STOCKHOLM SCHOOL OF ECONOMICS
Department of Economics
5350 Master's thesis in economics
Spring 2026

Trade Effects of Economic Sanctions on Russia

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Abstract: Economic sanctions have become a key instrument of geoeconomic policy, yet their effectiveness through trade channels remains contested. This paper examines the effects of sanctions on Russia's trade following the outbreak of the full-scale invasion of Ukraine. Combining structural gravity equations with a computable general equilibrium framework, I assess average, partner-specific and product-level sanction effects. The novelty of this study lies in examining the general-equilibrium trade effects of post-2022 sanctions on Russia using a uniquely granular dataset covering the near-complete universe of Russian trade flows together with disaggregated measures of sanctions, tariffs and non-tariff barriers. Reduced-form estimates show a sharp decline in bilateral trade due to sanctions, amounting to 72 percent across all sanctioning states and 46 percent for the EU. At the same time, I document large increases in trade with non-sanctioning countries driven by declining bilateral trade frictions. Counterfactual simulations show that sanctions significantly reduced EU exports to Russia (by a median of 17–21 percent) while boosting imports from third-party countries (by 10–16 percent), with only a minimal net effect on Russia's total imports. Price-based substitution induced by sanctions accounts for only around a quarter of the observed trade reorientation toward non-sanctioning countries. The evidence suggests that a significant part of the sanction effect is likely explained by non-price factors. Overall, these results underline both the limits of sanctions and the conditions necessary for their effectiveness as a coercive policy tool.

Keywords: economic sanctions, Russia, trade diversion, gravity, CGE modelling

JEL: C68, F13, F14, F17, F51

Supervisor:	Jaakko Meriläinen
Date submitted:	May 18, 2026
Date examined:	May 28, 2026
Discussant:	Tilda Lindén
Examiner:	Céline Zipfel

Acknowledgements

I would like to thank my supervisor, Jaakko Meriläinen, whose support was invaluable throughout the writing process and whose guidance and mentoring extended well beyond this thesis. I am also grateful to Kevin O'Rourke, Yoto Yotov and Dzhamilya Nigmatulina for their advice and assistance in translating my initial ideas into a workable implementation. Finally, I thank Julia Lundquist, Gustav Kjellgren, Ritam Das, Edha Reddy, Amund Martinsen Tandberg, Kseniia Sharnina and Michelle Shajan for their useful comments.

AI Disclosure Statement

This thesis has made use of artificial intelligence (AI) tools, specifically ChatGPT and Claude. These tools were used to assist with writing code in R, refining ideas and proofreading the text. Any AI-assisted output has been carefully reviewed and verified to ensure its accuracy and appropriateness in the context of this work.

Contents

1 Introduction

The onset of a post-liberal world order and the associated rise of geopolitical turbulence have recently sparked a new strand of literature situated at the intersection of geopolitics and economics – geoeconomics (Mohr & Trebesch, 2025) – and one of the primary focuses of these studies has been sanctions. Growing academic interest in sanctions as a geoeconomic tool has coincided with their increased prevalence in foreign policy. According to the Global Sanctions Database (GSDB), the number of active sanction measures in 2023 was three times higher than in 2013 (Yalcin et al., 2025). Indeed, sanctions have become entrenched as one of the primary coercive tools at the disposal of governments around the world. This is particularly true for democracies (Cox & Drury, 2006), as such measures generally represent an attractive alternative to military force, especially when governments pursue human rights and democratisation-related goals (Felbermayr et al., 2020).

However, the effectiveness of sanctions[1] has been hotly debated, both in academic studies and in the media. Historically, the threat of economic embargoes has sometimes been successful in preventing military conflict, for example, in the case of Yugoslavia and Greece in the 1920s (Mulder, 2022). And yet, general estimates suggest that only about a third of sanctions ultimately result in achieving stated goals, and, in the 21st century, this success rate has been on the decline (Felbermayr et al., 2020; Morgan et al., 2014). This question has been complicated further by the increased prevalence of trade reorientation and retaliatory measures such as counter-sanctions, which can undermine the effectiveness of sanctions and inflict non-negligible damage on the sanctioning countries' economies (Berg-Andersson & Kotilainen, 2016; Miromanova, 2023a). Moreover, sanctions may be more difficult to implement in a more globalised world, as a larger coalition may be necessary for a successful sanctions regime (Chowdhry et al., 2024).

Although the direct, bilateral sanction effect on trade between the sanction sender and target is usually unambiguously negative, the overall impact can vary due to traditional general-equilibrium (Crozet & Hinz, 2020; Flach et al., 2024) and extraterritorial effects (Kwon et al., 2024; Yalcin et al., 2025). Indeed, sanctions can be viewed as a price-distorting shock that naturally redirects trade flows, much like when a trade agreement is signed, leading to standard trade diversion. Alternatively, trade flows can be reoriented to bypass such measures, often with the help of government intervention.

[1] It is important to note that the term "sanction effectiveness" is ambiguous, primarily because the stated goals of sanctions are often diverse and not clearly articulated. For the purposes of this study, sanction effectiveness mostly refers to the ability of the sanctioned state to obtain access to sanctioned goods, unless stated otherwise.

This issue has become especially salient after the outbreak of the full-scale Russo-Ukrainian war and the subsequent imposition of sanctions on Russia in 2022. The left panel of Figure 1 shows how Russia's trade with selected sanctioning countries has evolved since 1995. Some of Russia's biggest trading partners, such as Germany, the Netherlands and the US, have drastically reduced their trade after the first sanctions were imposed in 2014-2015, following the annexation of Crimea and the shoot-down of Malaysia Airlines Flight 17. However, they still remained among Russia's largest trading partners. When the full-scale invasion of Ukraine began in 2022, Russia became subject to the most stringent sanctions regime to date, causing trade to plummet.

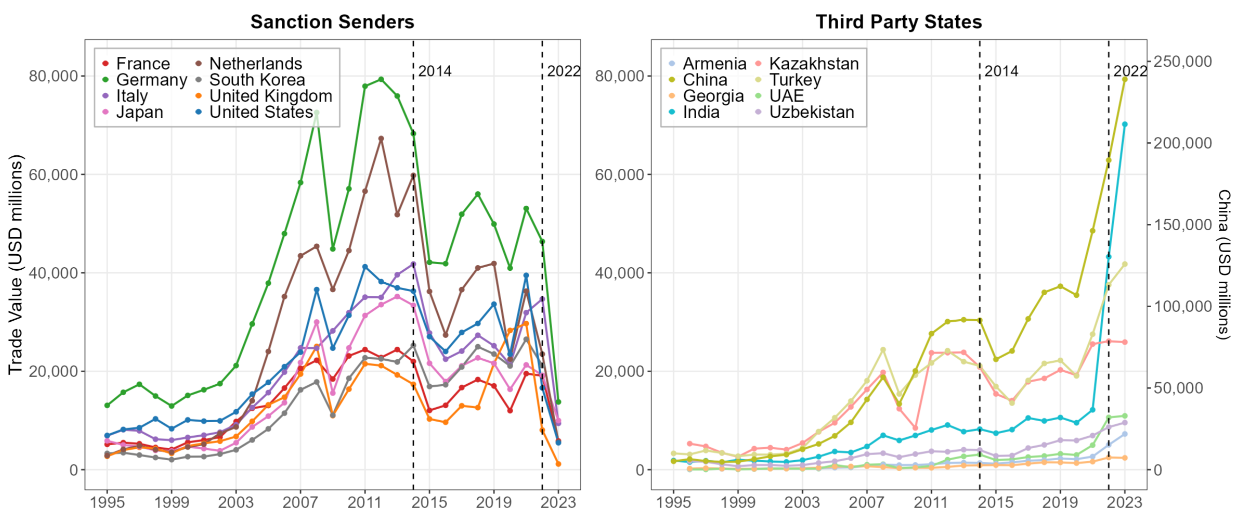

Figure 1: Bilateral Trade of Russia with Selected Sanctioning and Third-Party Countries

Notes: The figure plots Russia's bilateral trade (exports plus imports) with selected partner countries over 1995-2023, measured in current USD millions. Trade values are aggregated from BACI data at the country-year level. Vertical dashed lines mark 2014 (Crimea-related sanctions) and 2022 (full-scale invasion of Ukraine). In the right panel, China is plotted on a secondary axis.

The right panel of Figure 1 shows Russia's trade with several non-sanctioning or third-party countries. Russo-Indian trade, for instance, has experienced a remarkable rise after 2022, and, for many smaller economies like Armenia and the UAE, relative increases have also been significant. Most importantly, the surge in trade ties with China dwarfs any other development, as bilateral trade reached almost US$250 billion in 2023. Even if increased trade with these countries could not fully substitute for Western goods, numerous accounts document successful sanction evasion efforts through so-called "connector" countries such as Turkey, China and states in the Caucasus, Central Asia and the Persian Gulf region (Jijavadze, 2025; Scheckenhofer et al., 2026). These considerations constitute key concerns about the effectiveness of sanctions imposed by the Western-led coalition.

This paper seeks to address these questions and contribute to the growing literature on the impact of sanctions and their effectiveness. Using the case of post-2022 sanctions, I study their effects on Russia's trade in 2022-2023 in complementary partial- and general-equilibrium settings[2]. I first extend the approach of Kwon et al. (2024) and Yalcin et al. (2025) and use the structural gravity equation framework to evaluate the impact on Russian trade overall, as well as to reveal heterogeneity in country responses. The results suggest a large reduced-form negative effect of 72 percent on bilateral trade flows between Russia and sanctioning countries post-2022 and an effect of 46 percent for the EU specifically. However, I also document large positive effects for third-party countries such as India, the UAE, Armenia, China and Saudi Arabia. My identification strategy suggests that such positive effects cannot be attributed to traditional trade diversion and are instead explained by significant decreases in bilateral trade frictions. These estimates, however, are likely to be inflated by non-sanction bilateral disruptions that occurred after 2022 and represent an upper bound on sanction effects per se.

The effectiveness of sanctions, however, cannot be fully evaluated without accounting for general-equilibrium effects. This paper focuses in particular on sanctions that restrict Russian imports. Although such measures may be comparatively less effective from a political-economy viewpoint (given that rents from trade in oil and gas – Russia's primary export revenue sources – are largely captured by the elites), they may have larger implications for overall welfare (Hausmann et al., 2024; Itskhoki & Mukhin, 2025). Moreover, the targeting of dual-use goods imported by Russia constitutes a central pillar of Western-led sanctions policy.

