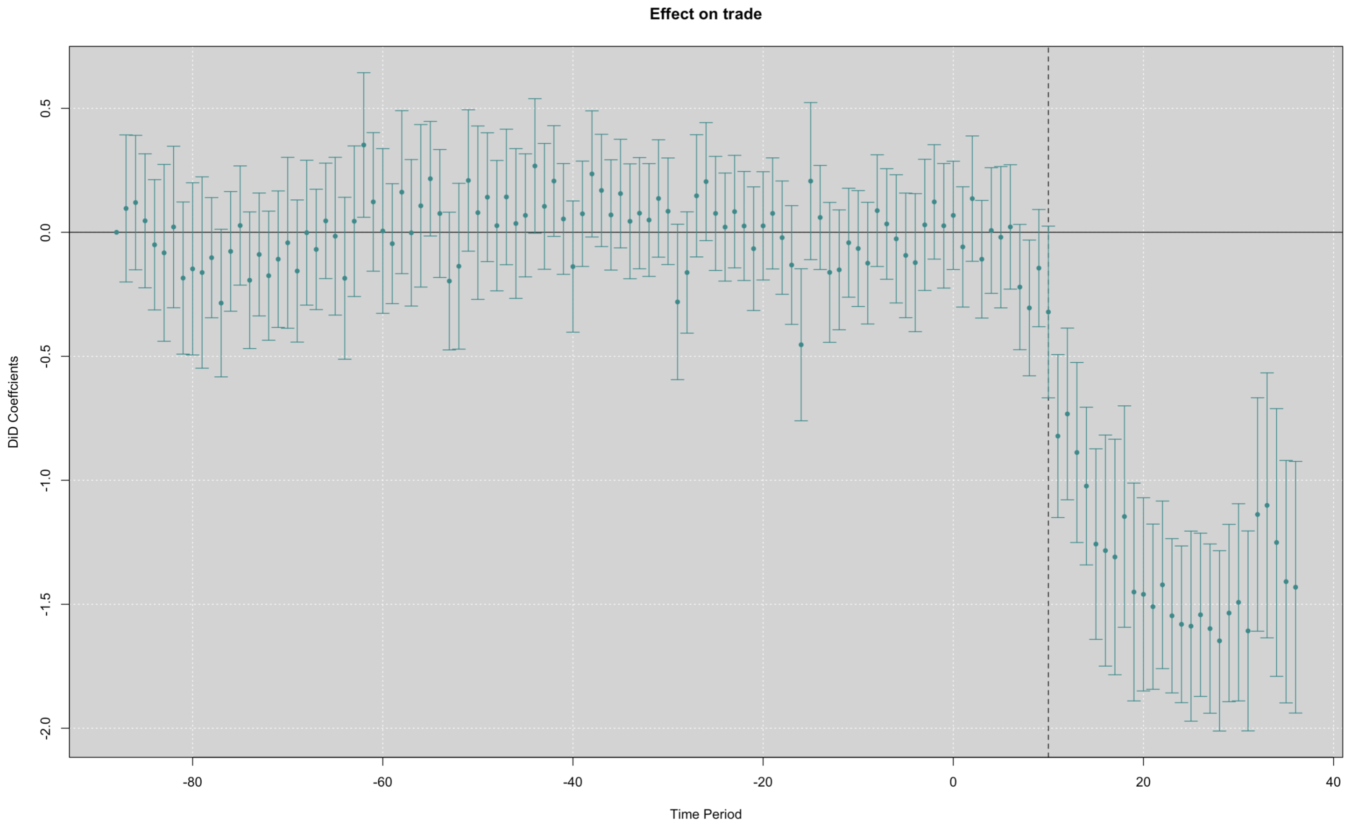
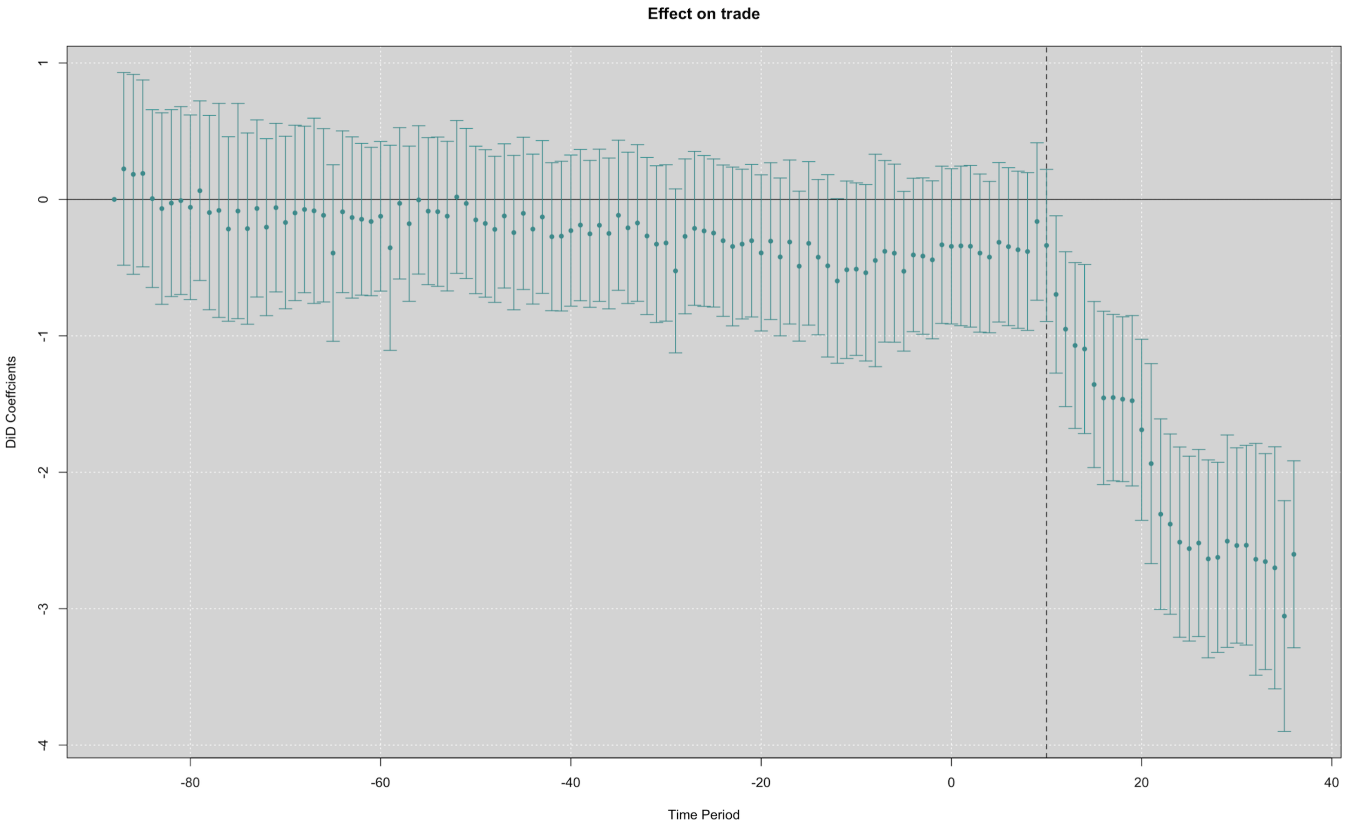


