

Causal Impacts of the 2014 Russia-Ukraine Conflict on Machinery and Pharmaceutical Trade: A Synthetic Control Analysis*

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This study examines the long-term geopolitical and economic impacts of the 2014 Russia-Ukraine conflict on the industrial sectors of both nations, with a focus on pharmaceuticals (HS code 30) and machinery (HS code 84) trade. Utilizing the Synthetic Control Method (SCM) with data from 2009 to 2022 across 105 countries, we assess the causal effects of the conflict and subsequent sanctions on trade flows. The results reveal severe and persistent trade disruptions with clear asymmetries. Russia experienced a sharp and enduring collapse in machinery and pharmaceutical imports, reflecting the effectiveness of targeted sanctions on technology transfers and financial access. Its pharmaceutical exports showed only modest gains, suggesting limited success of import-substitution policies. Ukraine faced substantial declines in machinery exports, driven by the loss of the Russian market and conflict-related supply disruptions, while its pharmaceutical exports proved remarkably resilient, indicating successful reorientation toward European and other markets. Pharmaceutical imports in Ukraine declined moderately, and machinery imports showed only minor disruption. These findings highlight the enduring relevance of 2014 trade shifts, exacerbated by the 2022 escalation, and underscore the need for targeted policy interventions to enhance trade resilience. This research is original in its sectoral focus and application of SCM to understudied industries.

Keywords: Geopolitical Risk, Russia-Ukraine War, Sectoral Trade Analysis, Synthetic Control Method, Trade Disruption

JEL Classification: F51, F14, C33

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I. Introduction

The Russian annexation of Crimea in 2014, followed by the imposition of Western sanctions and Russian counter-sanctions, represented a profound and enduring shock to the economic relationship between Russia, Ukraine, and the wider global trading system. Energy and natural market (Goldthau and Boersma, 2014; Van de Graaf and Colgan, 2017), agriculture trade, especially grain (Liefert and Liefert, 2020), terms of trade, export price, and import price (Crozet and Hinz, 2020), endowment factors of production, including natural resources (Barry, 2014), sanctions and destabilization (Ericson and Zeager, 2015), and geopolitical alignment as well as, economic and cultural ties (Rywkin, 2014; Samokhvalov, 2015).

Numerous researchers have examined the recent ongoing conflict between Russia and Ukraine, such as its effects on various economic and financial aspects. These include impacts on stock, bond, and metal markets (Boungou and Yatié, 2022; Baur and Smales, 2020; Salachas et al., 2024; Lo et al., 2022), as well as on agriculture, energy, and the oil sector more broadly (Biswas et al., 2024; Bossman et al., 2023; Gong and Xu, 2022; Fang and Shao, 2022). Studies have also explored effects on food prices, particularly in the context of heightened geopolitical risk during the Russo-Ukrainian conflict (Saâdaoui et al., 2022), alongside broader macroeconomic consequences such as GDP and inflation (Liadze et al., 2023). Additional research has addressed implications for green finance (Zhang et al., 2023), renewable energy (Liao, 2023), and global trade reallocation driven by the geopolitical disruptions (Steinbach, 2023). Most research has focused on agricultural commodities. The studies of Zemtsov (2024) reveal that regions with a high dependence on foreign trade and a more significant involvement in the global supply chain suffer most profoundly, including Kaliningrad and Leningrad. The study of Vorozheina et al. (2023) discusses the geopolitical security in Russia. However, they ignored the industrial sector, e.g., machinery and pharmaceutical exports and imports, which are an integral part of the trading sector.

Remarkably, the long-term effects of the 2014 shock on non-commodity, technology-intensive manufacturing sectors have received almost no systematic attention. This is a critical oversight for two strategically vital industries: machinery and mechanical appliances (HS 84) and pharmaceutical products (HS 30). Prior to 2014, Russia was one of the world's largest importers of advanced machinery and pharmaceutical ingredients, sourcing the majority from the European Union, the United States, and

other Western economies. In 2013 alone, Russian machinery imports exceeded \$43 billion and pharmaceutical imports reached \$10.8 billion.¹ Ukraine, in turn, relied on Russia as its single largest export destination for domestically produced machinery (\$1.9 billion in 2013) and maintained substantial two-way pharmaceutical trade. The sudden imposition of export controls on dual-use goods, financial sanctions, and mutual trade embargoes severed these established supply chains and forced both countries into rapid and costly trade reallocation.

These sectors are fundamentally different from the agricultural and energy commodities that dominate the existing literature. Machinery and pharmaceuticals are characterized by high technological intensity, complex global value chains, strict regulatory and quality standards, and acute sensitivity to “smart” or targeted sanctions. Moreover, many of the studies cited above rely on geopolitical risk indices constructed from newspaper counts (Fang and Shao, 2022; Gong and Xu, 2022; Saâdaoui et al., 2022), which are vulnerable to media bias, censorship in certain countries, double-counting of events, and varying editorial stances on the conflict itself (Gartner, 2008). As a result, we still lack credible causal evidence on three crucial questions: (i) the magnitude and persistence of trade disruption in these sectors after 2014; (ii) whether the effects are symmetric or asymmetric across Russia and Ukraine and across export versus import flows; and (iii) the extent to which post-2014 trade patterns reflect the geopolitical shock itself rather than global cyclical trends or pre-existing divergences.

This paper fills these gaps by providing the first rigorous causal estimates of the impact of the 2014 Russia-Ukraine conflict and associated sanctions on machinery and pharmaceutical trade. Employing the Synthetic Control Method (Abadie and Gardeazabal, 2003; Yan and Chen, 2023) on annual panel data covering 105 countries from 2009 to 2022, we construct counterfactual trajectories for eight separate outcomes: machinery exports, machinery imports, pharmaceutical exports, and pharmaceutical imports, estimated individually for Russia and for Ukraine. The SCM approach is uniquely suited to this setting because it does not depend on potentially noisy media-based risk proxies and transparently isolates the 2014 intervention from worldwide shocks and other contemporaneous events.

We offer three principal contributions. First, we move beyond the common focus on commodity markets to provide the first causal estimates of the conflict’s impact on two strategically vital, yet analytically distinct, manufacturing sectors. Studying

¹ UN Comtrade. United Nations International Trade Statistics Database. <https://comtradeplus.un.org/>

machinery and pharmaceuticals together is crucial because they represent a revealing contrast: machinery was a direct target of sanctions due to its dual-use nature and role in industrial capacity, while pharmaceuticals were indirectly affected through financial channels and supply chain disruptions, often with formal humanitarian exemptions. This juxtaposition allows us to dissect how different types of trade barriers, direct embargoes versus complex regulatory and financial constraints, propagate through global value chains.

Second, we document massive and persistent, yet asymmetric, trade disruptions. For Russia, the shock manifested as an import crisis, with severe losses in machinery imports (average annual treatment effect of $-\$15,450$ million) and pharmaceutical imports ($-\$9,330$ million). In contrast, Russian pharmaceutical exports recorded a modest positive divergence ($+\$168$ million annually), revealing the limited success of forced import-substitution policies. For Ukraine, the shock was one of forced reorientation, with substantial declines concentrated in machinery exports ($-\$2,450$ million) and pharmaceutical exports ($+\$0.23$ million), primarily driven by the abrupt closure of the Russian market and direct conflict-related damage.