For this purpose, I formulate a theoretical model of the Russian economy and employ computable general equilibrium (CGE) techniques to simulate no-sanctions counterfactuals. In particular, my modelling allows me to capture price-based substitution leading to trade diversion. For the EU, the results suggest median sanction-induced declines of 17 percent in 2022 and 21 percent in 2023. At the same time, however, sanctions contributed to an increase in imports from non-sanctioning countries. Specifically, the effects amounted to 16 percent in 2022 and 10 percent in 2023 for a sample of third-party countries. Overall, sanctions accounted for a quarter of the total change in imports from these countries and had a minimal effect on Russia's total imports. Comparing these results with sanction effects estimated using gravity equations, I conclude that the gap is likely to be explained by

[2] Although I use the terms "partial" and "general" equilibrium, the analysis presented in this paper is not nested in the traditional sense. More precisely, partial-equilibrium results refer to the construction of reduced-form bilateral-friction estimates, while general-equilibrium results refer to the analysis of price-based trade diversion.

factors that do not affect import prices directly, such as (among others) financial sanctions, war-related bilateral frictions and government-facilitated trade deepening.

The CGE design also allows me to exploit the granularity of trade data and derive disaggregated results for specific product groups. This is especially important because the sanctions regime targets trade in specific products, such as strategic goods. I document substantial sanction effects for imports of dual-use goods from the EU, with median declines of 32 percent in 2022 and 50 percent in 2023. My findings suggest, however, that price-based trade diversion led to full substitution by imports from non-sanctioning countries.

This study contributes to the literature in a few ways. First, I present both gravity-based and CGE estimates of the impact post-2022 sanctions had on Russia's trade. To the best of my knowledge, no other study to date has explored the general-equilibrium trade effects of these measures in a granular setting. Second, I assemble a highly disaggregated dataset with comprehensive coverage of important trade measures that affect Russian trade, including sanctions, tariffs and non-tariff measures, and leverage this to present highly granular results. Third, I use an experimental data source to capture the disaggregated nature of sanctions[3]. This is crucial, as sanctions were introduced gradually and significant loopholes remained for much of 2022-2023 (Hausmann et al., 2024; Scheckenhofer et al., 2026).

The remainder of the paper is structured as follows. Section 2 reviews the literature, highlighting the latest developments in empirical research. Section 3 describes the dataset. Section 4 presents the structural gravity equation framework and partial equilibrium results. Section 5 is devoted to the general-equilibrium analysis. It includes a description of the theoretical model used in CGE simulations and discusses the assumed elasticity parameters before presenting counterfactual results. Finally, Section 6 offers an overview and final remarks.

2 Literature Review

Recognising that power, conflict and strategic interests – categories that were traditionally studied by political scientists or international relations scholars – are important factors affecting economic phenomena, scholars in geoeconomics have recently explored the geopolitics of currency reserve formation (Eichengreen et al., 2019), the role of economic dependence in political alignment (Kleinman et al., 2024), as well as the interplay between international

[3]The same data source has been used by Egorov et al. (2025) but without any analysis of partial- or general-equilibrium effects.

trade and geopolitical leverage (Liu & Yang, 2026), among many other topics. Similarly, a closer examination of sanction effects has become increasingly prominent in the economic literature (Felbermayr et al., 2021). This section provides a brief overview of the main recent developments in the scholarship on sanctions, focusing mainly on empirical studies and on studies addressing the effects of sanctions on Russia in particular.

Before turning to studies quantifying the effects of sanctions, it must be noted that a large part of this research is essentially atheoretical. This may be explained by the fact that most theoretical work on why countries impose sanctions and what their effects are has come from the fields of political science and international relations (Hufbauer et al., 1985; Lindsay, 1986; Morgan & Schwebach, 1997; Schwebach, 2000). This literature mostly concludes that sanctions are symbolic devices and are often unlikely to achieve their goals, except under specific conditions (for example, when the target country is small and the goals are modest).

Recently, however, this has changed. In a series of papers by Itskhoki and Mukhin (2023, 2025), as well as Itskhoki and Ribakova (2024), the authors develop theoretical models of trade and financial sanctions. In these models, the effectiveness of trade sanctions hinges on the dependence of the target country on (aggregate) imports[4], the ease of substitution between domestic production and imports, as well as bottlenecks in specific supply chains (similar criteria are identified by Hausmann et al. (2024)). The authors also discuss the symmetrical effects of import and export sanctions, drawing on the concept of Lerner symmetry, which posits that a similar import tariff and an export tax are equivalent in terms of allocational and welfare outcomes. In the case of Russia, the lack of sanctions on Russian exports of oil until late 2022, together with the *promise* of such sanctions in the future, significantly undermined the effectiveness of the sanctions regime and presented a departure from the general logic of Lerner symmetry. Although beyond the scope of this review, the authors also provide a detailed theoretical framework of financial sanctions and their interplay with trade sanctions.

It is important to note that the aforementioned studies argue that nominal variables – such as exchange rates – are not a good proxy for sanction effectiveness. This finding is corroborated by Eichengreen et al. (2024), who test the theory of Itskhoki and Mukhin (2025) empirically in a sample covering the interwar period. An important conclusion of this literature is that, to understand the effectiveness of sanctions, one must primarily consider the effects on real variables reflecting economic activity.

[4]Itskhoki and Ribakova (2024) argue that "it is the aggregate trade share, not bilateral trade shares with specific trade partners, that is generally (but not always) most informative. The ability to substitute goods and input sourcing away from sanctioning coalition to allied and third-world countries grossly limits the effectiveness of sanctions."

The imposition of sanctions also comes with a cost to the sender and hence an inherent trade-off. Among other factors, this cost decreases with the size of the sanctioning coalition (Hufbauer et al., 1985; Itskhoki & Ribakova, 2024). Joshi and Mahmud (2020) adopt a network-based approach and show that the connectedness of both sender and target countries is central to determining the effectiveness of sanctions. They highlight in particular that third-party countries – which are neither senders nor targets – can form alliances with the target, undermining the sanctions regime. The sender can prevent this by blocking such alliances (for example, by threatening with secondary sanctions). However, the success of this crucially depends on which country holds a dominant position in the network. This view is supported by international relations scholars, who posit that the central position of the US and Europe is crucial for weaponising their interdependence with other states (Farrell & Newman, 2019).

Empirical studies have explored the impact of sanctions on a variety of micro- and macro-level variables. For instance, Neuenkirch and Neumeier (2015) examine the impact of UN sanctions and estimate that they decrease the target's GDP per capita growth rate by more than 2 percentage points, while the harshest sanctions reduce it by more than 5 percentage points. Their estimates suggest that the nature of these effects is long-term, with the impact waning only after 10 years. The authors also note that, when sanctions are imposed only by the US, the effect is significantly lower, underscoring the need for a broad coalition even when the sender state is dominant. Neuenkirch and Neumeier (2016) reach similar conclusions with regard to poverty, estimating that being sanctioned increases the poverty rate by about 4 percentage points. They also confirm that this effect increases with the severity of the measures imposed, as well as with multilateral sanctions, and that the impact is long-term. In addition, several studies show that sanctions have unintended consequences for migration (Gutmann et al., 2024), food security (Kwaku Afesorgbor, 2021), infant mortality (Mohammadi-Nasrabadi et al., 2023), informal employment (Kelishomi & Nisticò, 2024), trade in medical supplies (Miromanova, 2024), as well as overall health outcomes (Pintor et al., 2023).

Several researchers have investigated sectoral outcomes of economic sanctions. For instance, Hatipoglu and Peksen (2018) examine the financial sector and show that sanctions increase the probability of banking crises in a broad panel of emerging countries. Dizaji (2021) assembles a panel of Iranian banks covering 2006-2018 and shows that their cost-effectiveness declined under sanctions. Similarly, Itskhoki and Mukhin (2025) remark that the absence of a banking crisis following the imposition of financial sanctions on Russia in 2022 is surprising.

Indeed, sanctions appear to have a significant negative effect on financial flows. However, the duration of such an effect is less clear. For instance, Dizaji and Van Bergeijk (2013) use the sanctions on Iran as a case study to show that the negative impact of an oil boycott on investment and oil rents fades after 2 years. This finding is supported by Mirkina (2018), who shows in a global panel that, even though high-cost sanctions have a negative effect on FDI in the short run, it dissipates in the long run, and most sanction episodes have no significant impact at all. Outside the financial sector, other researchers find evidence of significant negative effects of sanctions on agriculture (Larch et al., 2024) and mining (Larch et al., 2022).

Perhaps surprisingly, the impact of economic sanctions on trade has not been rigorously investigated until recently. Significant progress in empirical evaluations of sanction effects was achieved thanks to the introduction of the GSDB by Felbermayr et al. (2020). Although other sanction databases had been available before, such as TIES (Morgan et al., 2014) and EUSANCT (Weber & Schneider, 2022), the GSDB offers the most comprehensive sanctions database to date. This contribution has enabled many new empirical studies, especially at the macro level.

For instance, Felbermayr et al. (2025) analyse the effects of trade sanctions and find that only complete sanctions decrease trade by more than 70%, while partial sanctions have no significant effect. Zooming in on sanctions against Iran, the authors report significant heterogeneity in country responses. Most notably, they document potential sanction bypassers (for example, China) and even positive sanction effects for some third-party countries such as the UAE. This analysis is complemented by Kwon et al. (2024), who report significant extraterritorial sanction effects for third-party countries. For the case of sanctions against Cuba – a small island nation – these effects are mostly negative due to the threat of a US embargo. This supports the theoretical perspective that sanction evasion efforts enabled by third parties can be prevented if the sender's threats are sufficiently credible. However, the authors also find that extraterritorial effects can be positive for other countries that were economically or geographically close to Cuba.

One would expect a pronounced and abrupt negative sanction effect in the short term: as transportation and transaction costs increase, supply chains are disrupted and overall uncertainty grows. As a result, not only trade between the target and the sender, but also trade with third-party countries may suffer. However, it is not clear that these effects dissipate after the sanctions are lifted, as network linkages take time to recover and supply chains may not necessarily revert to their pre-sanction state. This view is supported by Crozet et al. (2021), who use monthly French export data and employ fixed effects probit models to study several sanction episodes. They show that the introduction of sanctions significantly decreases the likelihood of exporting goods to targeted countries, and these effects do not disappear when the sanctions are lifted. Similar evidence for Danish firms is provided by Jäkel et al. (2024). Kohl (2021) also confirms this finding using the GSDB and disaggregated trade data for the US. Both Crozet et al. (2021) and Kohl (2021) also find some evidence in favour of sanction evasion, as exports are redirected to countries neighbouring the target after sanctions are imposed.

Unsurprisingly, many studies focus on the trade effects of economic sanctions imposed on Russia. Itskhoki and Mukhin (2025) construct a dynamic general-equilibrium model of the Russian economy, accounting for both trade and financial sanctions imposed after 2022. The authors show that the decline in real imports leads to the largest welfare losses, with the effect of import sanctions (i.e., bans on exports of goods from sanctioning countries to Russia) dominating in 2022 and early 2023. Sanctions on exports, however, appear to be more potent in the longer run. The authors estimate the overall welfare effect on the sanctioning coalition to be zero. However, they do not account for potential heterogeneity among senders.