Figure 2: Russia Trade Flow Map 2022



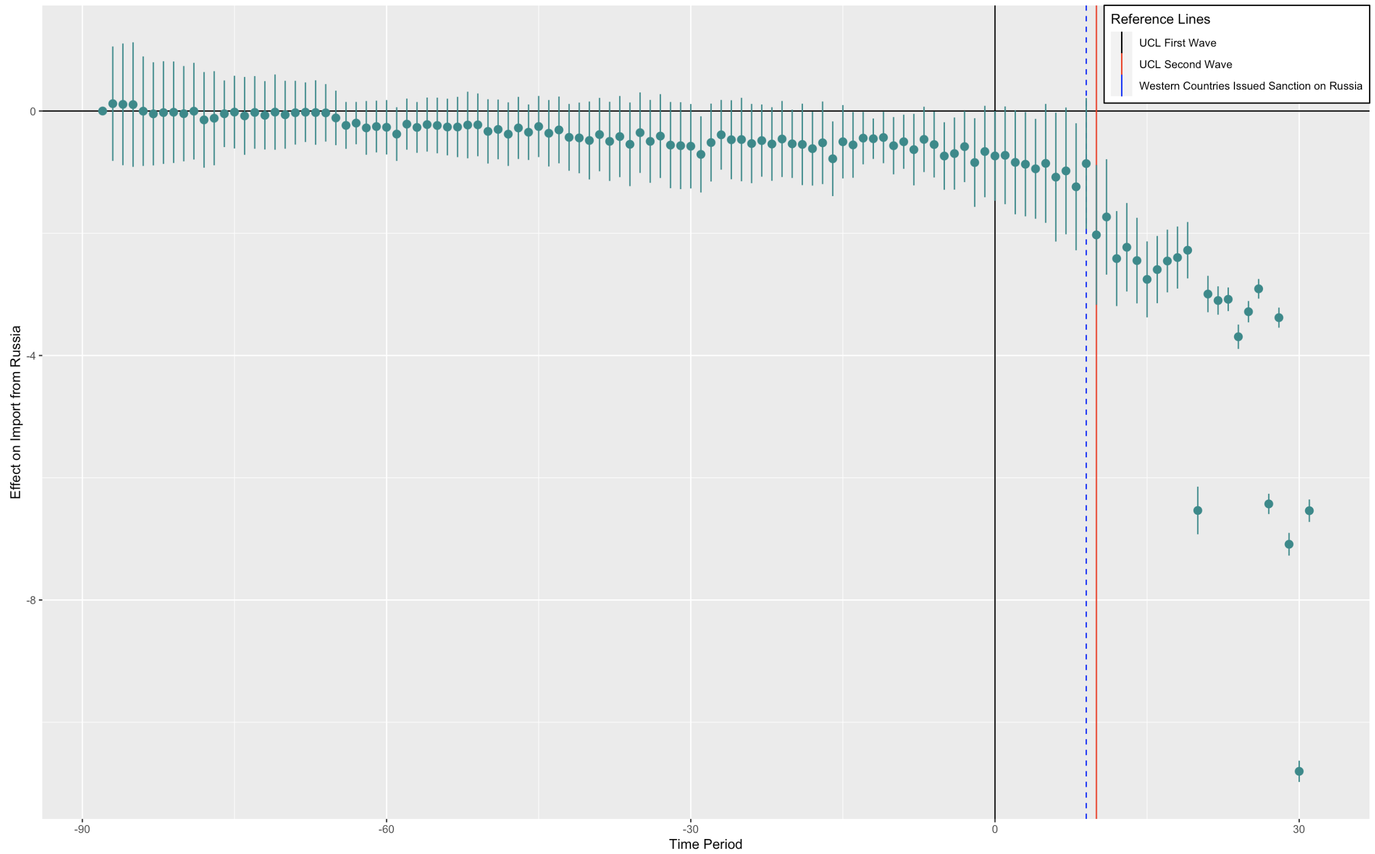
Note: The dependent variable is the export from investigated countries to Russia. The x-axis represents the period indexed. The vertical dashed line is added in March 2022 ($t = 10$). The y-axis measures the estimated of the coefficients β_t^{pre} and β_t^{post} in the pooled regression. The blue dots represent the point estimation at the corresponding periods, and the blue lines represent the 95% confidence intervals.