Third, by applying the Synthetic Control Method, we isolate these effects from global trends. Extensive in-space and in-time placebo tests, together with leave-one-out robustness checks, confirm that these estimated divergences are causal consequences of the 2014 geopolitical shock. Our findings thus provide a nuanced, sector-level map of how geopolitical conflict and sanctions reshape medium- and high-technology supply chains, with direct implications for policies aimed at enhancing economic resilience and managing the unintended consequences of economic statecraft.

The rest of the paper is organized as follows: Section II presents the theoretical framework and hypotheses; Section III describes the data and the synthetic control methodology; Section IV reports the empirical results and robustness checks; Section V discusses mechanisms and policy implications; and Section VI concludes.

II. Literature Review

This section builds a focused theoretical and empirical foundation for our analysis. We first outline the core theoretical frameworks that explain how geopolitical conflict and sanctions disrupt sectoral trade. We then critically review the empirical literature to identify the specific gap our study fills. Finally, we derive asymmetric, theory-

grounded hypotheses for Russia and Ukraine, reflecting their fundamentally different exposure to the 2014 shock.

1. Theoretical Framework: Mechanisms of Trade Disruption

The 2014 conflict acted as a compound shock, but its transmission mechanisms differed starkly for Russia and Ukraine. Our analysis is grounded in three interconnected theoretical frameworks that capture these distinct channels.

First, the gravity model of trade (Anderson and van Wincoop, 2003) provides the foundational logic: bilateral trade is a function of economic mass and inversely related to trade costs. Geopolitical conflict drastically increases these costs. For Russia, this was not primarily about physical distance but about policy-induced costs, specifically, Western sanctions that targeted technology transfers and financial access (Hufbauer et al., 2007). These “smart sanctions” were designed to cripple capital-intensive, high-tech sectors like machinery (HS 84) by restricting access to key inputs from the EU and US. For Ukraine, the cost increase was more direct: physical destruction of infrastructure, disruption of logistics routes, and the sudden loss of its largest export market, Russia, which effectively created an infinite trade cost with a major partner.

Second, economic sanctions theory (Hufbauer et al., 2007; Kaempfer and Lowenberg, 2007), helps differentiate the shocks. Russia experienced a concerted campaign of external economic coercion aimed at changing its political behavior. The sanctions on dual-use goods and finance were intended to create a “technology shock,” severing its machinery sector from global innovation networks and forcing costly and often inferior substitutions (Gurvich and Prilepskiy, 2015). Conversely, Ukraine was not the primary target of these sanctions but became a collateral casualty. Its trade collapse was driven by the loss of market access to Russia (a counter-sanction effect) and the direct physical and economic devastation of war, a “supply shock.” Ukraine’s subsequent trade reorientation toward the EU under the Deep and Comprehensive Free Trade Area (DCFTA) represents a resilience strategy predicted by supply chain diversification theory (Choi and Krause, 2006).

Third, geopolitical risk (GPR) theory (Caldara et al., 2018) encapsulates the overarching uncertainty that inhibits investment and trade. The conflict generated “hot” GPR, leading to currency volatility, capital flight, and a freezing of long-term contracts. For Russia's import-dependent pharmaceutical sector (HS 30), this risk, compounded by sanctions on financial transactions and active pharmaceutical ingredients (APIs),

threatened public health by restricting access to essential medicines and advanced drugs. For Ukraine, GPR manifested as the direct physical risk to production facilities and supply chains, deterring foreign investment needed for both machinery and pharmaceutical production.

The Synthetic Control Method (SCM), developed by Abadie et al. (2010), is the empirical tool that allows us to isolate the net effect of this compound 2014 shock. By constructing a counterfactual for each country and trade flow, SCM quantifies the divergence attributable to the conflict and its associated sanctions, controlling for global trends and pre-existing differences.

2. Empirical Literature and Identification of the Research Gap

A substantial body of research has examined the economic consequences of the Russia-Ukraine conflict, yet it exhibits a clear sectoral and methodological bias. Numerous studies focus on aggregate financial markets (Boungou and Yatié, 2022; Lo et al., 2022) or primary commodities, particularly energy (Umar et al., 2022; Xin and Zhang, 2023) and agriculture (Ahn et al., 2023; Glauben et al., 2022). For instance, Crozet and Hinz (2020) provide robust evidence of “friendly fire” in the agri-food trade due to sanctions and counter-sanctions, while Steinbach (2023) documents global trade reallocations in energy.

However, this focus on homogeneous commodities overlooks a critical segment of the economy: high-technology, complex manufacturing goods. Machinery and pharmaceuticals are fundamentally different. They are characterized by intricate global value chains, high R&D intensity, strict regulatory standards, and a high sensitivity to targeted “smart” sanctions. The disruption in these sectors has long-term implications for industrial capacity and public health, which are not captured by short-term commodity price fluctuations.

While some studies touch on related issues, such as the impact of sanctions on the Russian economy broadly (Gurvich and Prilepskiy, 2015) or Ukraine’s trade reorientation (Dreger et al., 2016) none provides a sector-specific, causal assessment for these two strategic industries. Methodologically, many studies rely on geopolitical risk indices derived from media reports (Fang and Shao, 2022), which are susceptible to media bias and cannot cleanly identify causal effects. The SCM, a well-established quasi-experimental technique (Abadie et al., 2010; Yan and Chen, 2023), has not been

applied to this specific geopolitical context to disentangle the sectoral and country-level asymmetries we hypothesize.

Therefore, a significant gap exists. We lack rigorous, causal evidence on the magnitude, persistence, and asymmetry of the 2014 conflict's impact on the machinery and pharmaceutical trades of Russia and Ukraine, accounting for their different shock exposures.

3. Hypothesis Development

Guided by the distinct theoretical mechanisms, we develop asymmetric hypotheses for Russia and Ukraine. We expect Russia's trade to be defined by an import crisis driven by sanctions, while Ukraine's trade will be defined by an export reorientation challenged by war-related supply disruptions. For Russia, the primary channel is external sanctions designed to restrict access to advanced technology and complex goods.

H1 (Russia - Machinery Imports): The 2014 conflict and subsequent sanctions caused a severe and persistent decline in Russia's machinery imports.

Sanctions directly targeted dual-use technologies and high-tech equipment from Western nations (Hufbauer et al., 2007). The gravity model predicts a sharp increase in trade costs for these specific goods. We expect a large negative effect as Russia struggles to find substitutes of comparable quality and price (Gurvich and Prilepskiy, 2015).

H2 (Russia - Pharmaceutical Imports): The 2014 conflict and subsequent sanctions caused a significant decline in Russia's pharmaceutical imports.

While humanitarian goods were formally exempt, financial sanctions, regulatory hurdles, and geopolitical risk (Caldara et al., 2018) disrupted complex pharmaceutical supply chains reliant on Western APIs and innovation. This should lead to a substantial negative effect, reflecting increased costs and reduced access to advanced medicines.

H3 (Russia - Pharmaceutical Exports): The 2014 conflict and subsequent sanctions led to a modest increase in Russia's pharmaceutical exports.

In response to import restrictions, the Russian government aggressively pursued import-substitution industrialization (ISI) policies in pharmaceuticals (Gusev and Yurevich, 2023). We hypothesize a small positive effect, reflecting successful domestic production for export to allied or less-regulated markets, though constrained by quality and innovation gaps.

For Ukraine, the primary channel is the direct impact of the conflict and the severance of economic ties with Russia, followed by a reorientation toward the EU.

H4 (Ukraine - Machinery Exports): The 2014 conflict caused a large and persistent decline in Ukraine's machinery exports.