As underscored by the theoretical literature, the size and depth of the sanctions regime are crucial to its success. Hausmann et al. (2024) focus on the impact of sanctions imposed on Russian imports in 2022. They argue that the effectiveness of these measures could be significantly improved by more precisely targeting products for which Russia relied most heavily on the sanctioning coalition, along with improved coordination among the sanction senders. Flach et al. (2024) show in a general-equilibrium setting in the case of post-2014 sanctions that a broad coalition participation and extensive product coverage are imperative for making sanctions economically costly. However, Chowdhry et al. (2024) argue that the horizontal expansion of sanctions (i.e., a broader coalition) would have imposed a larger welfare cost on Russia than vertical expansion (i.e., wider coverage of products) in the aftermath of the 2014 sanctions. In general, and to the best of my knowledge, however, the effects of post-2022 sanctions on Russia have not been studied in a general-equilibrium setting using granular trade data.

Building on Kwon et al. (2024), Yalcin et al. (2025) show that, although the 2022 sanctions on Russia decreased trade flows, the average effect masked significant heterogeneity. Specifically, such countries as India, Turkey and China have expanded their trade with Russia after the imposition of sanctions beyond what would be expected from standard general equilibrium trade diversion effects. Descriptive evidence also suggests that, in 2022-2023, many of the sanctioned products, including dual-use goods, reached Russia through third-party countries, such as China, Turkey, Hong Kong, the UAE, as well as several South Caucasian and Central Asian states (Hilgenstock et al., 2025; Itskhoki & Ribakova, 2024). This is supported by a more robust causal analysis by Scheckenhofer et al. (2025), who use difference-in-differences estimators to show that sanction evasion for military goods took place in 2022-2023. These studies therefore provide additional evidence of potential "leakage" within the sanctions regime, underscoring the importance of both enforcement and a broad coalition to ensure effectiveness.

Micro-level data also allow researchers to study the effects of the so-called "smart" sanctions that target specific entities. Such measures have played an important role in the sanctions regime imposed on Russia since 2014. Ahn and Ludema (2020) use firm and individual-level data and show that targeted sanctions on Russia not only had negative effects on affected firms, but also imposed "shielding" costs on the regime, as strategically important firms had to be protected or even bailed out. Nigmatulina (2025) provides a comprehensive analysis of smart sanctions using data on 2 million Russian firms and shows that, although smart sanctions were very efficient at limiting these firms' imports, they simultaneously experienced significant increases in capital and revenue. Taken together, these findings can be reconciled by accounting for government compensation, indicating a further welfare cost for the target country.

The effectiveness of sanctions has also been debated in light of the increased prevalence of retaliatory measures employed by the target. Miromanova (2023b) uses firm-level customs data to estimate extensive and intensive margin effects of the Russian counter-sanctions implemented after 2014. The author finds a significant negative impact on both margins: an approximately 8% decline in the probability of importing an embargoed product and a 14% decline in the value of import transactions of such products. Consistent with Ahn and Ludema (2020) and Nigmatulina (2025), the author also provides some evidence confirming that government-connected firms suffer less. These results are also supported by the evidence on aggregate-level trade flows (Miromanova, 2023a).

Bělín and Hanousek (2021) find that Russian sanctions imposed on European and American products were about 8 times more severe than those imposed by the EU and the US. Similarly, Berg-Andersson and Kotilainen (2016) calculate a much greater negative effect of Russian counter-sanctions on Finnish food exports than the effect of EU sanctions. Overall, Crozet and Hinz (2020) estimate the total trade losses of the 2014 sanctioning episode and conclude that, in absolute terms, Russia lost only around a quarter more than the Western countries (US$53 billion and US$42 billion, respectively). In relative terms, however, the negative effect on the sanctioning coalition is evidently much smaller. Similarly, Flach et al.

(2024) present a general-equilibrium analysis of post-2014 sanctions and conclude that the negative effect on sanctioning countries is modest. These studies motivate the need to examine the policy responses of both sides when analysing trade flows, especially with regard to counter-sanctions.

Overall, this paper contributes to the literature by studying both partial- and general-equilibrium effects of sanctions imposed on Russia after 2022. As highlighted above, accounting for general-equilibrium effects can significantly change the perception of sanction effectiveness because of both extraterritorial and trade diversion effects. As sanctions often target trade in specific goods, I present product-level results as well. Motivated by the aforementioned studies focusing on the retaliatory measures by the target country, I also account for Russian countermeasures. All this required considerable data collection effort, which I describe in detail in the next section.

3 Data

To study the heterogeneous impact of recent economic sanctions on trade between Russia and other countries, trade data were obtained from the latest edition of the CEPII BACI dataset (Gaulier & Zignago, 2010)[5]. This dataset contains bilateral trade flows in USD reported by year, exporter, importer and product at the six-digit Harmonised System product code (HS-6) level. BACI is based on raw UN Comtrade data but presents a harmonised version of this dataset and addresses two issues. First, both imports and exports are reported FOB (Free on Board), which facilitates the comparison of import and export values. Second, the reliability of data reporting is taken into account when calculating harmonised trade values.

Overall, the granularity of the resulting dataset is high, as trade in 5168 products is reported for each country. Although this is crucial for inference, especially in CGE models (de Bromhead et al., 2019), it makes computations substantially more demanding. For this reason, different aggregation levels of products were tested (HS-6, HS-4 and HS-2 codes) and the fully aggregated level (i.e., without any product-level granularity) was preferred whenever aggregation was feasible and did not impact the results significantly. It is worth noting that, in theory, estimates obtained with the Poisson Pseudo-Maximum Likelihood (PPML) estimator (described in more detail in Section 4.1) are valid in a structural gravity context when using both aggregated and disaggregated data. Specifically, estimates obtained

[5] An alternative approach would entail using raw UN Comtrade data, which would potentially be more suitable for gravity equation estimation (Yotov et al., 2016) but was not feasible within the scope of this project due to data availability.

using aggregated data can be interpreted as a weighted average of estimates obtained using disaggregated data, assuming no differences in product-level trade costs (Breinlich et al., 2024).

The resulting sample covers more than 200 countries between 1995 and 2023, which enables me to evaluate sanction effects across the full universe of trade flows. As argued by Larch et al. (2025), this helps avoid sample selection bias in gravity estimations and improves estimator efficiency. The panel was then balanced by replacing missing trade flows with zeros. Importantly for the purposes of this paper, the sample period includes two years (2022 and 2023) when the latest sanctions on Russia were applied. When estimating gravity equations, consecutive-year panel data were used to improve efficiency and diminish bias related to short- and long-run effects, as argued by Egger et al. (2022). The wide coverage and detailed granularity of the assembled panel also enable detailed CGE analysis.

For reporting and analytical purposes, I arrange goods into seven broad groups based on the HS classification. As sanctions often target products with potential military applications, I classify certain products as high-tech using the Advanced Technology Products classification developed by the US International Trade Administration. I also classify some products as dual-use or economically critical using the respective lists produced by the European Commission. All of these are available in the Data Appendix.

An important trade data concern that needs to be addressed is the reliability and availability of Russian data. Since 2022, Russian authorities have significantly reduced transparency and precluded access to data that were previously publicly available, such as foreign trade statistics. This paper follows the standard approach in both the academic and policy literature and infers Russian imports from export statistics published by Russia's trade partners. Such an approach, however, has limitations – chiefly, export statistics are generally considered less reliable than their import counterparts.

A significant limitation of this dataset is that I cannot discern imports genuinely originating in third countries from imports originating in sanctioning countries that bypass sanctions through "connector" countries. Indeed, available evidence suggests that this was a significant factor in determining the effectiveness of sanctions (Itskhoki & Ribakova, 2024; Scheckenhofer et al., 2025), especially in 2022-2023. Although one potential solution would be to subtract re-exports from observed export figures, doing so would significantly reduce the sample size. Another caveat is that these data do not include transit goods travelling from sanctioning countries to third countries through Russia that never reached their final destination and remained in Russia instead. Recent calculations, however, show that these constituted only a minor share of military good imports (Scheckenhofer et al., 2026). Finally, the dataset does not include any unrecorded or illegal transactions such as smuggling or those accompanied with falsified documentation.

Bilateral data on sanction incidents were obtained from the latest (fourth) release of the GSDB (Yalcin et al., 2025), which contains 1547 sanction cases. When constructing dummy sanction variables, any sanctioning episode between a given pair of countries was coded as 1 for that year, regardless of its duration. Moreover, all types of sanctions were coded as valid sanction episodes, as I assume that other sanction types (for example, financial sanctions) also have significant effects on trade.

These data were further supplemented with disaggregated HS6-level information on products whose exports to Russia were subject to sanctions. Such data were obtained from Alta.ru – a commercial Russian website providing customs consulting services to firms engaged in "foreign economic activity". The main advantage of this source is that, in legal texts, sanctions are often defined either at more detailed levels (HS-10) or through textual descriptions of specific goods. The data presented on Alta.ru are manually matched by experts to the corresponding HS-6 or HS-4 codes. To obtain lists for 2022 and 2023, archived versions of the website were scraped (precise details of this are available in the Appendix). When sanctions are listed at a level broader than HS-6, I assume that they apply to all sub-products within that category. Overall, these data cover only 8 sanctioning entities: the EU, USA, the UK, Japan, Korea, Switzerland, Australia and Canada. Together, however, these countries accounted for 96 percent of Russian imports from all sanctioning countries in 2021, making the coverage nearly complete. Still, this is necessarily an experimental data source with imperfect product-level coverage, which necessitates additional caution when interpreting the results. Nevertheless, this source has been used in recent scholarship on Russian sanctions (Egorov et al., 2025).

One of this paper's contributions is the assembly of a granular dataset covering most of the relevant (and recorded) trade policy measures directly affecting Russia's trade, i.e. tariffs and non-tariff measures (NTMs) imposed by Russia, as well as sanction measures imposed by other countries. Data on effectively applied tariffs, used both in CGE models and in elasticity estimations, were obtained from the International Trade Center, using the Market Access Map tool. Non-ad valorem tariffs were expressed as ad valorem equivalents (among others, this applies to tariff-rate quotas extensively used by Russia), and missing observations were replaced with zeros. The share of trade flows for which tariff data are missing remained around 1.6 percent before the war and increased to around 4 percent after 2022. However, this is unlikely to bias the results significantly, as the increase in the share of missing observations is rather small.