Figure 3: Relaxed Test for Parallel Trends Assumptions: Export to Russia Data



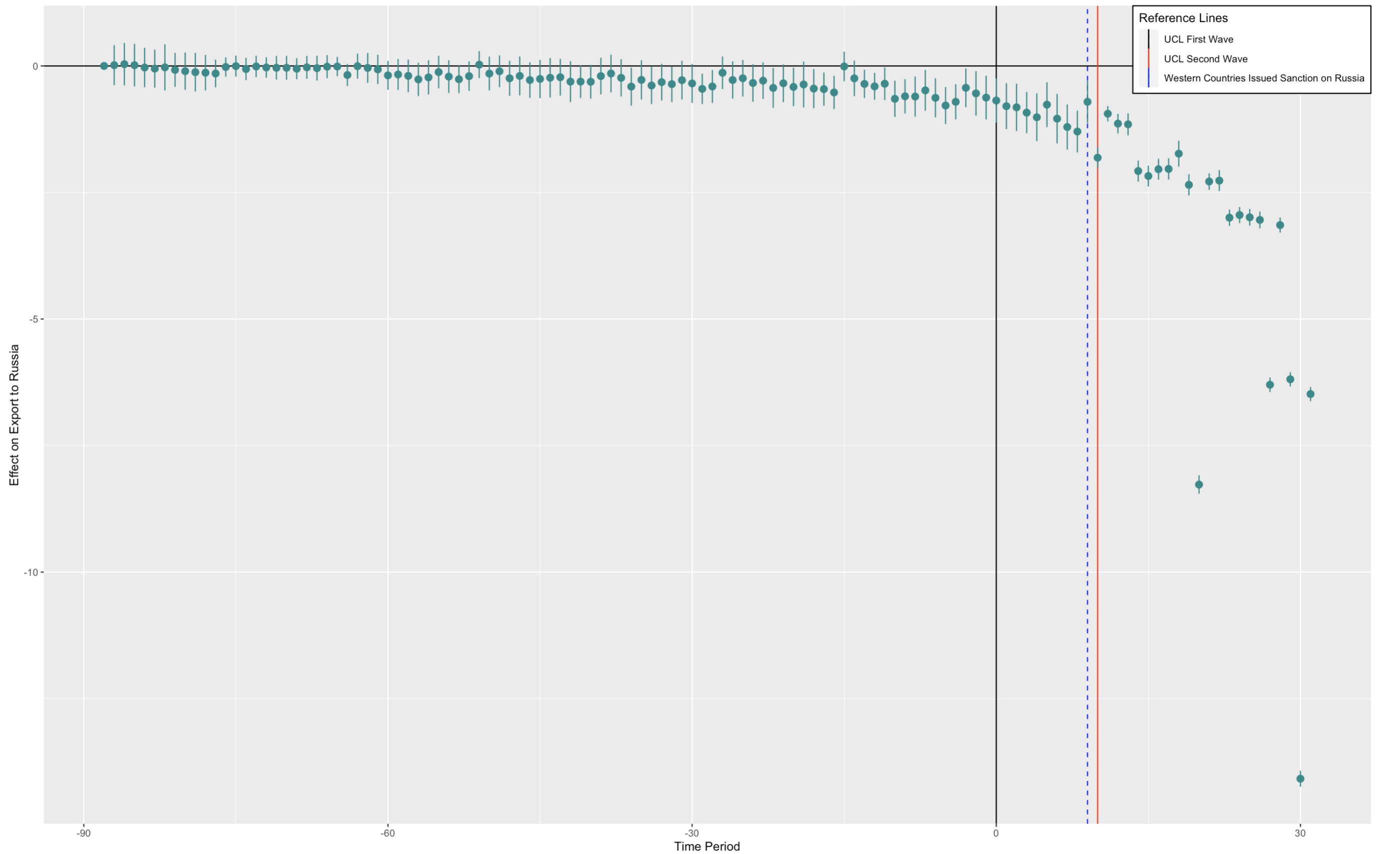
Note: The dependent variable is the import from investigated countries to Russia. The x-axis represents the period indexed. The vertical dashed line is added in March 2022 ($t = 10$). The y-axis measures the estimated of the coefficients β_t^{pre} and β_t^{post} in the pooled regression. The blue dots represent the point estimation at the corresponding periods, and the blue lines represent the 95% confidence intervals.