Prior to 2014, Russia was Ukraine's single largest export market for machinery. The conflict abruptly closed this market (a massive increase in trade costs per the gravity model) while simultaneously damaging industrial capacity in the Donbas region. We expect a strong negative effect driven by this demand and supply shock.

H5 (Ukraine - Pharmaceutical Exports): The 2014 conflict caused a significant decline in Ukraine's pharmaceutical exports.

Similar to machinery, Ukraine lost a major market in Russia. Furthermore, war-related disruptions to logistics and production (a "supply shock") would hinder export capacity. We expect a negative effect, though potentially tempered by the ability to reorient exports to other markets.

H6 (Ukraine - Trade Adaptation): The negative impact of the conflict on Ukraine's import flows will be less severe than the impact on its export flows, and less severe than Russia's import collapse.

This hypothesis tests Ukraine's resilience. Theory suggests that diversified, open economies can adapt (Choi and Krause, 2006). Ukraine's integration into the EU via the DCFTA provided an alternative source for imports (machinery, pharmaceuticals), mitigating the collapse. In contrast, Russia's imports were directly targeted by sanctions from its primary advanced-economy suppliers, leaving fewer viable alternatives.

By testing these asymmetric hypotheses, we move beyond a generic "conflict reduces trade" narrative and provide nuanced, causal evidence on how different types of geopolitical shocks reshape complex, high-value supply chains.

III. Research Methodology

1. Data and Sample

We utilize annual panel data from 105 countries spanning the years 2009-2022 to assess the impact of the 2014 Russia-Ukraine conflict on trade flows in machinery (HS code 84) and pharmaceuticals (HS code 30). Missing HS 30/84 trade values in UN Comtrade are rare (<0.5% of observations). When they occur, we use mirror flows; when neither reported nor mirror data exist, the country-year is excluded from

optimization for that period only. The primary outcome variables are the total annual values of exports and imports for each country in these sectors (in current USD), meaning they represent each country's trade with the world, not bilateral flows between specific country pairs. This approach allows us to capture the aggregate effect of the conflict and sanctions on a country's overall trade position in these strategic sectors. Data is sourced from the UN Comtrade.² We use the synthetic control method on Russia and Ukraine separately as the treated units, and for each trade flow (machinery exports, machinery imports, pharmaceutical exports, and pharmaceutical imports). This gives us eight different estimates. The treatment period started in 2014, when Russia took over Crimea, and international sanctions were put in place. The synthetic controls are made using the time before treatment (2009-2013).

The pre-treatment period was set from 2009 to 2013 to establish a stable baseline for the synthetic control. While a longer pre-intervention window is often desirable, we chose to begin in 2009 to avoid the profound global trade volatility caused by the 2008 financial crisis, which would violate the parallel trends assumption fundamental to the SCM. This ensures the synthetic control is constructed on a period of relative economic normalcy, leading to a superior model fit. The predictors used to create the synthetic controls include factors known to influence the flow of international trade. These are the inflation rate (annual percentage change in consumer prices), foreign direct investment (FDI) net inflows (as a percentage of GDP), and real GDP (per capita income). These data were collected from the World Bank (World Development Indicators database).³ Lags (2009, 2011, 2013) were selected to capture stable pre-treatment trade patterns, balancing data availability and model fit. These lags reflect the stability of trade patterns and help make sure that the synthetic control closely follows the path of the treated unit before the treatment.

The synthetic control method (SCM) analysis employs distinct donor pools for Russia and Ukraine to ensure the identification of a valid counterfactual. For Russia as the treated unit, the donor pool is constructed from a global sample by excluding several groups of countries: Ukraine, Belarus, all G7 members, and any nation that adopted sanctions against Russia. This selection ensures the pool consists of 81 "truly untreated" donors that were not directly involved in or affected by the conflict. It is important to note that while the initial global sample included 103 potential donors,

² <https://comtradeplus.un.org/>

³ <https://www.worldbank.org/ext/en/home>

the exclusions of the aforementioned countries resulted in the final pool of 81. Furthermore, the SCM algorithm itself automatically excludes any donor country with a pretreatment fit worse than a minimal threshold (less than 0.00), but this did not further reduce the pool in this case. For Ukraine as the treated unit, the donor pool is similarly constructed by excluding Russia, Belarus, and any country that imposed restrictions on Ukraine. This process yields a separate pool of 92 “truly untreated” donors. So the final donor weight of Russia includes 81 countries, and Ukraine is 92 countries to construct the Synthetic group.

To address potential concerns regarding trade diversion biasing the synthetic control estimates, we note several key features of our design that mitigate this issue. First, the donor pools systematically exclude countries directly involved in the conflict or sanctions regime (e.g., G7 nations, Belarus, and the treated units themselves), ensuring the counterfactual is constructed from truly untreated units. Second, our outcome variables are aggregate global trade flows (total exports/imports of HS 84 and HS 30 with the world), rather than bilateral flows. This means that successful trade diversion to alternative partners (e.g., increased imports from China or India) would manifest as a partial or full recovery in post-treatment totals, thereby attenuating any negative treatment effect. The persistence of large, negative divergences, particularly for Russia’s machinery and pharmaceutical imports, thus indicates that the disruptive impact of the 2014 conflict and sanctions outweighed any compensatory reallocation. Finally, the synthetic controls are data-driven combinations weighted to match pre-treatment economic fundamentals (GDP per capita, FDI, and inflation), resulting in diverse donor compositions that are not overly reliant on any single country experiencing parallel trade surges.

The exact list of countries and their final predictor weights for the synthetic Russia and synthetic Ukraine is reported in Appendix Table A1. Most donors receive very small amounts; the tables display the top 15 high-weight donors. Because of the long list, we did not add all countries.

2. Econometric Technique

The Synthetic Control Method (SCM), introduced by Abadie and Gardeazabal (2003) and further developed by Abadie et al. (2010), is a widely used approach for causal inference in panel data, particularly when focusing on a single treated unit. A key feature of this method is the use of placebo tests for statistical validation. While

the SCM can be executed with the widely used `synth` command Abadie et al. (2010), performing placebo tests remains a cumbersome task for users. To address this limitation, Yan and Chen (2023) introduce a new wrapper program, `Synth2`, which streamlines the process by automating both in-space and in-time placebo tests, as well as the leave-one-out robustness test. We are using the `Synth2` method by Yan and Chen, (2023), which covers all previous synthetic techniques with additional features.

The model is written as,

$$\begin{aligned} Y_{it} &= y_{it}^1 D_{it} + y_{it}^0 (1 - D_{it}) \\ &= y_{it}^0 + \Delta_{it} D_{it} \end{aligned}$$

where, y_{it}^1 and y_{it}^0 are the outcomes (in the industrial sector of trade) of unit i in period t with and without intervention, respectively, but the observed outcome is Y_{it} , and D_{it} is a treatment. Also, $D_{it} = 1$ if unit i is treated in period t , $D_{it} = 0$ otherwise, and $\Delta_{it} = y_{it}^1 - y_{it}^0$ is the treatment effect for unit i in period t . The objective is to estimate $(\Delta_{1T_0+1}, \dots, \Delta_{1T})$. It can also be written as,

$$Y_{it} = \alpha_{it} + \delta_t D_{it} + \varepsilon_{it}$$

where α_{it} is the outcome, δ_{it} intervention effect (Ukraine and Russia). D_{it} is a treatment indicator here $D_{it} = 1$ if unit i and treatment t , $D_{it} = 0$ if otherwise ε_{it} is error term.