Several studies show that non-tariff measures (NTMs) have a non-negligible effect on trade (Essaji, 2008; Fontagné et al., 2015). Such measures, however, are rarely considered in the literature, mainly due to coverage issues. To account for the impact of NTMs, which may be especially important given Russia's retaliatory measures, I obtain data from the TRAINS database. I then group NTMs into several categories based on the UNCTAD classification (more detail can be found in the Data Appendix). Prohibitions-related NTMs are of the greatest importance for the present analysis, as these are most likely to contain data on counter-sanction measures. Using these data, I construct dummy variables equal to 1 if a country's exports of a specific product were subject to these measures. An important limitation of this dataset is that data collection for Russia only took place in two years: 2016 and 2020. This allows me to capture NTMs that were in place in those years, as well as their implementation dates. However, any measures that were implemented in 2016 or later and were cancelled before 2020 are not included. Moreover, the dataset does not capture NTMs implemented after 2020.

To estimate the gravity equations in Section 4, data on WTO and EU membership were obtained from the Dynamic Gravity Dataset (Gurevitch & Herman, 2018). Data on RTA membership were obtained from the latest edition of the database compiled by Egger and Larch (2008). Additional data were recovered from the Bank for International Settlements and the World Bank. Further details are provided in the Data Appendix.

Having established how the dataset was built, I now turn to estimating the effects of sanctions in a structural gravity equation framework.

4 Partial Equilibrium Effects

4.1 Structural Gravity Equation Framework

The first part of this paper's empirical strategy builds on the work of Kwon et al. (2024) and, especially, Yalcin et al. (2025) that employ the structural gravity framework, a standard technique in the empirical trade literature that is firmly grounded both theoretically and econometrically. In brief, the structural gravity equation decomposes exports X_{ij} from country i to destination j into two terms: size and trade cost:

$$X_{ij} = \underbrace{\frac{Y_i E_j}{Y}}_{\text{size}} \underbrace{\left(\frac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma}}_{\text{trade cost}} \tag{1}$$

As suggested by Yotov et al. (2016), $\frac{Y_i E_j}{Y}$ can be interpreted as a size term, where Y_i is country i's national production, E_j is country j's national expenditure and $Y \equiv \sum Y_i$ denotes global production. In this model, the size term describes the maximum level of trade in the absence of trade costs. In other words, in this hypothetical frictionless world, the share of country j's expenditure on goods produced by country i, i.e. $\frac{X_{ij}}{E_j}$, would be equal to the share of country i in global production, i.e. $\frac{Y_i}{Y}$.

On the other hand, $\left(\frac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma}$ can be interpreted as a trade-cost term. Specifically, t_{ij} governs the bilateral trade costs between countries i and j, such as physical distance or tariffs. Importantly for this paper, the main variable of interest – sanctions – also forms part of t_{ij}. Π_i was termed *outward multilateral resistance* by Anderson and van Wincoop (2003) and essentially describes how easy it is for country i (the exporter) to access all other markets. Similarly, P_j denotes *inward multilateral resistance*, reflecting how easy it is to access country j's (the importer's) market. The coefficient σ is the elasticity of substitution between different varieties – that is, variants of the same good originating from different countries. Assuming $\sigma > 1$, one can easily see that X_{ij} is higher for larger economies with lower bilateral trade costs. It is also important to note that, although Equation 1 is formulated at the aggregate level, the same equation can be derived for sectoral (or product-level) variables (Larch et al., 2025).

The presence of multilateral resistance terms specific to each country motivates the introduction of fixed effects when estimating the gravity equation econometrically. In a panel setting, these take the form of importer-time and exporter-time fixed effects, which control for all country-specific time-varying factors and, by construction, for global shocks affecting all countries in a given year. These can be expanded to importer-product-time and exporter-product-time fixed effects when using disaggregated data (Larch et al., 2025). It is crucial to include the time dimension in the fixed effects, as, conceptually, multilateral resistance terms can vary significantly across industries or countries over time. Furthermore, as bilateral trade costs t_{ij} can be either stable or dynamic over time (for example, tariffs can change, but the distance between countries mostly does not), exporter-importer fixed effects are also warranted. These can be further expanded to include the product dimension if bilateral trade flow data are disaggregated. Following Baier et al. (2019), I allow exporter-importer fixed effects to vary by the direction of trade flows so that the fixed effects for country i exporting to country j and vice versa are two distinct fixed effects. This can account for potential asymmetries in bilateral trade costs, for example, situations when passing customs checks is more difficult on one side of the border.

A remaining issue concerns the time-varying component of bilateral trade costs. Besides sanctions, I use other important determinants of these as controls, following Kwon et al. (2024) and Yalcin et al. (2025). In particular, controls include regional trade agreements (RTA) and membership in trade-facilitating organisations such as the WTO and the EU. It must be noted that trade policy estimates are often subject to endogeneity concerns. In this case, however, the extensive use of high-dimensional fixed effects is likely to mitigate omitted variable bias[6].

Following the seminal work of Santos Silva and Tenreyro (2006), I use the PPML estimator to estimate the gravity equation in the multiplicative form, instead of log-linearising it. This approach ensures that the obtained estimates (i) are consistent with the theoretical gravity equation, (ii) remain consistent in the presence of heteroscedasticity and (iii) perform well when the proportion of zeros in the sample is large (Santos Silva & Tenreyro, 2011). To account for the large number of fixed effects, I use the estimation method developed by Correia et al. (2020) for Poisson regression models. Standard errors were clustered at the country-pair level.

Taking stock of all the considerations listed above, the baseline specification for the gravity equation used in Section 4 is given by Equation 2[7]:

$$X_{ij,t} = \exp\left[\beta \text{Sanction}_{ij,t} + \gamma \text{Controls}_{ij,t} + \pi_{i,t} + p_{j,t} + \overrightarrow{\lambda_{ij}}\right] \times \varepsilon_{ij,t}, \tag{2}$$

where $X_{ij,t}$ denotes the exports of country i to country j in year t, $\text{Sanction}_{ij,t}$ is a sanctions indicator equal to 1 if country i imposes sanctions on country j at time t, $\text{Controls}_{ij,t}$ is a vector of controls (RTA, WTO and EU membership), $\pi_{i,t}$ and $p_{j,t}$ are, respectively, the exporter and importer fixed effects, $\overrightarrow{\lambda_{ij}}$ are directional country-pair fixed effects, and $\varepsilon_{ij,t}$ is the error term.

The main coefficient of interest is β, and, in general, I expect a negative effect of sanctions on trade, i.e. an increase in bilateral trade costs. However, if estimated for third-party countries that did not impose sanctions themselves, β may also be positive (Kwon et al., 2024; Yalcin et al., 2025). In this context, it is important to note that $\text{Sanction}_{ij,t}$ is a vector of dummy variables that is specified to capture the effect of specific sanctions. Moreover,

[6] Furthermore, the 2022 sanctions on Russia were imposed after the full-scale invasion of Ukraine, which was itself unlikely to have been motivated by trade considerations or any other economic factors, and therefore represent an exogenous shock.

[7] The precise mechanism of going from 1 to 2 is as follows. I first log-linearise Equation 1 to obtain $\ln X_{ij} = \ln Y_i + \ln E_j - \ln Y + (1-\sigma)(\ln t_{ij} - \ln \Pi_i - \ln P_j) = (1-\sigma)\ln t_{ij} + \pi_i + p_j - \ln Y$, where π_i and p_j are fixed effects that capture terms specific to i and j, respectively (t subscripts are omitted for convenience). I then add an error term ε_{ij} and exponentiate the equation to get: $X_{ij} = \exp((1-\sigma)\ln t_{ij} + \pi_i + p_j) \times \varepsilon_{ij}$. Note that $\ln Y$ disappears because it is absorbed by π_i and p_j.

interacting these variables with country dummies will also yield country-specific sanction effects.

It is important to note that the estimates obtained in the next subsection represent an inherently crude measure of sanction effects due to several caveats. First, and most importantly, a binary sanction dummy does not differentiate between several factors, such as sanctions per se, national counter-measures, the impact of the war and other important structural transformations occurring in 2022-2023. This is only partially addressed by including country-year fixed effects, as all these processes may have affected bilateral trade costs differently. Second, the sanctions regime has evolved significantly but unevenly since 2022. This is also not captured by models that treat 2022 as a single structural break and present average estimates of a sanction effect. Third, a binary aggregate-level sanction variable does not differentiate between granular effects on different sectors. For these reasons, the preferred interpretation of this partial-equilibrium analysis is that the estimated effects represent reduced-form changes in bilateral trade frictions, which represent an upper bound on sanction effects.

4.2 Gravity Results

I estimate the impact of sanctions on trade flows using Equation 2 and the PPML estimator, largely following the methodology of Yalcin et al. (2025) and Kwon et al. (2024). Table 1 reports the estimation results and focuses primarily on the coefficient β, which captures the effect of sanctions.

Column (1) presents the benchmark specification, which captures the average effect of sanctions imposed on any of the countries in the sample. The estimated sanction effect is negative and statistically significant, but relatively small. More precisely, it indicates that trade between sanctioned and non-sanctioned states decreases by about 13 percent following the imposition of sanctions[8]. The estimated coefficients on the control variables are consistent with expectations. The estimated sanction effect is low but very close to estimates obtained by Kwon et al. (2024) and Yalcin et al. (2025), who note that this may be explained by heterogeneity in sanction measures, not all of which directly affect trade or are equally restrictive. The following columns gradually narrow the focus to Russia and specific time periods, which allows for some comparison.

As a robustness check, identical specifications were estimated using pooled disaggregated

[8] This effect can be calculated as $100 \times (\exp(-0.139) - 1) \approx -13\%$. A similar calculation can be applied to all other coefficients as well.