Figure 4: Test for Parallel Trends Assumptions: Import from Russia Data



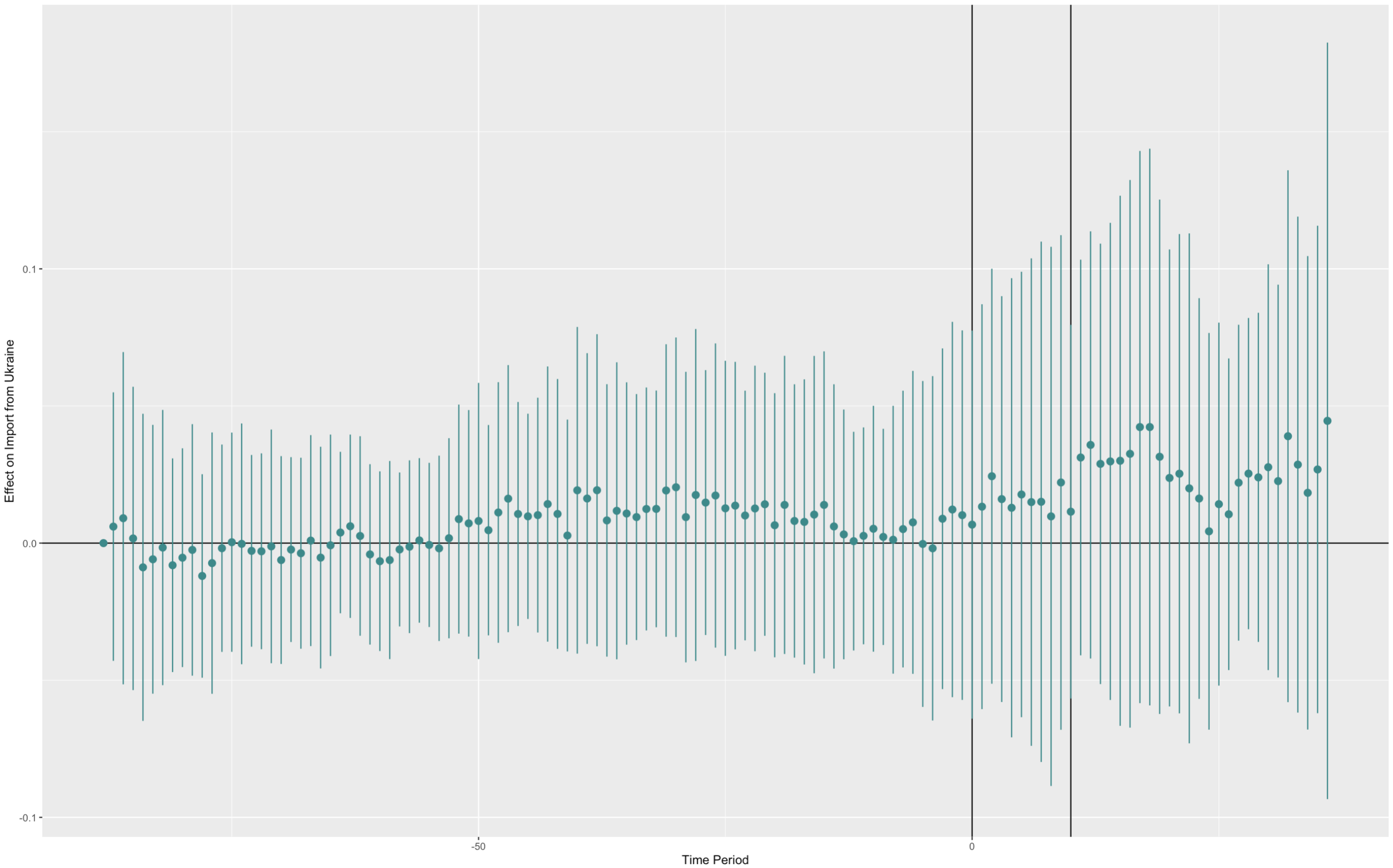
Note: The x-axis represents the period indexed. Black vertical lines are added in May 2021 ($t = 0$), the first wave of the UCL. The red vertical line stands for March 2022 ($t = 10$), the second wave of the UCL. The blue dashed line is in February 2022 ($t = 9$), when most UCL countries issued sanctions on Russian individuals, firms, and industries. The y-axis measures the estimated mean difference in the import flows of the treatment group versus the control group. The blue dots represent the point estimation at the corresponding periods, and the blue lines represent the 95% confidence intervals.

Figure 5: Effect of UCL on Imports of Investigated Countries from Russia: Time-specific Effects, with Extra Covariates



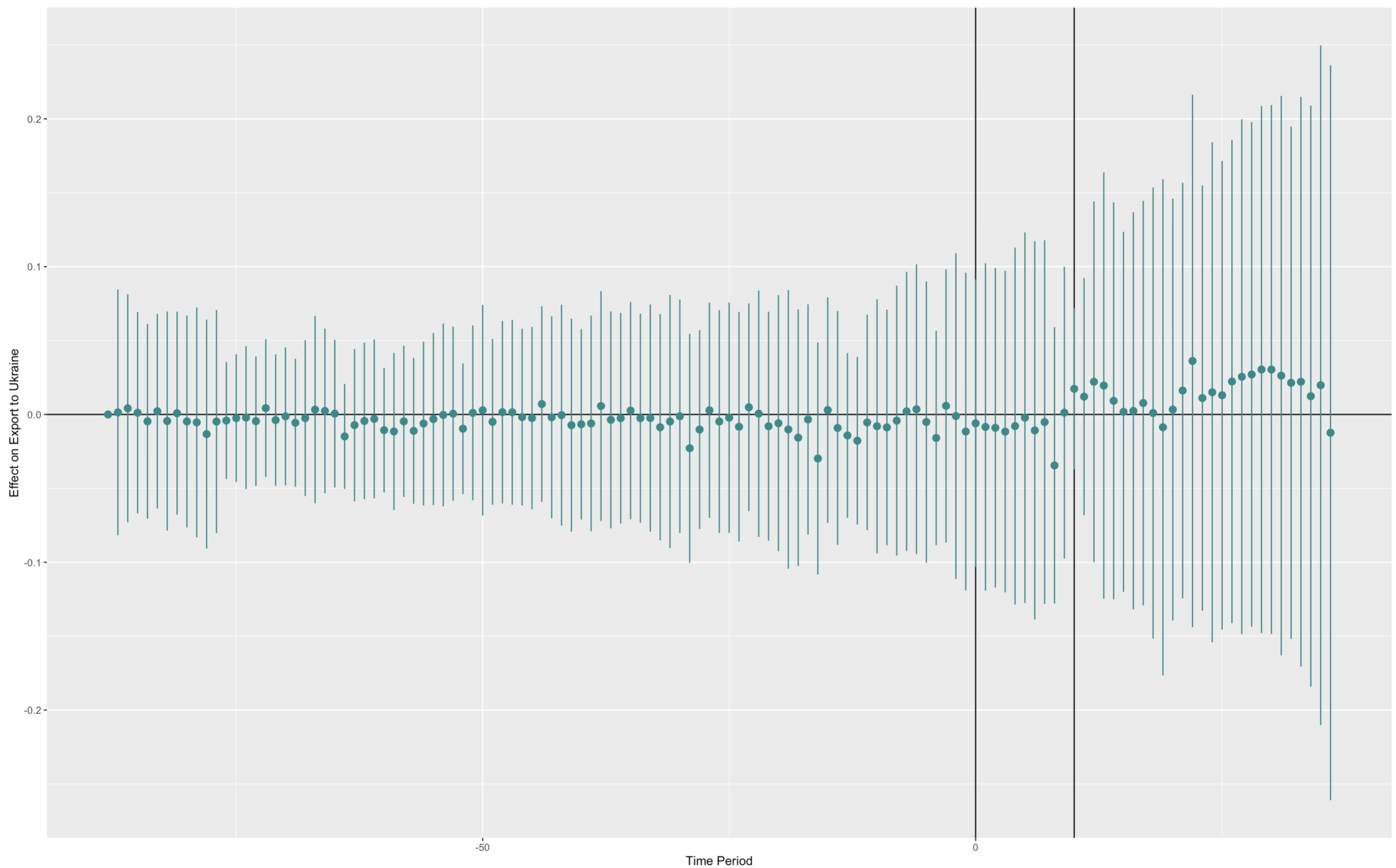
Note: The x-axis represents the period indexed. Black vertical lines are added in May 2021 ($t = 0$), the first wave of the UCL. The red vertical line stands for March 2022 ($t = 10$), the second wave of the UCL. The blue dashed line is in February 2022 ($t = 9$), when most UCL countries issued sanctions on Russian individuals, firms, and industries. The y-axis measures the estimated mean difference in the export flows of the treatment group versus the control group. The blue dots represent the point estimation at the corresponding periods, and the blue lines represent the 95% confidence intervals.