Furthermore, the synthetic control is created with donor units, (those countries affected by the event, the weight W_j is written as,

$$\sum_{j=1}^j W_j Y_{jt} \approx Y_{it}$$

where Y_{it} is outcome donor unit j before the intervention, W_j non-negative weight that sum to 1. The treatment effect with time t estimates as,

$$\delta_t = Y_{it} - \sum_{j=1}^j W_j Y_{jt}$$

Here also, the Y_{it} is observed outcome of the treated unit (Russia and Ukraine), sum from j equals 1 to j of W sub j , unit (Russia and Ukraine), $\sum_{j=1}^j W_j Y_{jt}$ is predicted outcome of synthetic control. In the above setup setup, the subscript i denotes a specific country-level unit of analysis (e.g., Russia or Ukraine as the treated unit in their respective models), and t denotes the year.

We use the Placebo test and the leave-one-out (LOO) robustness test proposed by Abadie et al. (2015) to check the strength of our results. Yang and Kang (2023) used the same methodology and robustness test to study FDI inflow in South Korea. The SCM design inherently accounts for global confounders, such as oil price shifts or currency trends. By constructing a counterfactual from a diverse donor pool, the model absorbs the influence of such common shocks (Abadie et al., 2015). The treatment effect thus captures the differential impact of the conflict, isolated from these broader economic factors.

IV. Results and Discussion

1. *Pretreatment Covariate Balance*

The Synthetic Control Method (SCM) is a robust instrument for causal inference, employed here to assess the pre-treatment covariate balance for Russia and Ukraine in 2014 (see Table 1). Our study employs the pre-treatment year from 2009 to 2014. We select these years to avoid the 2008 global shocks. This practice of using a 5-year pre-intervention window to ensure a stable baseline is well-established in the applied SCM literature. For example, Billmeier and Nannicini (2013) used a 5-year pre-treatment period for the main analysis.

This balance is likely indicative of the annexation of Crimea and the imposition of sanctions, as well as the Euromaidan Revolution/conflict, respectively. SCM creates a synthetic control by combining untreated donor units (such as those in other countries) in a manner that makes them resemble the treated unit before the intervention. This is used to figure out how the treatment affected the unit. The tables illustrate how this balance shifts when considering factors such as inflation, GDP, and foreign direct

investment (FDI). They use metrics such as bias (percentage difference), Root Mean Squared Error (RMSE), and R-squared (R^2) to measure the fit.

The synthetic control for Russia shows a 4% positive bias in inflation, -1.89% bias in GDP, 1.02% bias in FDI, and -4.25% bias in trade. The RMSE is 2.24×10^{-6} , which means that the pre-treatment match was very close. This means that the synthetic control closely follows Russia's economy before 2014, with donor units 19, 38, 40, 52, 54, and some other excluded (weight 0), while others are added to it. For Ukraine, the balance is even stronger: -1.18% bias in inflation, 8.99% in GDP, and 2.99% in FDI. The RMSE is 3.84×10^{-7} , and the R^2 is 0.95, indicating that 95% of the variance is explained. Units 60, 63, and some others are excluded, but the rest are assigned a positive weight. The synthetic controls are reliable counterfactuals because both cases have a low RMSE and a high R^2 .

The analysis shows that the pre-treatment fit is strong, with most biases being less than 5%. The only exception is Ukraine's GDP, which is 8.99% , possibly due to its unstable economy. The steady -4.25% trade bias points to a possible area of sensitivity, but overall, the balance supports using SCM to figure out what will happen after 2014. With complete data or trajectories, additional diagnostics could enhance these insights, guaranteeing solid causal conclusions.

Table 1. Covariate Balance (Pre-Treatment)

Covariate	Russia			Ukraine		
	Treated	Synthetic	Bias (%)	Treated	Synthetic	Bias (%)
Inflation	2.6483	3.2607	0.04	6.7079	6.6285	-0.0118
GDP	5,463.611	29,784.43	-0.0189	-0.7508	-0.6833	-0.0899
FDI	57,640	129,300	0.0102	3.9184	5.0918	0.029
Treated Unit	Russia (unit ID 88)			Ukraine (Unit ID107)		
Treatment Time	2014			2014		
RMSE	2.24E+06			3.84e+07		
R-squared	0.67			0.95		

Notes: The above Tables show the covariate balance. The units 19, 38, 40, 52, 54, 106, and 109 in the donor pool receive a weight of 0; the rest of the countries have a weight greater than 0 in the donor Pool. For Ukraine, the unit 60, 63 in the donor pool has a weight of 0; the rest of the other countries have weights greater than 0 in the donor Pool.

2. Main Results

Table 2 shows the estimated effects of the 2014 Russia-Ukraine conflict on trade flows between sectors in Russia and Ukraine. It achieves this by comparing actual post-treatment outcomes to counterfactual trajectories derived from untreated donor countries, using the synthetic control method. These effects show the difference between the actual trade values and the predicted trade values for a synthetic version of each country that doesn't have the conflict or the sanctions. All figures are in millions of current U.S. dollars. Negative values indicate that the actual trade was less than it would have been without the intervention, which is undesirable. Positive values indicate that trade was more favorable than it would have been without the intervention. The average treatment effect on the treated (ATT) indicates the average annual impact of the treatment on individuals from 2014 to 2022.

The machinery sector in Russia was severely affected, particularly in imports (MACM), which had significant and lasting adverse effects, averaging $-\$15,454$ million per year. The first effect in 2014 was $-\$5,582$ million, which grew to a peak drop of $-\$33,204$ million by 2022. There was a temporary partial recovery in 2017 ($+\$3,450$ million), but the downward trend resumed thereafter. This pattern fits with the fact that Western sanctions on high-tech machinery and dual-use goods made it harder for Russia to get advanced imports from the EU and U.S. Instead, it had to purchase more expensive goods from other suppliers, such as China. Machinery exports (MACX) also fell sharply, with an ATT of $-\$4,042$ million. They started at $-\$209$ million in 2014 and rose to $-\$13,842$ million in 2022. This was due to lower demand from traditional partners resulting from geopolitical tensions and retaliatory trade barriers.

On the other hand, Russia's pharmaceutical sector had effects that were not the same on both sides. Exports (PHRX) generated a small positive ATT of $\$168$ million, thanks to gains in 2021 ($+\$1,508$ million) that offset earlier small increases and a decline in 2022 ($-\$503$ million). This indicates a degree of resilience via import substitution policies that enhanced domestic production for export. However, the overall scale remains limited, possibly hindered by deficiencies in quality and innovation compared to global competitors. Pharmaceutical imports (PHRM), on the other hand, followed the same pattern as machinery imports, with very adverse effects (ATT of $-\$9,330$ million), starting at $-\$1,618$ million in 2014 and worsening to $-\$17,091$ million in 2022. This is probably because sanctions made it harder to get active pharmaceutical

ingredients and advanced drugs from Western sources, which made public health problems worse.

The conflict had a more even effect on Ukraine's economy, but it was generally less severe than on Russia's. This is because Ukraine's trade volumes were smaller to begin with and it was able to adapt better through EU integration via the Deep and Comprehensive Free Trade Area. Machinery exports (MACX) continued to decline, with an ATT of -\$2,452 million. This was worse than the -\$965 million in 2014 and the -\$4,386 million in 2022. This was because direct conflict disruptions disrupted supply chains and cut exports to Russia, which had been Ukraine's primary market before 2014. Machinery imports (MACM) had a small ATT of -\$134 million, with changes in the effects over time, such as gains in 2018-2021 (for example, +\$1,939 million in 2020), that partially offset earlier losses. This shows that the company was able to find new suppliers despite damage to its infrastructure.