Table 1: Gravity Estimates of Sanction Effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Any sanction	-0.139***	-0.101***	-0.100***	-0.101***	-0.101***	-0.099***	-0.099***
	(0.032)	(0.035)	(0.035)	(0.034)	(0.034)	(0.034)	(0.034)
Sanctions on Russia		-0.431***	-0.132	-0.117	-0.081	-0.098	-0.117
		(0.081)	(0.113)	(0.113)	(0.100)	(0.101)	(0.113)
Sanctions on Russia after 2014			-0.457***	-0.246***	-0.271***	-0.271***	-0.247***
			(0.080)	(0.065)	(0.063)	(0.063)	(0.065)
Sanctions on Russia after 2022				-1.261***	-0.581**	-0.847***	-1.198***
				(0.167)	(0.252)	(0.153)	(0.213)
EU sanctions on Russia after 2022						-0.616***	
						(0.184)	
Third-party trade with Russia after 2022						0.972***	
						(0.168)	
EU sanctions on imports to Russia after 2022							-0.648***
							(0.229)
Third-party exports to Russia after 2022							0.797***
							(0.221)
Sanctioning Countries							
United States					-1.106***		
					(0.301)		
United Kingdom					-1.238***		
					(0.188)		
European Union					-0.636***		
					(0.203)		
Remaining countries omitted for space							
Third-party Countries							
China					0.924***		
					(0.162)		
Turkey					0.504***		
					(0.186)		
India					1.739***		
					(0.345)		
Remaining countries omitted for space							
RTA	0.083***	0.083***	0.083***	0.083***	0.083***	0.081***	0.083***
	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
WTO	0.093	0.160**	0.148	0.126*	0.137**	0.145**	0.129**
	(0.065)	(0.064)	(0.063)	(0.064)	(0.064)	(0.064)	(0.064)
EU	0.123***	0.115***	0.113***	0.113***	0.114***	0.113***	0.113***
	(0.042)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)	(0.041)
Observations	818,276	818,276	818,276	818,276	818,276	818,276	818,276
Exporter-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Importer-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Directional dyad FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table reports regression coefficients estimated using Equation 2 and the PPML estimator. The outcome variable in all models is bilateral trade flows. Models (1) to (4) separate incrementally the effects of different sanctions on trade. Column (1) presents the effect of any sanctioning episode in the sample, column (2) separates the effect of sanctions on Russia, and columns (3) and (4) further isolate the effect of post-2014 sanctions and post-2022 sanctions on trade with Russia. Column (5) provides estimates of the post-2022 effect for specific countries. Column (6) aggregates sanction effects for the EU and a sample of third-party countries (India, China, Turkey, Iran, Saudi Arabia, UAE, Azerbaijan, Georgia, Armenia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan). Column (7) isolates the sanction effects on Russian imports for the EU and the same sample of third-party countries. All models control for exporter-year, importer-year and directional dyad FE, as well as RTA, WTO and EU membership. The sample includes the whole universe of countries in 1995–2023. Standard errors (in parentheses) are clustered by directional dyad. *, ** and *** denote statistical significance at 10%, 5% and 1%, respectively.

data at HS-4 and HS-2 product levels. This drastically increases the number of observations to around 20 and 110 million, respectively, which complicates computations significantly. However, the estimated β coefficients reported in Appendix Table A4 were only slightly smaller than those obtained using aggregate data, and the difference between them was not statistically significant. Furthermore, including fixed effects of higher dimensions (country-product-year) or clustering standard errors at the dyad-product level yielded very similar results. For these reasons, specifications using aggregate data were preferred for the remaining columns of Table 1.

Column (2) pinpoints the effect of sanctions on Russia by introducing an interaction of the sanction variable with a Russia-specific dummy, independent of whether Russia was an importer or an exporter. Moreover, it is important to note that the interpretation of the "Any sanction" variable changes in this and all following specifications, as its coefficient now captures the effect of sanctions on all countries except Russia. The Russia-specific coefficient is negative and statistically significant, indicating that sanctions reduce trade flows involving Russia by roughly 35 percent, which is significantly higher than for other sanctioned states.

Column (3) introduces a new variable that allows me to narrow the focus down to sanctions imposed after the 2014 annexation of Crimea. Specifically, the new dummy variable takes the value one from 2014 onward, while the general "Sanctions on Russia" dummy becomes equal to zero. As expected, the coefficient on the new variable is very similar to that obtained in column (2), and the coefficient on the general dummy becomes statistically insignificant. This is mainly due to the fact that there were few sanctions on Russia prior to 2014[9], and their trade effect was comparatively small.

The next specification in column (4) adds a dummy variable for sanctions introduced after the 2022 full-scale invasion of Ukraine, constructed analogously to the one in column (3). Here, the estimated effect is substantially larger than for previous sanctions, reflecting the scope and depth of measures imposed in 2022-2023. Specifically, this estimate implies a reduction in trade of roughly 72 percent.

It is well documented that Russia's trade with some countries did not collapse after 2022, but instead expanded, particularly through new trade linkages in Asia and the so-called "connector" countries (Itskhoki & Ribakova, 2024). Column (5) examines this by including interaction terms between country dummies and the "Sanctions on Russia after 2022" dummy. This exercise points to a significant heterogeneity in trade responses following the imposition

[9]There were two episodes coded as sanctions before 2014 in the GSDB dataset. The first refers to military sanctions imposed by Ukraine on Russia in 1996. The second refers to sanctions imposed by Georgia after the Russo-Georgian War in 2008.

of the 2022 sanctions. However, it should be noted that the exact interpretation of these coefficients is less straightforward, as the estimated β coefficients on the country-specific dummy variables are interpreted relative to the reference group consisting of countries for which estimates are not reported. This group is inherently heterogeneous, as it includes both other sanctioning countries and third-party countries.

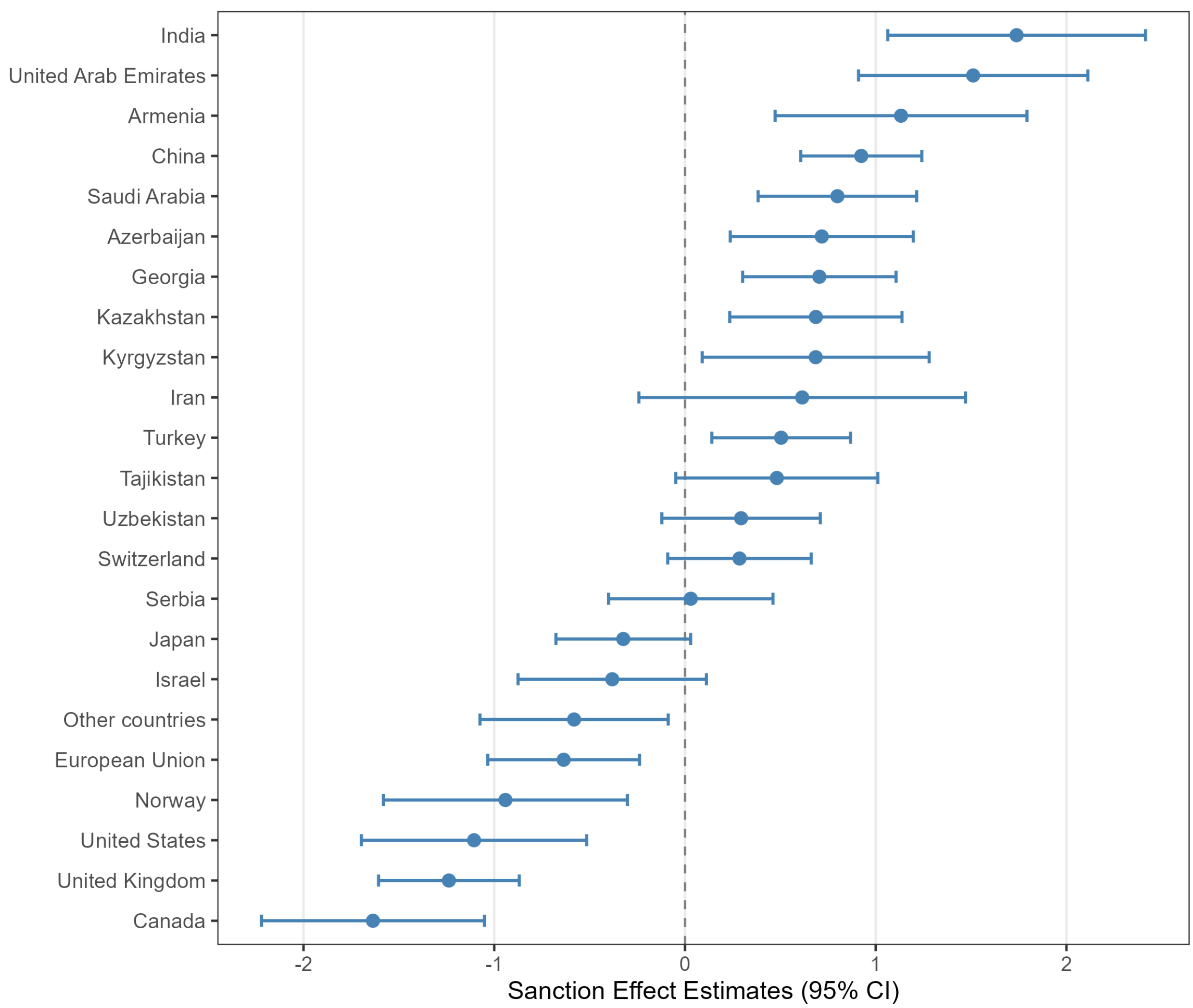

Figure 2: Sanction Effect Estimates of the 2022-2023 Sanctions on Russia

Notes: This figure shows the estimated country-specific post-2022 sanction effects on bilateral trade, obtained from the specification described in column (5) of Table 1. Confidence intervals were constructed using standard errors obtained from the same regression.

Figure 2 presents a visual representation of all estimated country-level sanction effects. It confirms that substantial trade diversion has taken place: while most Western countries experienced declines in trade due to sanctions[10], the same has not been the case for most Asian economies, confirming previous findings (Steinbach, 2023). The choice of particular countries was motivated by their sanctioning activity (for Western states), as well as by their "connector" role, as documented in previous research and policy reports (Bjoertvedt, 2024; Itskhoki & Ribakova, 2024; Mills & Curtis, 2025; Scheckenhofer et al., 2025). In particular, South Caucasus countries (Armenia, followed by Azerbaijan and Georgia), Gulf states (the UAE and Saudi Arabia), as well as China and India – the latter experiencing the largest relative sanction effect – stand out. This aligns with the results of Kwon et al. (2024), who document positive extraterritorial effects of Cuban sanctions for countries geographically or economically close to Cuba.

As I control for multilateral resistance terms, these effects cannot be explained by standard trade diversion that affects all trading partners uniformly, conditional on size. Large positive coefficients therefore suggest a deepening of specific bilateral trade ties and RTA-like reductions in bilateral trade costs. This can be attributed both to sanction evasion (and its facilitation) and to the creation of new trade linkages since 2022. Column (6) then presents aggregated post-2022 sanction effects for the EU and for a sample of third-party countries[11]. Crucially, the "Sanctions on Russia after 2022" dummy now captures the effect of all remaining sanctioning entities. The estimates suggest an about 46 percent decrease in trade with Russia due to sanctions and about a 164 percent increase for third-party countries. The impact on third-party countries, however, is likely to be inflated, as the effect is identified relative to a pre-2022 baseline and may partly be contaminated by pre-existing upward trends, which are apparent for countries such as China and Turkey (Figure 1). These findings should therefore be interpreted as exploratory.

To facilitate comparison with the detailed analysis of sanctions on Russian imports in Section 5, column (7) computes analogous effects for Russian imports from the EU and third-party countries. Importantly, the "Sanctions on Russia after 2022" dummy now captures both the effect of non-EU sanctions on imports and the effect of all sanctions on Russian exports and is therefore not easily interpretable. Estimates suggest a 48 percent decrease in Russian imports from the EU and a 122 percent increase for imports from non-sanctioning third-party countries. Although the caveat on pre-war trends for third-party countries applies here as well, the magnitude of the effect suggests substantial trade reorientation driven by both sanctions and war-induced changes.