Figure 6: Effect of UCL on Exports from Investigated Countries to Russia: Time-specific Effects, with Extra Covariates



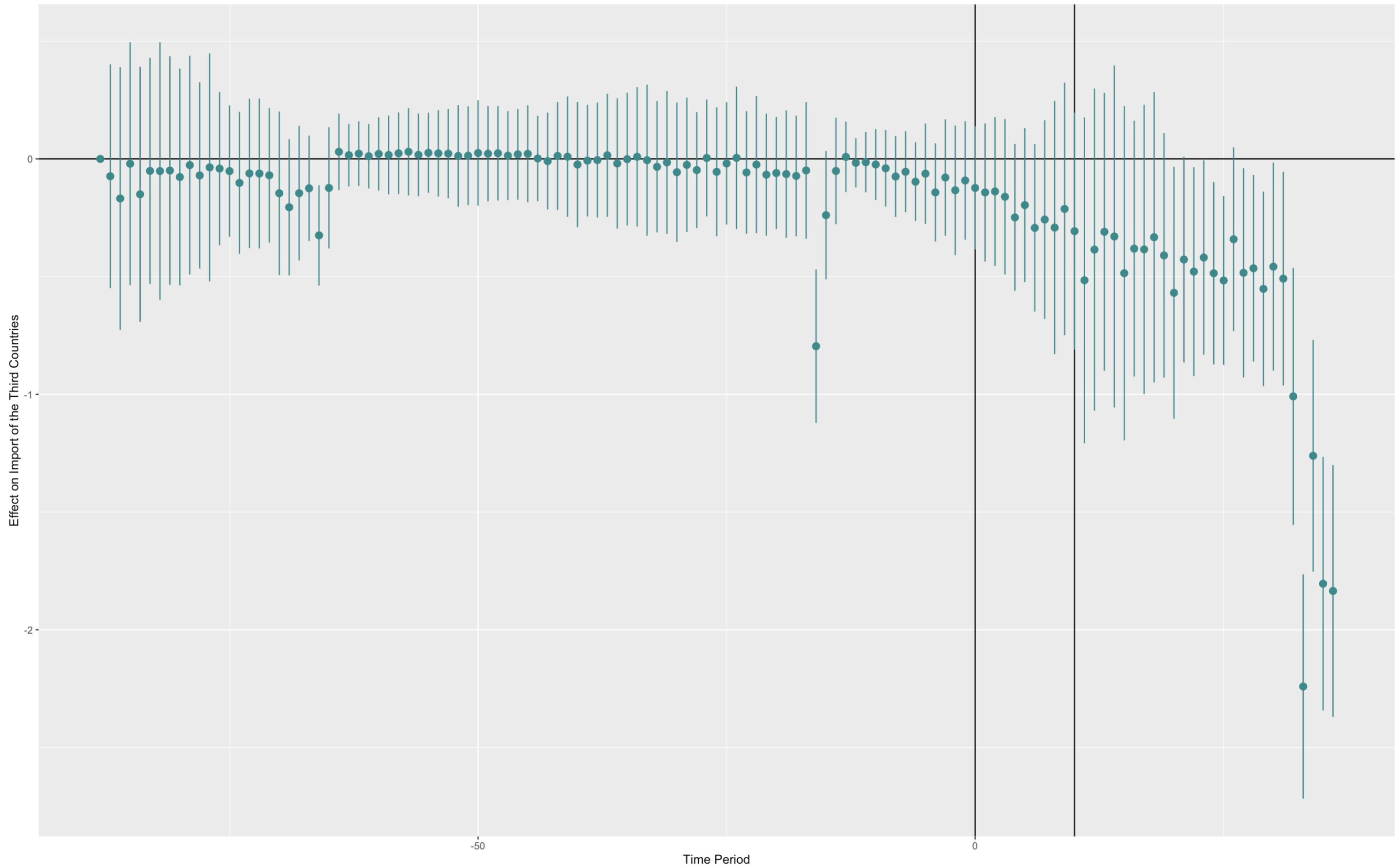
Note: The x-axis represents the period indexed. Two black vertical lines are added in May 2021 ($t = 0$) and March 2022 ($t = 10$). The y-axis measures the estimated mean difference in the import flows of the treatment group versus the control group. The blue dots represent the point estimation at the corresponding periods, and the blue lines represent the 95% confidence intervals.