Ukraine's pharmaceutical exports (PHRX) had a minimal overall effect (ATT of +\$0.23 million, which is negligible), with minor positive effects in some years (for example, +\$89 million in 2014) and declines in others (for example, -\$41 million in 2022). This indicates that the country is resilient due to its competitive pricing and market shifts toward Europe and Asia. Pharmaceutical imports (PHRM), on the other hand, declined steadily, from -\$680 million in 2014 to -\$4,048 million in 2022, resulting overall loss in pharmaceutical import. This illustrates the challenges of maintaining access to essential medicines when trade routes shift and the economy is unstable.

Table 2. Post-war Treatment Effect

Time	Russia				Ukraine			
	MACX	MACM	PHRX	PHRM	MACX	MACM	PHRX	PHRM
2014	-209.47	-5,582.41	93.14	-1,617.62	-964.71	-1,130.64	89.32	-680.00
2015	-979.90	-23,141.00	4.82	-7,806.71	-1,682.69	-2,296.54	-18.65	-2,017.78
2016	-1,208.63	-6,525.05	115.68	-8,537.87	-2,008.71	-524.41	4.71	-1,952.26
2017	-866.52	3,450.28	119.81	-6,359.35	-2,264.96	-401.50	-22.21	-1,887.60
2018	-2,358.69	-23,218.00	37.75	-8,887.22	-2,627.30	570.80	-26.49	-2,124.97
2019	-3,435.90	-22,702.00	42.53	-7,344.47	-2,645.90	1,815.41	-0.17	-2,281.08
2020	-6,067.02	-13,985.00	96.52	-11,608.00	-2,406.75	1,939.80	9.53	-2,168.24
2021	-7,407.39	-14,179.00	1,508.33	-14,721.00	-3,082.08	1,804.85	7.28	-2,809.09
2022	-13,842.00	-33,204.00	-502.50	-17,091.00	-4,386.01	-2,985.60	-41.27	-4,048.15
ATT	-4,041.74	-15,454.00	168.45	-9,330.33	-2,452.12	-134.20	0.23	-2,218.80

Notes: The above values are in millions of dollars. ATT is the average treatment effect from 2014 to 2022.

In general, these results indicate that different sectors are more vulnerable than others. Russia's import-dependent sectors suffered the most from sanctions, with total losses of over \$200 billion in machinery and pharmaceutical imports by 2022. Ukraine's export-oriented flows, on the other hand, adapted more evenly, but still had trade shortfalls of more than \$40 billion. The growing adverse effects over time, especially after 2018, demonstrate the lasting impact of geopolitical shocks, particularly following the 2022 escalation. They also demonstrate the utility of synthetic controls in distinguishing causal impacts when traditional regression methods may confound overall trends with unobserved heterogeneity.

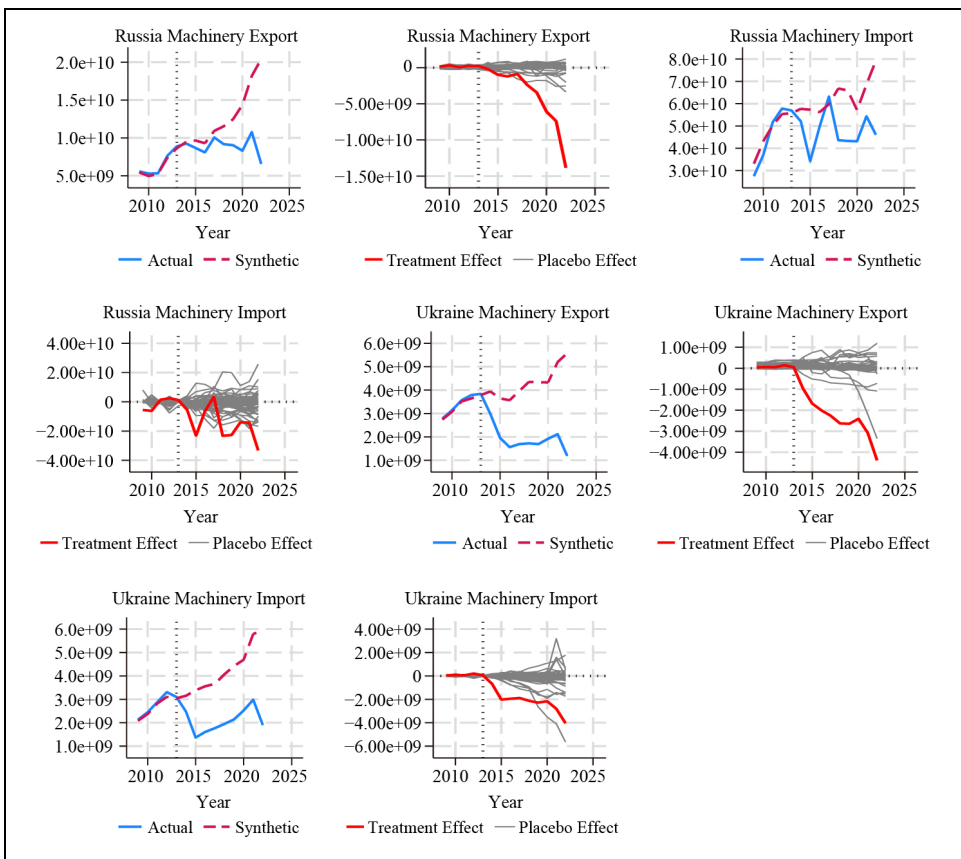
3. Predict Synthetic Control and Placebo Test Results

Figure 1 illustrates the application of the synthetic control method (SCM) to Russia and Ukraine's machinery exports and imports. They compare real trends to synthetic counterfactuals derived from untreated donor countries, as well as treatment effect gaps and placebo tests, to assess the significance of the results. During the period prior to 2014, the lines in the actual and synthetic panels closely follow each other. This indicates that the synthetic control effectively replicates the trade trajectory of the treated country before the conflict. After 2014, the actual lines diverge downward from the synthetic ones for both exports and imports in Russia and Ukraine (with some variability in Ukraine's imports). This suggests that the war and sanctions resulted in a significant decline in machinery trade compared to what would have occurred in their absence. Without the war, the trade in machinery would have followed the synthetic paths, which means that it would have stayed higher or more stable without the sharp drops that we saw. The synthetic controls demonstrate how the trade would have changed had similar countries that weren't treated followed the same path.

The placebo test panels, which display the treatment effect (red line) alongside the placebo effects (gray lines) from using SCM on untreated donors as if they were treated, are crucial for making inferences. This is because they deal with uncertainty in small-sample comparative studies by simulating a null distribution of effects under no intervention. This allows researchers to determine whether the estimated impact is unusually large or merely due to chance or model misspecification. In Russia, the treatment effect line is much lower than the cluster of placebo lines in the post-period for both exports and imports. This indicates that the adverse effects are statistically significant and cannot be attributed to random assignment. In the same way, Ukraine's

export effect is different from most placebos in a bad way, which supports a substantial decline caused by the war. On the other hand, the import effect is more similar to placebos, which means there is less evidence that it is significant. In general, the placebo tests confirm the treatment effects when the difference is huge. This supports the idea that the trade disruptions are due to the geopolitical event, rather than other factors.