[10] Except for Switzerland whose coefficient is positive but statistically insignificant.

[11] The sample of third-party countries consisted of countries with positive sanction effect estimated in column (5), as shown in Figure 2.

As mentioned before, a limitation of my data is that I cannot account for sanction evasion. On the one hand, this implies that the estimated negative effects for sanctioning countries are potentially inflated, as the decrease in reported export flows from Germany to Russia, for instance, does not necessarily imply a decline in German goods reaching Russia of the same magnitude. The effects therefore conflate genuine trade destruction with trade reclassification. On the other hand, however, large positive sanction effects reflect both substitution towards imports from third countries and sanction-evasion efforts. Specifically, in the case of smaller countries such as Armenia and even the UAE, which were unlikely to expand production or significantly reorient trade, the estimated coefficients are consistent with the development of sanction-evasion infrastructure. Even though the precise mechanism behind decreases in bilateral trade frictions is beyond the scope of this paper, the effect may also be explained by the "re-wiring" of supply chains and trade networks, guided by extensive government intervention (Kalvelage & Tups, 2024).

Overall, gravity results highlight the average relative effects of the 2022 sanctions and the heterogeneity of responses across sanctioning and third-party countries. However, for the reasons discussed here and in Section 4.1, these estimates are best interpreted as reduced-form measures of changes in bilateral trade frictions and, therefore, as an upper bound on the effects of sanctions. A key concern is that an aggregate, country-level sanctions dummy conflates several post-2022 effects. Although the inclusion of country-time fixed effects alleviates this issue, it does not account for factors that affect bilateral trade frictions asymmetrically across country pairs. For instance, war-induced logistical frictions are likely to have had a much greater impact on Russia's trade with Poland than on its trade with Kazakhstan. Similarly, financial sanctions imposed after 2022 and Russia's disconnection from SWIFT, which can be viewed as a mechanism distinct from trade sanctions per se, likely affected trade with sanctioning countries more strongly, as alternative financial transfer systems have been used to facilitate payments with other countries (Reuters, 2025).

The next section employs CGE modelling to look at the general structure of Russian trade. By focusing on the import channel in particular, it allows me to obtain a clearer picture of the sanction effect on both absolute values and shares of different countries in Russian imports. Crucially, it also allows me to address the caveats listed above and to inspect the impact of sanctions on specific products, which is of particular importance in the context of sanctions on imports.

5 General Equilibrium Effects

5.1 Theoretical Framework

To assess the impact of sanctions on Russian imports, it is necessary to construct a counterfactual scenario in which no sanctions were imposed. This requires developing a formal framework. In this section, I present a model of the Russian economy and its trade, with particular emphasis on the structure of imports, drawing on the methodology of de Bromhead et al. (2019), Arthi et al. (2024), and Lampe et al. (2025).

The demand side is modelled using a nested utility approach developed by Broda and Weinstein (2006). It features a representative agent maximising a CES utility function with a three-level structure, as shown in Figure 3, subject to the usual budget constraint. The first and highest level of aggregation is represented by Equation 3, which defines the agent's utility U_t at time t:

$$U_t = (\alpha_t D_t^{\frac{\kappa-1}{\kappa}} + (1-\alpha_t) M_t^{\frac{\kappa-1}{\kappa}})^{\frac{\kappa}{\kappa-1}}, \tag{3}$$

where D_t denotes consumption of the domestically produced good at time t, M_t denotes consumption of the composite imported good at time t, κ is the elasticity of substitution between these goods and α_t is the preference parameter associated with D_t.

The second level of aggregation, represented by Equation 4, defines the construction of the composite imported good M_t:

$$M_t = (\sum_{g \in G} \alpha_{gt} M_{gt}^{\frac{\gamma-1}{\gamma}})^{\frac{\gamma}{\gamma-1}}, \tag{4}$$

where M_{gt} denotes consumption of imported good g at time t, γ is the elasticity of substitution among imported goods, G is the set of all imported goods and α_{gt} is a taste parameter for good g at time t.

The third and lowest level of aggregation defines the imported good variable M_{gt} as an Armington aggregate of different varieties of good g, where a variety corresponds to imports of good g from a specific country:

$$M_{gt} = (\sum_{c \in I_{gt}} \beta_{gct} m_{gct}^{\frac{\sigma_g-1}{\sigma_g}})^{\frac{\sigma_g}{\sigma_g-1}}, \tag{5}$$

where m_{gct} is consumption of a variety c of an imported good g at time t, $I_{gt} \subseteq C$ is the

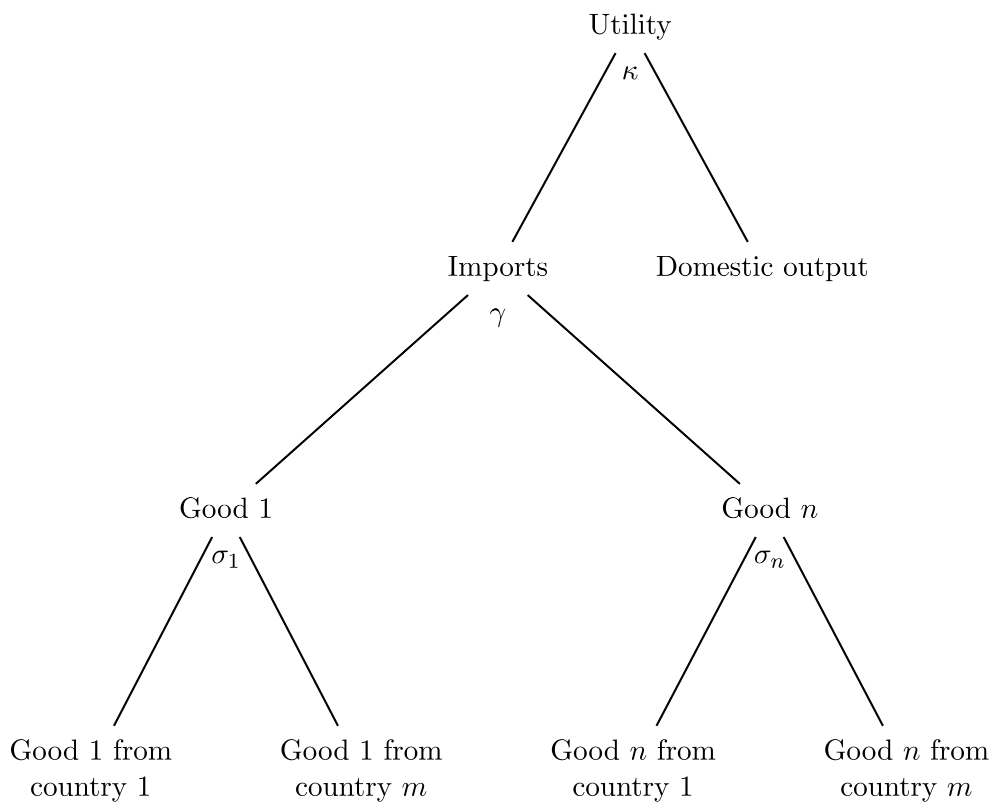

Figure 3: Nesting Structure of the Utility Function

Notes: Figure adapted from de Bromhead et al. (2019).

subset of all countries supplying good g to Russia at time t, C is the set of all countries in the sample, with each country corresponding to a distinct variety, σ_g is the elasticity of substitution among varieties of good g and β_{gct} is a taste parameter for a variety c of good g at time t.

For simplicity, the sets I_{gt} and G_t are assumed to be fixed, i.e. $I_{gt} = I_g$ and $G_t = G$ for all g, t. The extensive margin of trade in the model is therefore constant, which corresponds to the observed data and is justifiable in a short duration of time.

The supply side is governed by a simple model inspired by Anderson and Neary (1996). As data on domestic Russian production are unavailable at the same level of granularity as the import data, a more parsimonious production structure is necessary. The representative agent is endowed with a single factor, GDP_t, which is transformed at time t into two goods – the domestic good D_t and the export good X_t – through a constant elasticity of transformation production function:

$$GDP_t = (\theta_t D_t^{\frac{\eta+1}{\eta}} + (1-\theta_t) X_t^{\frac{\eta+1}{\eta}})^{\frac{\eta}{\eta+1}}, \tag{6}$$

where η is the elasticity of transformation between D_t and X_t and θ_t is the share of domestic production in GDP at time t. Producers maximise $p_{D_t} D_t + p_{X_t} X_t$ subject to Equation 6, where p_{D_t} and p_{X_t} are the prices of the domestic and export goods, respectively. The export good is sold to other countries in order to generate the foreign exchange needed to finance imports.

The domestic prices p^D_{gct} of an imported good g from country c at time t are defined as:

$$p^D_{gct} = p^W_{gct} \times \tau_{gct}, \tag{7}$$

where p^W_{gct} denotes the world price of variety c of good g at time t and $(\tau_{gct} - 1)$ is the ad valorem trade cost, including tariffs, non-tariff barriers and sanctions imposed on imports of good g from country c at time t.

I assume that p^W_{gct} is exogenous and not affected by Russia. Indeed, Russia's GDP was only about a tenth of EU GDP before 2022, so treating Russia as a small economy would not necessarily be inappropriate. However, its size in international energy markets makes such an assumption non-trivial. Itskhoki and Mukhin (2025) argue that, even though a country's exports may influence world prices, the country may still behave as a price-taker, especially in the context of energy markets. Another potential concern is related to the endogeneity of prices in the context of the energy crisis and the subsequent inflation shock. Although this effect is likely to affect Russian exports more strongly, the inflation surge was also translated into higher world prices of Russian imports. However, this issue is alleviated by the fact that the model is calibrated to observed imports, which already reflect the inflation shock. The counterfactual values are therefore calculated using the same world prices. As the aim of this analysis is to estimate the effect of sanctions rather than the effects of the war, this is unlikely to introduce substantial bias.

τ_{gct} can be further defined as follows:

$$\tau_{gct} = \left(\prod_{i=1}^{n} b_i^{\delta_{igct}} \right) (1 + t_{gct}), \tag{8}$$

where $(b_i - 1)$ is the ad valorem equivalent of a non-tariff trade barrier i, δ_{igct} is a dummy variable indicating whether a non-tariff barrier i applies to the imports of good g from country c at time t, and t_{gct} is the ad valorem tariff rate applied to imports of good g from country c at time t. The revenues collected from tariffs, as well as the rents and revenues arising from non-tariff barriers (for example, quotas or licences) and sanctions, are received as income by the representative agent. In particular, rents generated by sanctions reflect implicit rents and producer surpluses that emerge due to scarcity, reduced competition and restricted access to certain goods (for example, via networks or political connections).