Figure 7: Effect of UCL on Imports of Investigated Countries from Ukraine: Time-specific Effects



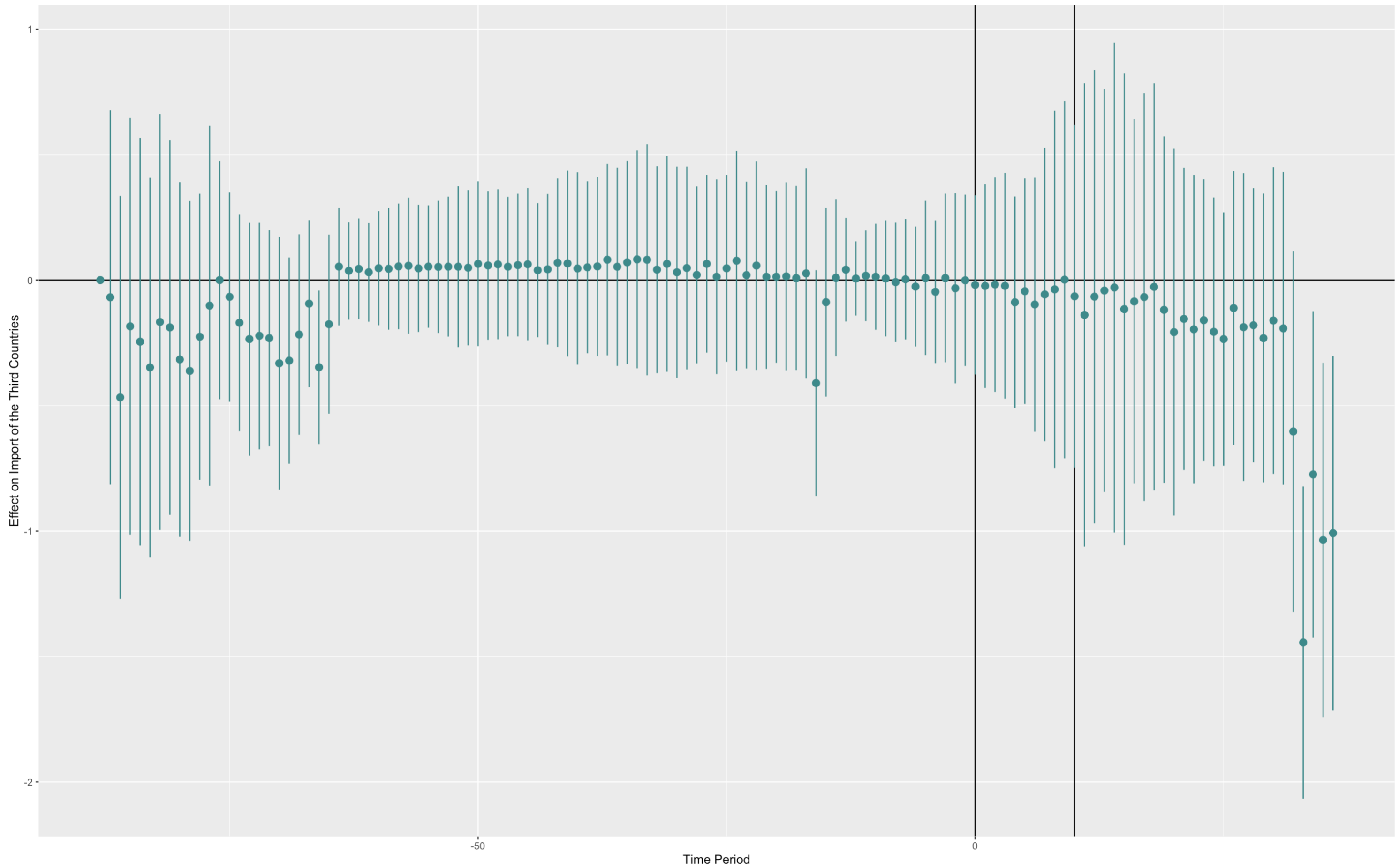
Note: The x-axis represents the period indexed. Two black vertical lines are added in May 2021 ($t = 0$) and March 2022 ($t = 10$). The y-axis measures the estimated mean difference in the export flows of the treatment group versus the control group. The blue dots represent the point estimation at the corresponding periods, and the blue lines represent the 95% confidence intervals.

Figure 8: Effect of UCL on Exports of Investigated Countries to Ukraine: Time-specific Effects



Note: The x-axis represents the period indexed. Two black vertical lines are added in May 2021 ($t = 0$) and March 2022 ($t = 10$). The y-axis measures the estimated mean difference in the import flows of the treatment group versus the control group. The blue dots represent the point estimation at the corresponding periods, and the blue lines represent the 95% confidence intervals.

Figure 9: Effect of UCL on Imports of Investigated Countries from Four Major Crude Exporters: Time-specific Effects



Note: The x-axis represents the period indexed. Two black vertical lines are added in May 2021 ($t = 0$) and March 2022 ($t = 10$). The y-axis measures the estimated mean difference in the import flows of the treatment group versus the control group. The blue dots represent the point estimation at the corresponding periods, and the blue lines represent the 95% confidence intervals.