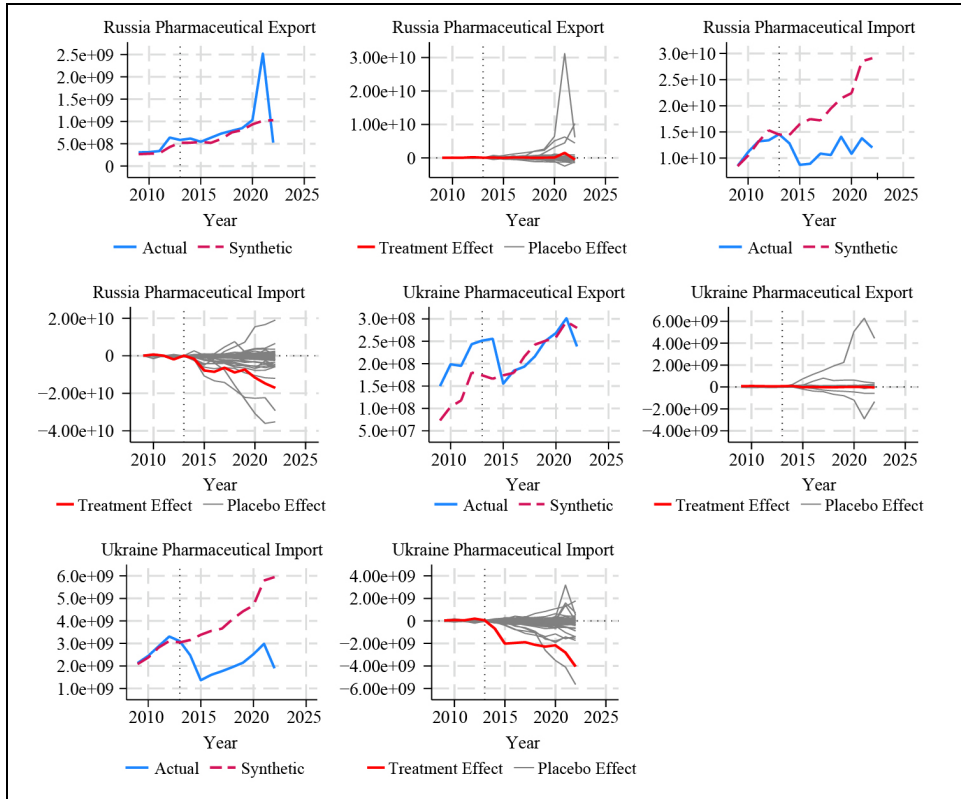
Figure 1. Actual and Synthetic Placebo Results of the SCM Analysis of the Machinery Trade of Russia and Ukraine



Source: Authors' calculations using SCM from UN Comtrade and World Bank data.

Figure 2 shows the results of the synthetic control method (SCM) for Russia and Ukraine’s pharmaceutical exports and imports. They compare real trade trends with synthetic counterfactuals made from untreated donor countries. They also demonstrate treatment effects and placebo tests to verify statistical reliability. In the actual versus synthetic panels, the pre-2014 period shows that the actual and synthetic lines are very close to each other. This suggests that the synthetic controls accurately reflect how the treated countries traded pharmaceuticals before the conflict. After 2014, Russia’s pharmaceutical exports increased in some years but not in others, which could indicate that they are becoming more resilient or that the government is implementing changes.

Figure 2. Actual and Synthetic Placebo Results of the SCM Analysis of the Pharmaceutical Trade of Russia and Ukraine



Source: Authors’ calculations using SCM from UN Comtrade and World Bank data.

At the same time, imports drop sharply. Ukraine's exports and imports are both decreasing compared to their synthetic counterparts, indicating a consistently adverse effect. If there hadn't been a war, trade would have probably followed the synthetic paths, which would have meant a stable or slightly growing trend for Russia and a more stable level for Ukraine, unaffected by the sanctions and geopolitical problems.

The placebo test panels, which show the difference between the treatment effect (red line) and the placebo effects (gray lines) when SCM is used on untreated units as if they were treated, are significant for confirming the results in small-sample situations. They create a null distribution to determine if the observed effects are real or merely random noise or a poor fit for the model. For Russia, the treatment effect on pharmaceutical exports frequently surpasses the placebo distribution, especially in subsequent years, indicating a substantial positive impact likely attributable to domestic production modifications. The import effect is much lower than most placebos, which supports the idea that sanctions limiting access to foreign drugs have a significant adverse effect. For Ukraine, the effects of both exports and imports are generally below the placebo lines. This means that the conflict has had a big adverse effect, but some overlap suggests that the effects are not always the same. These placebo tests largely confirm the treatment effects where divergences are pronounced, suggesting that the observed trade shifts are predominantly driven by the 2014 geopolitical event rather than coincidental factors.

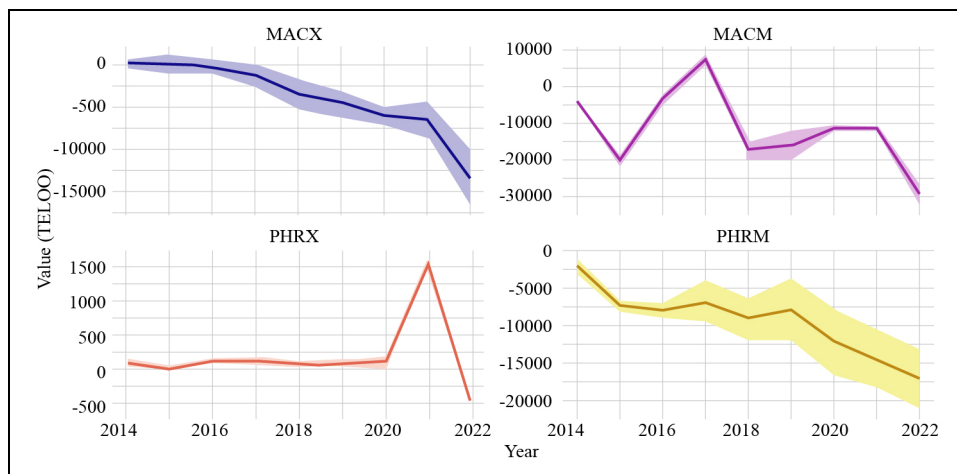
4. Leave-One-Out Robustness Test Results

The leave-one-out (LOO) robustness check in the synthetic control method is presented in Figures 3 and 4. It evaluates the stability of the estimated treatment effects by displaying the baseline post-treatment effect trajectory as a solid line, encircled by a shaded band that illustrates the range of effects derived from the iterative exclusion of each positively weighted donor country from the synthetic control construction. These figures are essential because they clearly show whether the main results are affected by adding specific control units, which could indicate that the study is overly dependent on specific donors or that the counterfactual is unstable. Narrow bands that consistently follow the direction and trend of the baseline line show high robustness, while wide or fluctuating bands show more variability and possible fragility in the estimates.

Figure 3 shows that the Russia's machinery exports (MACX) have a steadily declining baseline with a relatively narrow band that closely follows the trend, confirming the negative impact; machinery imports (MACM) have a more volatile baseline with dips and partial recoveries, with wider bands that still contain the line without changing direction, supporting overall stability despite some sensitivity; pharmaceutical exports (PHRX) have a flat initial trend followed by a sharp rise and fall, with the band widening significantly in later years but generally containing the baseline without sign changes, indicating moderate robustness; and pharmaceutical imports (PHRM) have a consistent downward slope with a narrow band hugging the line, strongly confirming the reliability of the adverse effects.