At the heart of the model lies the interaction between domestic prices of imported goods p^D_{gct} and their demand. In counterfactual scenarios, I vary τ_{gct} to examine the impact of changes in domestic prices on imports from particular countries. As prices change, the representative agent adjusts consumption of both domestically produced and imported goods, while producers adjust production accordingly. Specifically, I am interested in the effect of sanctions on the volume and structure of Russia's imports in 2022-2023. I evaluate this by setting $\delta_{igc2022} = \delta_{igc2023} = 0$ for all values of i, g and c corresponding to sanction measures in the counterfactual scenarios.

It is therefore important to underscore that this approach models sanctions as a factor affecting prices. Alternatively, and perhaps more naturally, one could view sanctions as an embargo, i.e. a total ban on specific good exports to the target country. As will be shown in Section 5.2, the chosen approach yields an ad valorem estimate of sanctions that is close to a prohibitive tariff. Moreover, this modelling choice reflects the markup paid by Russian importers on goods that continued to flow through official or quasi-official channels at elevated cost. Indeed, the evidence suggests that sanctioned Western goods entered Russia after the imposition of sanctions (Scheckenhofer et al., 2026). However, it must again be noted that the lack of data on sanction circumvention represents an unavoidable limitation of this analysis.

As shown in Broda and Weinstein (2006), aggregate price indices associated with M_t and M_{gt} can be computed using p^D_{gct}. Given data on m_{gct}, τ_{gct} and GDP_t, as well as values for the elasticities (κ, γ, σ_g and η), the remaining parameters (θ_t, α_t, α_{gt} and β_{gct}) can be calibrated. Thus, under the additional standard assumptions of perfect competition, market clearing, and balanced trade, the model can be solved. The next subsection discusses the estimation of the elasticities required for the model.

5.2 Elasticity Estimation

Aside from raw data on imports, trade policy measures and GDP, elasticity parameters are necessary to calibrate the model described above. The exact elasticities chosen have a significant impact on the results, but there is little consensus on their values (Hillberry & Hummels, 2013). In particular, κ and η are important for determing substitution from imports as a whole towards consumption of domestic goods and domestic production, respectively. They do not, however, affect countries' shares in the Russian import structure, as preferences are assumed to be homothetic. Changes in shares are in turn governed by γ and, especially, σ_g. This section provides an overview of how these elasticities were estimated econometrically or selected from the literature. In all cases, I also consider the standard errors of the estimates to account for potential uncertainty.

Estimating σ_g:

According to Hillberry and Hummels (2013), σ_g is "the most important parameter in modern trade theory". Similarly, de Bromhead et al. (2019) show that their results are most sensitive to the choice of σ_g. I follow these authors' methodology and estimate σ_g using a gravity-equation framework, similar to Equation 1. In this case, however, the equation is estimated for trade flows imported into Russia using highly disaggregated product-level data, which does not violate the underlying assumptions of the structural gravity model (Larch et al., 2025). As the left-hand side of Equation 1 is expressed in domestic prices, I follow Baier et al. (2018), as well as de Bromhead et al. (2019), and divide it by τ_{gct} to obtain the world-price version. Using notation described in Section 5.1 and equations 7 and 8, I obtain the following expression after log-linearisation:

$$\begin{aligned} \ln\left(m_{gct}p_{gct}^{W}\right) &= \ln\left(\frac{m_{gct}p_{gct}^{D}}{\tau_{gct}}\right) \\ &= \ln\left(m_{gct}p_{gct}^{D}\right) - \ln\tau_{gct} \\ &= \ln M_{gt} + \ln Y_{gct} - \ln Y_{gt} - \sigma_g \ln(1+t_{gct}) - \sigma_g \sum_{i=1}^{n} \ln b_i \, \delta_{igct} \\ &\quad - (1-\sigma_g)\ln P_{gt} - (1-\sigma_g)\ln \Pi_{gct}. \end{aligned} \tag{9}$$

I then estimate this equation in its multiplicative form using PPML, as described in Section 4.1. I introduce product-year fixed effects (FE) to account for the terms M_{gt}, P_{gt} and Y_{gt}. These control for global product-specific structural changes, crises such as the Covid-19 pandemic and demand shifts across goods. To account for Y_{gct}, I use total exports of good g by country c at time t, as granular production data are unavailable. Although de Bromhead et al. (2019) instead use GDP data for country c at time t, I prefer total exports due to higher granularity. In some specifications, I follow the authors in including bilateral exchange rates as an additional control. It is important to note that Equation 9 is also central to estimating the tariff equivalents of NTMs and sanctions through the coefficient on δ_{igct}.

In an ideal setting, the outward multilateral resistance terms π_{gct} would be controlled for by product-exporter-year FE. This is, however, impossible, in a setting with only one importer. I therefore employ two alternatives approaches. First, I use broader product categories (sectors) to construct sector-exporter-year FE. Specifically, I use HS-2 codes to construct these sectors. These FE account for any exporter-specific sectoral shocks in a given year, such as productivity changes, input cost shocks, policy measures, etc. By construction, they also control for any time-invariant trade cost differences such as geographical factors and historical ties. For robustness, I also collapse the FE to the product-exporter level, implying that the outward multilateral resistance terms do not change over time. As I use data covering only a relatively short period of time when estimating the elasticities (2013-2023)[12], this is not an unreasonable assumption.

Ideally, σ_g would be estimated for all products. However, the dimensions of the dataset do not allow precise estimation at that level of disaggregation. I therefore estimate this elasticity for seven broad product groups: (1) foods, (2) minerals and metals, (3) chemical products, plastics and rubber, (4) leather and textiles, (5) materials, (6) machinery and vehicles, and (7) miscellaneous manufactured articles. Further details are provided in the Data Appendix.

I first perform exploratory analysis to compare different methods for estimating σ using Equation 9, while imposing a common elasticity across all products (Table A5 in the Appendix). As expected, using OLS instead of PPML severely biases the results (Santos Silva & Tenreyro, 2006). Changing the dataset structure from unbalanced to balanced does not have a statistically significant effect on the estimated elasticity. Similarly, clustering standard errors by exporter, exporter-product or exporter-product-year has no substantial impact on inference. As there appears to be no general rule for the level of clustering when estimating structural gravity equations (Larch et al., 2025), I prefer the method yielding the most conservative (largest) standard errors. Overall, my chosen model uses the PPML estimator, a balanced dataset and standard errors clustered by exporter and product.

Table 2 presents the results from different specifications of Equation 9, using the method described above and maintaining a common σ across all g. Model (1) is the most basic specification, using sector-exporter-year FE to account for π_{gct}. As expected, both the logs of tariffs and total exports are statistically significant, and the estimates suggest an average σ value of 1.68. Model (2) is similar to model (1), but introduces product-exporter FE instead. This appears to have a large effect on the estimates, substantially reducing the absolute value of σ and rendering it statistically insignificant. However, omitting exporter-

[12]The period was mainly dictated by computational reasons.

year fixed effects allows the inclusion of several additional controls. In particular, in model (3), the specification is adjusted to control for the bilateral exchange rate, RTA and WTO membership, as well as sanction measures. This substantially alters the results, yielding an estimated σ value of 2. Model (4) introduces both sector-exporter-year and product-exporter FE (in addition to the usual product-year FE). The resulting estimate of σ is very close to the one estimated in model (1). As model (4) yields results very similar to those of model (1) while being substantially more computationally demanding, I prefer the simpler model (1) in the following specifications.

Table 2: Trade Elasticity (σ) Estimations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log of (1+tariff)	-1.675**	-0.789	-2.003**	-1.637**	-1.490**	-1.504**	-1.612*	-1.538**
	(0.738)	(1.657)	(0.929)	(0.650)	(0.691)	(0.686)	(0.903)	(0.689)
Log of total exports	0.983***	1.198***	1.034***	0.960***	0.983***	0.983***	1.023***	0.983***
	(0.019)	(0.087)	(0.033)	(0.022)	(0.019)	(0.019)	(0.033)	(0.019)
NTM: Sanitary measures					-0.225	-0.225	0.004	
					(0.167)	(0.167)	(0.089)	
NTM: Antidumping duties					-0.225	-0.225	-0.163	
					(0.167)	(0.167)	(0.153)	
NTM: Licensing					0.370*	0.338*	-0.531***	
					(0.202)	(0.200)	(0.147)	
NTM: Prohibitions					-0.932**	-0.928**	-1.636***	-0.935**
					(0.428)	(0.427)	(0.222)	(0.411)
NTM: Tariff-rate quotas					-0.167	-0.167	-0.866**	
					(0.452)	(0.452)	(0.345)	
NTM: Shipment formalities					0.371***	0.376***	0.142*	
					(0.130)	(0.131)	(0.081)	
Sanctions (disaggregated)						-0.626***		-0.628***
						(0.145)		(0.145)
Sanctions (aggregated)							-0.466***	
							(0.149)	
N	4,028,520	2,361,435	2,343,671	2,221,251	4,028,520	4,028,520	2,343,671	4,028,520
Sector-exporter-year FE	Yes	No	No	Yes	Yes	Yes	No	Yes
Product-exporter FE	No	Yes	Yes	Yes	No	No	Yes	No
Product-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	No	Yes	No	No	No	Yes	No

Notes: The table reports regression coefficients based on specification 9, exponentiated and estimated using the PPML estimator. The outcome variable in all models is imports to Russia by product, exporter and year. All specifications also include product-year FE. Columns (1)–(3) are the most basic specifications that include tariffs only. Column (1) includes sector-exporter-year FE, where sector is a product group defined at the HS-2 level. Column (2) includes product-exporter FE, and column (3) augments it by including controls for bilateral exchange rates, sanctions, as well as RTA and WTO membership. Column (4) introduces both sector-exporter-year and product-exporter FE. Column (5) introduces NTM measures to the specification of column (1). Column (6) introduces the experimental sanctions variable, disaggregated by product and sender. Column (7) then compares the estimates with the more traditional GSDB sanctions variable and uses product-exporter FE alongside controls, as in column (3). Column (8) then presents the final specification, with disaggregated sanctions and prohibitions as the only NTM variable. The sample includes all exporters to Russia in 2013–2023 and products at the HS-6 level. Standard errors (in parentheses) are clustered by exporter and product. *, ** and *** denote statistical significance at 10%, 5% and 1%, respectively.

Model (5) introduces NTMs. Many of these are collinear with other measures or return statistically insignificant coefficients, or estimates with the conceptually wrong sign, depending on the exact specification used. Including NTMs also reduces the absolute value of σ to around 1.5. In model (6), I further introduce disaggregated sanctions on Russian imports, using data from Alta.ru. The coefficient on the sanctions variable is negative and statistically significant, as expected. To assess the validity of my experimental sanctions data, I then compare these estimates to model (7), where the sanctions indicator comes from GSDB and enters the equation at the aggregate country level. Crucially, this makes it impossible to use sector-exporter-year FE, which are instead replaced with product-exporter fixed effects and time-varying controls. The estimated sanctions coefficient is close to that obtained in model (6), which further supports the use of the disaggregated measure.