Figure 10: Effect of UCL on the Oil Import of the Investigated Countries from Four Major Crude Exporters: Subset of Countries that Increased Crude Imports from the Four Oil Exporters After the Initiation of UCL

Appendix 1. Russian Oil Statistics

Country	Pre-UCL Oil Import	Post-UCL Oil Import	Import Increase Dummy
ARG	5.20e+07	1.07e+08	TRUE
AUS	2.38e+07	4.91e+07	TRUE
AUT	1.23e+07	2.16e+07	TRUE
BEL	3.63e+07	7.34e+07	TRUE
BRA	3.74e+08	3.67e+08	FALSE
CAN	5.27e+08	6.85e+08	TRUE
CHE	1.42e+07	2.81e+07	TRUE
CHL	2.11e+08	2.75e+08	TRUE
CHN	2.14e+09	2.72e+09	TRUE
COL	9.15e+07	1.36e+08	TRUE
CZE	1.59e+07	1.93e+07	TRUE
DEU	1.69e+08	3.33e+08	TRUE
DNK	5.07e+07	6.90e+07	TRUE
EGY	1.30e+08	1.46e+08	TRUE
ESP	2.27e+08	3.60e+08	TRUE
FIN	1.13e+07	5.50e+07	TRUE
FRA	2.53e+08	5.26e+08	TRUE
GBR	3.20e+08	5.88e+08	TRUE
GRC	1.24e+08	1.67e+08	TRUE
HUN	4.53e+06	7.28e+06	TRUE
IDN	1.55e+08	1.60e+08	TRUE
IND	1.51e+09	1.76e+09	TRUE
IRL	3.88e+07	5.31e+07	TRUE
ISL	2.28e+06	5.13e+06	TRUE
ISR	6.58e+06	2.92e+06	FALSE
ITA	2.13e+08	3.28e+08	TRUE
JPN	1.38e+09	1.88e+09	TRUE
KOR	1.04e+09	1.64e+09	TRUE
LUX	9.80e+03	3.53e+04	TRUE
MEX	1.69e+09	1.70e+09	TRUE
MYS	6.15e+07	2.47e+08	TRUE
NLD	2.37e+08	5.88e+08	TRUE
NOR	3.59e+07	3.99e+07	TRUE
NZL	4.92e+07	4.10e+06	FALSE
PHL	7.60e+07	8.20e+07	TRUE
POL	6.28e+07	2.35e+08	TRUE
PRT	8.67e+07	7.83e+07	FALSE
QAT	1.90e+06	1.36e+06	FALSE
ROU	1.43e+06	6.79e+06	TRUE
SGP	3.47e+08	4.80e+08	TRUE
SWE	3.43e+07	6.14e+07	TRUE
TUR	4.00e+07	5.60e+07	TRUE
USA	2.89e+09	3.59e+09	TRUE
VNM	1.71e+07	2.61e+07	TRUE
ZAF	1.06e+08	1.26e+08	TRUE

The table reports the average oil imports of the investigated countries from the four alternative oil exporters. The pre-UCL import is the average crude import before March 2022, when the expansion period of the UCL, and the post-UCL import is the average import after March 2022. The import-increasing dummy identifies whether the average imports from the alternative oil exporters increased after the UCL issuance. The countries that did not increase their imports are highlighted in red.

Table 14: Oil Import from the Four Major Oil Exporters Comparison: With Highlighted Non-Increasing Import Countries

Country	Pre-UCL Oil Import	Post-UCL Oil Import	Import Increase Dummy
ARG	5802853230.04	10273086224.56	TRUE
AUS	26858481946.79	44866408701.842	TRUE
AUT	16505337670.819	24159663770.2755	TRUE
BEL	54317903569.218	94554649163.862	TRUE
BRA	31872904464.0	45461255050.0	TRUE
CAN	30288980459.985	41642565147.332	TRUE
CHL	14003836249.282	20708231501.6245	TRUE
CHN	405433252593.0	525626953903.0	TRUE
COL	3766757558.71	6933254590.93	TRUE
CZE	12085966126.0	18038132123.5	TRUE
DNK	8409993654.633	15586377716.328	TRUE
FIN	11384403406.984	15753272193.804000	TRUE
FRA	72661276799.146	129432735865.094	TRUE
DEU	128071788562.567	169931783862.4820	TRUE
GRC	20028576487.961	29404715911.1455	TRUE
HUN	12531276310.0	19138061211.5	TRUE
ISL	591804546.543	1344042399.4765	TRUE
IDN	28840088962.0	42508493283.0	TRUE
IRL	7319959098.376	12331367145.446	TRUE
ISR	9131433000.0	12162232354.0	TRUE
ITA	75604145522.165	120912906463.049	TRUE
JPN	154729669753.146	224662152589.37400	TRUE
KOR	137572591484.0	218678954840.0	TRUE
LUX	2452460666.842	3679781955.5235	TRUE
MYS	29864879130.345	52845042842.74450	TRUE
MEX	42987829662.0	53073996819.0	TRUE
NLD	99569783336.359	161335257268.836	TRUE
NZL	3993034497.22	6798147784.601	TRUE
NOR	5411223017.796	9711626099.2675	TRUE
PHL	15480615466.0	23478012850.5	TRUE
POL	20974434992.0	35366376317.5	TRUE
PRT	11253105852.233	16215200759.7325	TRUE
QAT	283476192.275	661697622.9060000	TRUE
ROU	8776428992.23	13717773232.905000	TRUE
SAU	7389508340.862	15255838341.271	TRUE
IND	170398554314.657	248916027829.1300	TRUE
SGP	75341462776.422	96280223855.8575	TRUE
VNM	16390904374.073	26884109704.882	TRUE
ZAF	15483654590.995	23979020347.826	TRUE
ESP	55088311527.708	81899528298.18450	TRUE
SWE	18192271749.628	25051387667.058	TRUE
CHE	10895881027.128	18720876951.7585	TRUE
THA	39208151106.414	56132175296.192500	TRUE
ARE	36789890019.708	20924216447.6165	FALSE
TUR	50691986207.0	82831342475.5	TRUE
EGY	10973872567.043	13893082767.099500	TRUE
GBR	70266167358.353	114908613317.4000	TRUE
USA	223932092237.0	294645446117.5	TRUE

The table reports the total average oil imports of the investigated countries. The pre-UCL import is the average crude import before March 2022, when the expansion period of the UCL, and the post-UCL import is the average import after March 2022. The import-increasing dummy identifies whether the average imports increased after the UCL issuance. The countries that did not increase their imports are highlighted in red.