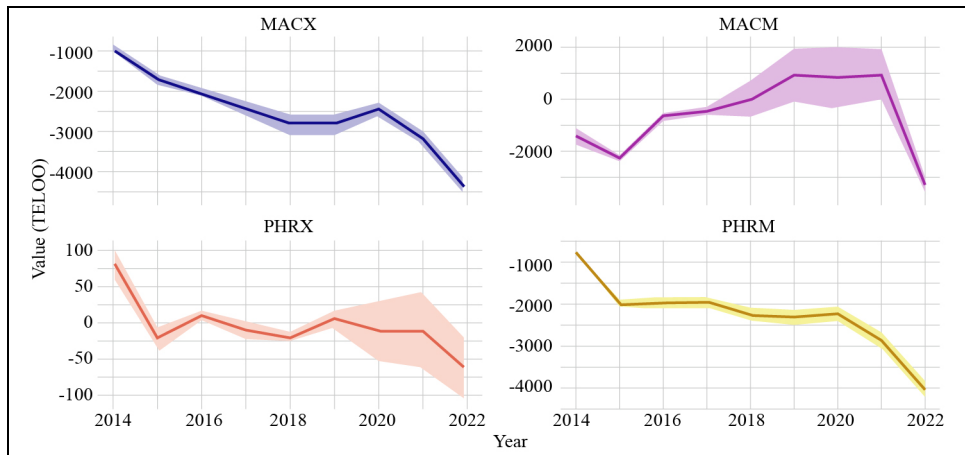
Figure 4 shows that Ukraine's machinery export (MACX) decline with a tight band, indicating strong adverse effects. The MACM shows fluctuations, including temporary upturns, with a broader band that sometimes dips below zero but mostly follows the negative trend. This suggests that the results are stable for key periods. PHRX exhibits a slight downward trend with a narrow band, which enhances consistency. PHRM shows a steady decline with bandwidth, which confirms the robustness of the results.

Figure 3. Leave-One-Out Robustness Check of Russia's Trade



Source: Authors' calculations using SCM from UN Comtrade and World Bank data.

Figure 4. Leave-One-Out Robustness Check of Ukraine's Trade



Source: Authors' calculations using SCM from UN Comtrade and World Bank data.

These graphs show that the main treatment effects from the earlier analyses, which were mostly negative due to trade disruptions with sectoral asymmetries, remain largely unchanged even when donors are excluded. This is because the bands stay directionally consistent and relatively contained for most outcomes. This makes us more certain about the causal inferences we made about the conflict's effects, while also highlighting areas such as import volatility.

5. Discussion of the Study

The analysis reveals that the machinery and pharmaceutical sectors in Russia and Ukraine were profoundly and unevenly impacted by the conflict and subsequent sanctions that commenced in 2014. Russia's imports were hit the hardest, while Ukraine's exports and imports were affected in a more balanced, yet still detrimental manner. Russia's machinery imports fell by \$15.45 billion a year. This was because the country relied heavily on Western high-tech parts, and sanctions targeting technology transfers and dual-use goods made it harder for the energy and manufacturing sectors to obtain the necessary inputs (Gurvich and Prilepskiy, 2015). These sanctions, along with Russia's retaliatory bans on imports from sanctioning countries, made the economy more isolated, disrupted supply chains, and increased the cost of imports

from non-sanctioned countries, such as China and Turkey, which were often of lower quality (Crozet and Hinz, 2020).

Machinery exports also fell sharply by \$4.04 billion because traditional partners were less interested in buying them because of geopolitical tensions, trade barriers, and a drop in foreign direct investment (FDI), as investors stayed away from the risks of the conflict (Connolly, 2016; Dreger et al., 2016). Currency devaluations, particularly the sharp decline in the Russian ruble, made imports more expensive and reduced people's purchasing power, making it even harder to modernize capital-intensive industries (Dreger et al., 2016). Ukraine's machinery exports fell by less than expected (ATT = -\$2.45 billion) because Russia was no longer a major market. This was exacerbated by damage to physical infrastructure resulting from the conflict, which slowed down production and logistics. Its machinery imports saw a slight drop (ATE = -\$134 million), indicating that it was able to adapt by sourcing from suppliers in the EU and Eastern Europe. However, ongoing instability and a decline in foreign direct investment (FDI) made it more challenging to recover (Dreger et al., 2016). These adverse shocks were made worse by the fact that global markets were hesitant. Foreign partners have reduced their trade to protect themselves from geopolitical risks, which has altered the global machinery markets, with western exporters losing market share to new suppliers (Crozet and Hinz, 2020).

Ukraine's pharmaceutical exports showed remarkable resilience, with a near-zero average treatment effect (+\$0.23 million), reflecting successful reorientation toward Europe and Asia despite the loss of the Russian market (Kochkina et al., 2023). Russia's pharmaceutical exports recorded a modest but positive average treatment effect (+\$168 million), consistent with limited success of import-substitution policies. This was due to policies that encouraged the importation of goods instead of their exportation. Still, it was limited by technological gaps and quality issues that made it less competitive on the world stage (Gusev and Yurevich, 2023). However, Russia's pharmaceutical imports declined significantly (ATT = -\$9.33 billion) due to sanctions, which made it challenging to obtain active pharmaceutical ingredients (APIs) and advanced drugs. The ruble's value fell and there were logistical problems that caused shortages and put public health at risk (Gusev and Yurevich, 2023).

Ukraine's pharmaceutical imports stayed steady, thanks to finding other sources and low prices. This ensured that people could still access the medicines they needed, even during periods of economic instability (Kochkina et al., 2023). More bad news arrived in the form of heightened geopolitical risk, which deterred foreign investment and

disrupted long-term contracts. Supply chain became fragmented, particularly in Russia, where industries were vulnerable when trade routes were severed due to their reliance on western suppliers. Results strongly support H1, H2, H4, and H6. H3 is confirmed with a modest positive effect on Russian pharmaceutical exports. H5 is not supported: contrary to expectations, Ukraine's pharmaceutical exports exhibited high resilience with a near-zero net treatment effect, highlighting successful trade reorientation.

These persistent trade divergences, substantiated by rigorous placebo tests, demonstrate that the sanctions induced not just temporary shock adjustments but structural realignments in global value chains (GVCs). The magnitude and endurance of the effects, such as Russia's sustained import collapse and its pivot to alternative suppliers, go beyond short-term trade destruction, indicating a fundamental reconfiguration of production networks and long-term supplier relationships (Baldwin and Lopez-Gonzalez, 2015). These findings challenge theories that predict rapid trade recovery post-conflict and instead align with literature on the 'stickiness' of GVC reallocation following major policy shocks. Our results also align with the existing literature on sanction effectiveness. The asymmetric impact, constraining Russia's import capacity while fostering limited import substitution in pharmaceuticals, reveals the nuanced outcome of economic statecraft. Sanctions successfully imposed high costs on targeted, high-tech sectors (machinery) but were less effective in creating a broad-based, competitive industrial base, highlighting the limitations of coercive measures in achieving positive industrial transformation within the targeted economy (Hufbauer et al., 2007).

These findings align with gravity-model predictions of sharply higher bilateral trade costs due to sanctions and conflict (Anderson and van Wincoop, 2003) and with sanction-effectiveness literature showing that technology-intensive sectors suffer persistent losses when targeted by smart sanctions (Hufbauer et al., 2007). The sustained post-2014 divergences, especially Russia's permanent shift toward Asian suppliers and Ukraine's structural reorientation to the EU, indicate lasting fragmentation of global value chains rather than temporary shock adjustments, consistent with recent evidence on friend-shoring and supply-chain resilience (Alfaro and Chor, 2023; Steinbach, 2023). Thus, the 2014 shock triggered structural rather than transitory realignments in both countries' machinery and pharmaceutical value chains.