Table 15: Total Oil Import Comparison: With Highlighted Non-Increasing Import Countries

Country	Pre-UCL Oil Import	Post-UCL Oil Import	Import Increase Dummy
ARG	843713.736663844	440112.386604577	FALSE
AUT	7918065.34813717	3497121.92604776	FALSE
CAN	4278286.80296359	472944.924611117	FALSE
CHL	1434297.01260231	683.093629247994	FALSE
DNK	12298602.8518911	891396.077697414	FALSE
FIN	84126407.0214084	32940067.41828	FALSE
DEU	251860663.609244	226523887.999297	FALSE
ISL	74.9837849280271	6.53715446348955	FALSE
IRL	6215829.05702794	1420616.80493411	FALSE
ISR	135901.778154107	18933.9145942733	FALSE
JPN	122401546.104064	100793068.928396	FALSE
KOR	186584539.96613	110545338.194788	FALSE
LUX	8623.2250635055	6428.45112454176	FALSE
MEX	980145.568727067	45972.753393441	FALSE
NLD	270208111.617669	200866788.947578	FALSE
NOR	8342134.69328253	6563252.35102546	FALSE
POL	149377399.266159	102263211.433667	FALSE
PRT	12160597.3025826	4238353.67526999	FALSE
QAT	27175.6542478126	13792.7658278014	FALSE
ROU	66280360.6931979	49563918.4967799	FALSE
SGP	28113470.0651002	13722533.4652829	FALSE
VNM	8328871.45831216	6389784.89437234	FALSE
ZAF	1247338.50379622	559676.860081244	FALSE
ESP	84264554.6543607	70323854.1203408	FALSE
SWE	22280010.458044	4855211.08904191	FALSE
CHE	256568.353542196	166351.669771129	FALSE
THA	11701079.7967683	3334176.21988507	FALSE
GBR	85073629.7143381	30760079.2680571	FALSE
USA	255677013.519616	52368684.3852175	FALSE

The table reports the average oil imports from Russia for the countries that decreased their oil imports from Russia after the UCL issuance. The pre-UCL import is the average crude import before March 2022, when the expansion period of the UCL, and the post-UCL import is the average import after March 2022. The import-increasing dummy identifies whether the average imports from Russia increased after the UCL issuance.

Table 16: Countries that Decreased Crude Imports from Russia After the UCL Issuance

Appendix 2. Alternative Staggered DiD Estimators

Sun and Abraham (2021) proposed an alternative staggered DiD estimator to capture the heterogeneous treatment effects. With regard to these assumptions, Sun and Abraham (2021) also presumed that parallel trends and no anticipation assumptions hold. Assuming that we still study the impact of UCL on trade, Equation (16) represents the regression model by applying the method of Sun and Abraham (2021).

$$TF_{it} = \exp\big(\lambda_i + \lambda_t + \sum_l b_l 1\{t - G_{ij} = l\}\big)\epsilon_{it} \tag{16}$$

The subscript l represents the time difference between the current time t and the time G_i when the country i receives UCL treatment. Similar to the previous models, g still stands for treatment groups (cohorts); that is, the country that received the UCL in the same period g belong to the same cohorts. The main difference between Sun and Abraham (2021) and Wooldridge (2023) is the definition of treatment indicators. Instead of having an indicator UCL_{gs} for each possible combination of the treatment group g and post-treatment period s (Wooldridge, 2023; Nagengast & Yotov, 2023), the treatment indicator $1\{t - G_i = l\}$ is defined as whether the current time t is l periods away from the treatment (Sun & Abraham, 2021).

To effectively interpret the coefficients b_l, Sun and Abraham (2021) suggested calculating the cohort-specific average treatment effect on the treated (CATT) and the ATT effect.

$$CATT_{g,l} = E[TF_{i,g+l} - TF_{i,NT} | G_i = g] \tag{17}$$

The CATT for cohort g in l periods after treatment $CATT_{g,l}$ is given by Equation (17): $TF_{i,g+l}$ is the trade flow between countries i and Russia in period $g + l$, and $TF_{i,NT}$ is a counterfactual result for country i if it does not receive treatment.[14] $CATT_{g,l}$ is the conditional expected difference between $TF_{i,g+l}$ and $TF_{i,NT}$, because country i receives UCL in period g, that is, $G_i = g$. The effect of ATT on each time difference l can be calculated using the weighted average of $CATT_{g,l}$ (Sun & Abraham, 2021).

$$ATT_l = \sum_g w_e CATT_{g,l} \tag{18}$$

where the weight w_e is given by the proportion of the sample that received an UCL in period g; that is, $w_e = \frac{N_g}{N_g s}$. The weighted average provides an unbiased estimate of the ATT effect with a time difference l from the onset of treatment in all the treated cohorts.

[14] The counterfactual for each treated country is constructed using the not-yet-treated country. Specifically, Sun and Abraham (2021) compared the results of units that have not yet received treatment to estimate the counterfactual of units that have already been treated. In addition, this method assumes that parallel trends are solid.