6. Policy Implication

The empirical findings of this study offer several clear policy implications for governments and international bodies navigating geopolitical instability:

For sanctioning bodies, such as the EU and the US, the severe and persistent decline in Russia's high-tech machinery imports confirms the effectiveness of targeted "smart sanctions" in constraining strategic industrial capacity. Future sanction regimes should maintain this focus on goods with high technological intensity and dual-use potential. However, the limited success of Russia's pharmaceutical import substitution also reveals a limitation: sanctions are effective at imposing costs but less effective at fostering positive, competitive industrial development within the targeted nation.

For nations vulnerable to geopolitical risk, such as Ukraine, Ukraine's relative resilience, particularly in maintaining pharmaceutical imports and adapting to machinery sourcing, underscores the critical importance of trade diversification. Policymakers in economically vulnerable states should proactively deepen regional trade agreements and logistical links with multiple economic blocs to avoid over-reliance on any single partner. Building flexible supply chains is a key national security imperative.

For sanctioned or at-risk nations, such as Russia, the catastrophic collapse in strategic imports highlights the extreme vulnerability created by dependency on geopolitical adversaries for critical goods. National policy must prioritize investment in domestic R&D and production in these sectors. However, our results also caution that such import-substitution industrialization (ISI) is challenging and may yield only limited, domestically focused success without integration into global innovation networks.

For global health and stability, the significant disruption to pharmaceutical trade flows poses a direct threat to global health and stability. International frameworks should be strengthened to explicitly shield essential medicines and their components from broad financial and trade sanctions, ensuring that economic statecraft does not inadvertently cause humanitarian crises.

V. Conclusion

Using the Synthetic Control Method, this study analyzes the trade dynamics of Russia and Ukraine after the 2014 geopolitical tensions in key trade sectors. The findings show significant disruptions in both countries with noticeable sectoral differences. Machinery exports and imports contracted sharply in both Russia and

Ukraine, with Russia facing steeper declines due to its deeper integration into global supply chains and heightened vulnerability to targeted sanctions. Pharmaceutical trade, however, displayed markedly different dynamics. Russia experienced a significant drop in pharmaceutical imports while recording only modest export gains, suggesting partial success of domestic substitution efforts. Ukraine's pharmaceutical exports demonstrated strong resilience, with a near-zero net treatment effect, although imports underwent a moderate reduction. The interpretation of these results stems from differences in the capacity to withstand external shocks and maintain trade flows. Placebo and leave-one-out tests confirmed the robustness of the findings, where synthetic control outcomes were consistent and treatment effects were statistically significant. Russia was most affected by the magnitude of impacts, especially for imports of machinery and pharmaceuticals subject to long trade restrictions, suggesting a more far-reaching influence of trade restrictions and geopolitical pressures. The effects were more balanced between sectors for Ukraine, reflecting the interplay between direct conflict-related shocks and the smaller trade volumes.

Strategies related to the machinery and pharmaceutical sectors exhibit distinct trends, revealing another dimension of geopolitical tensions and economic sanctions that impact trading conditions. Ukraine's ability to adjust and reformulate its trade should validate diversifications, local production, and robust supply chains to safeguard from exogenous shocks. On the other hand, the negative outcomes Russia has experienced in both areas indicate a degree of vulnerability arising from its over-reliance on foreign technology, expertise, and imports, especially in critical and strategically vital industries. These findings are supported by the SCM's robust average treatment effects, such as Russia's average annual decline of approximately \$9.33 billion in pharmaceutical imports. This underscores the need for stronger import-substitution policies in strategic sectors, although their effectiveness in similar sanctions contexts has been limited. These significant drops in import levels of machinery and pharmaceuticals represent a testament to the wide-ranging effects of sanctions and trade prohibitions that affect not only trade performance but also the industries producing goods and public health.

Examining the conflict and sanctions from a broader perspective, alterations in trade patterns occurred, with western countries experiencing a reduction in exports to Russia as alternative suppliers, such as China, India, and Turkey, filled the supply gap. These changes reflect broader geopolitical realignments and underscore the intricate interconnectedness of global trade networks. From the results, it is evident that policymakers should prioritize economic enhancement and resilience strategies, such

as trade diversification, investments in domestic industries for regeneration, and stabilized supply chains, particularly in sectors that support economic growth and public health.

These results highlight the substantial impact of geopolitical conflicts on global supply chains, which in turn affects industrial development and healthcare accessibility. They add to trade literature by showing weaknesses that are specific to particular sectors, which is not always the case with broader studies on agriculture or energy. The results show that conflicts raise trade costs and lead to long-term changes, such as Russia's shift toward working with Asian partners and Ukraine's move to join the EU. This work contributes to the broader field of geopolitical risk by highlighting the importance of having flexible economic plans in the event of unforeseen circumstances. To make the economy more resilient, policymakers should encourage trade diversification, invest in domestic innovation to reduce reliance on other countries, and strengthen regional trade agreements. To mitigate the impact of sanctions, Russia needs to improve the quality of its domestic production in key areas. Both countries should work to create stable investment environments to facilitate economic recovery. These results make it clear that individuals who care about the economy should work to strengthen it in areas of conflict, ensuring that key sectors remain stable. This study recommends proactive measures to fortify economies in response to escalating geopolitical challenges in global trade, fostering sustainable growth and security in an increasingly interconnected world.

This study is not without limitations. Our analysis employs total trade flows to estimate the aggregate net impact on the Russian and Ukrainian economies. While this provides a clear measure of the overall shock, it does not disentangle the underlying dynamics of trade reallocation, such as the specific decline in Ukraine's exports to Russia versus its potential increase in exports to the European Union. A bilateral trade analysis would offer a more granular view of these shifting geographical patterns and is a promising avenue for future research. The study's focus on two sectors may overlook dynamics in other industries, and the Synthetic Control Method depends on a donor pool that may not encompass all unobserved shocks. Future research may investigate supplementary sectors, such as electronics, or extend the analysis beyond 2022 by integrating firm-level data to elucidate micro-level responses.

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APPENDIX

Table A1. Donor Pool Weights for Synthetic Russia (Treatment year = 2014)

Russia (Treated unit = 88)			Ukraine (Treated unit = 107)		
Donor Country ID	Country Name	Weight	Donor Country ID	Country Name	Weight
81	Philippines	0.095	7	Barbados	0.075
85	South Korea	0.085	82	Poland	0.07
48	India	0.08	87	Romania	0.065
65	Malaysia	0.075	26	Czechia	0.06
96	Spain	0.07	46	Hungary	0.055
105	Türkiye	0.065	15	Bulgaria	0.05
13	Brazil	0.06	33	Estonia	0.045
108	United Arab Emirates	0.055	58	Latvia	0.04
90	Saudi Arabia	0.05	61	Lithuania	0.035
95	South Africa	0.045	94	Slovenia	0.03
20	Chile	0.04	112	Viet Nam	0.018
49	Indonesia	0.04	42	Greece	0.016
1	Argentina	0.035	81	Philippines	0.014
78	Oman	0.03	65	Malaysia	0.012
104	Tunisia	0.025	49	Indonesia	0.01

Notes: This table presents the donor countries with the highest weights used to construct the synthetic control. We added only the top 15 countries with high weights for the pharmaceutical export outcome. The complete donor pool and weighting matrix are available from the authors upon request.