My final and preferred model (8) uses disaggregated data on sanctions and prohibitions-related NTMs, together with sector-product-year FE. The choice to include only prohibitions among NTMs in the final specification was motivated by the fact that this was the only NTM category that consistently yielded a precisely estimated negative coefficient across specifications. This aligns with prior expectations, as NTMs coded as prohibitions are most likely to contain data on counter-sanction measures imposed by Russia. Overall, these estimates imply a σ value of 1.54. This value is similar to and just slightly lower than the recent average estimates obtained by Boehm et al. (2023). It is worth noting, however, that it is significantly lower than the original value reported by Broda and Weinstein (2006) for the US from the 1970s to the early 2000s. I also calculate the ad valorem equivalents of post-2022 sanctions and prohibitions, which amount to 50.4 and 83.6 percent respectively[13].

I check the robustness of these results by allowing σ to vary over time (Figure A10 in the Appendix). In principle, substitution may be more difficult in times of crisis, value chain disruption or great economic uncertainty, which would reduce σ. Trade dependence and persistence may also play a role if tariffs are increased abruptly. Lampe et al. (2025), for instance, find that trade elasticities decreased for Canada during the peak of the Great Depression. The results suggest that σ was never statistically significantly different from the previously estimated average value. However, it increased significantly in 2015-2016 to around 3 and decreased sharply in 2022-2023.

Although it is highly likely that both of these sudden changes were caused by Russia's military actions and the international response to that, the fact that the effects differed in direction is puzzling. One potential explanation is that the disruption following the annexation of Crimea resembled a price shock, which necessitated sudden reorientation of

[13] Using Equation 9, these can be calculated for some i as follows: $b_i - 1 = \exp \frac{\sigma_g \ln b_i}{\sigma_g} - 1$, where the numerator comes from the coefficient estimated for δ_{igct} and the denominator is equivalent to the coefficient of $\ln(1 + t_{gct})$.

trade flows. It also coincided with a sharp depreciation of the rouble, which significantly altered import prices. The 2022-2023 shock, by contrast, can be likened to a quasi-total embargo combined with a severe supply constraint. Combined with financial sanctions on Russia, including the exclusion of Russian banks from SWIFT, this may have generated trade frictions so large that reorientation became substantially more difficult. Regardless of the mechanism underlying these differences, it is important to note that the year-specific estimates of σ are considerably less precise than the average values estimated in the other specifications.

Finally, I try to estimate σ at a finer level of aggregation for 21 product groups. Most estimates obtained in this case are statistically insignificant. For this reason, a coarser level of aggregation was preferred. I use model (8) from Table 2 to estimate σ for seven broad product groups (Figure A11 in the Appendix). Although these estimates are also imprecise (for minerals and metals, the point estimate is even positive, albeit statistically insignificant), I use the resulting coefficient values and standard errors in the CGE models. Importantly, I restrict all elasticities to non-negative values. Thus, even if a positive value is drawn from the distribution of a given elasticity, it is replaced with zero.

Selecting γ, κ and η:

The remaining elasticities γ, κ and η are expected to affect the counterfactual country-level results substantially less than σ (de Bromhead et al., 2019). Still, similar to the case of σ, I am interested not only in their point estimates, but also in their standard errors to reflect uncertainty regarding the true values of these parameters.

Following Arthi et al. (2024), I set the elasticity γ, which governs the substitution across imported goods, equal to 1 (with a standard error of zero), implying that Equation 4 takes the Cobb-Douglas form.

Elasticity κ, governing the substitution between domestic and imported goods, is a central parameter in many models used to quantify, for instance, responses to trade policy changes or gains from trade. Bajzik et al. (2020) undertake a systematic analysis of this parameter and provide country-level point estimates of κ, as well as their standard errors. In the baseline CGE model, I therefore use $\kappa = 3.77$, with a standard error of 1.033 estimated by the authors[14].

[14] I also follow the procedure described in de Bromhead et al. (2019) and Arthi et al. (2024) to estimate κ econometrically by regressing imports on total expenditure for domestic and imported goods, exchange rates and aggregated tariff values. These estimates, however, are very imprecise and are therefore not included here. One potential explanation for this is that average tariff rates were gradually decreasing due to Russia's

Lastly, the elasticity of transformation η is important for aggregate counterfactual results, as it governs the ease of switching between the production of domestic and export goods in the model. As shown in de Bromhead et al. (2019), $\eta = \frac{\varepsilon^S}{1-\alpha_X}$, where ε^S is the own-price export supply elasticity and α_X is the share of exports in total production. Since trade is balanced in this model, I can replace α_X with the share of imports in total production (GDP). I then use the point estimate $\varepsilon^S = 0.2$ from Tokarick (2014) together with the standard error calculated for the sample of upper-middle-income countries. Reassuringly, a very similar point estimate of 0.15 is used by the Central Bank of Russia (Turdyeva, 2020), reflecting the difficulty of reallocating productive factors between exporting and non-exporting sectors in the Russian economy.

5.3 CGE Results

This section presents the results of CGE modelling, which allows me to analyse the effects sanctions had on Russian imports through the price channel. It is divided into three subsections focusing respectively on the overall impact of import sanctions, heterogeneity across countries and heterogeneity across product categories.

I calibrate the CGE models to ensure that the benchmark results match the observed data precisely. Given that the counterfactual results depend heavily on elasticities estimated econometrically or drawn from the literature, I follow Hillberry and Hummels (2013) and treat elasticity point estimates as draws from broader distributions. In particular, I assume these parameters are normally distributed. I then perform 500 iterations for each model and draw new elasticity values for each iteration, based on the point estimates and standard errors described in Section 5.2. All estimates obtained from the CGE models are therefore reported using their medians value together with confidence intervals, constructed from the 5th and the 95th percentiles of the simulated outcomes. In box plots, I also report the interquartile range (IQR) using the 25th and the 75th percentiles.

The main counterfactual scenario presented in this section is the no-sanctions scenario. Specifically, this scenario assumes that, although the full-scale invasion occurred in 2022 and all corresponding price shocks materialised, no sanctions were imposed. The benchmark scenario, in turn, refers to the observed dynamics of trade flows, which were influenced by sanctions. This allows me to pinpoint the effects of the sanctions regime on Russian imports and their composition, both in terms of products and trade partners.

accession to the WTO, without noticeably affecting imports directly.

5.3.1 Effect on Total Imports

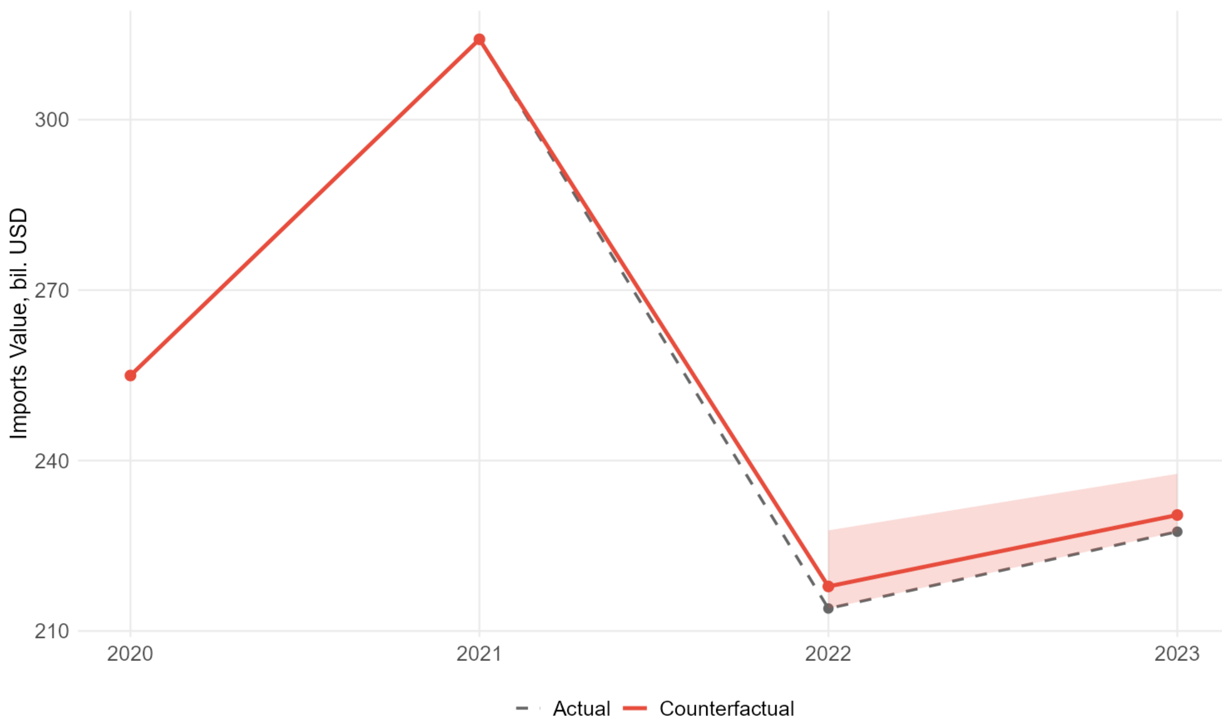

Figure 4: Russia's Total Imports from All Countries

Notes: The figure presents Russia's total imports in benchmark (grey dashed line) and the no-sanctions counterfactual (red line) scenarios. When calculating counterfactual results, 500 iterations were carried out to reflect the uncertainty in elasticity parameters. The red line represents the counterfactual median results, while the shaded area reflects the 90% confidence interval, constructed from the 5th and the 95th percentiles.

Figure 4 shows the modelled sanction effect on total Russian imports. Perhaps surprisingly, the model predicts that sanctions reduced Russian imports by only about 2 percent. This might reflect the geopolitical fragmentation that would likely have emerged after the outbreak of the war even in the absence of sanctions. Alternatively, this could be due to the macroeconomic shock caused by the war, which contributed to falling real incomes and the depreciation of the rouble, especially in the second half of 2022. Another potential explanation is the choice of the η elasticity, the implications of which are explored in Section 5.3.4.

As trade with Western countries collapsed, Russia faced the choice of substituting Western imports with either domestically produced goods or with imports from other, non-sanctioning countries. Because establishing new industries takes time and is difficult, sanctions contributed little to substitution towards domestic production during the early stages of the war in 2022-2023. Crucially, however, the ability to substitute imports from sanctioning countries with imports from alternative supplies depended on the incompleteness of the sanctioning coalition. This points to considerable heterogeneity in trade responses to sanctions across exporters, which is explored in the next subsection.

5.3.2 Country-level Heterogeneity

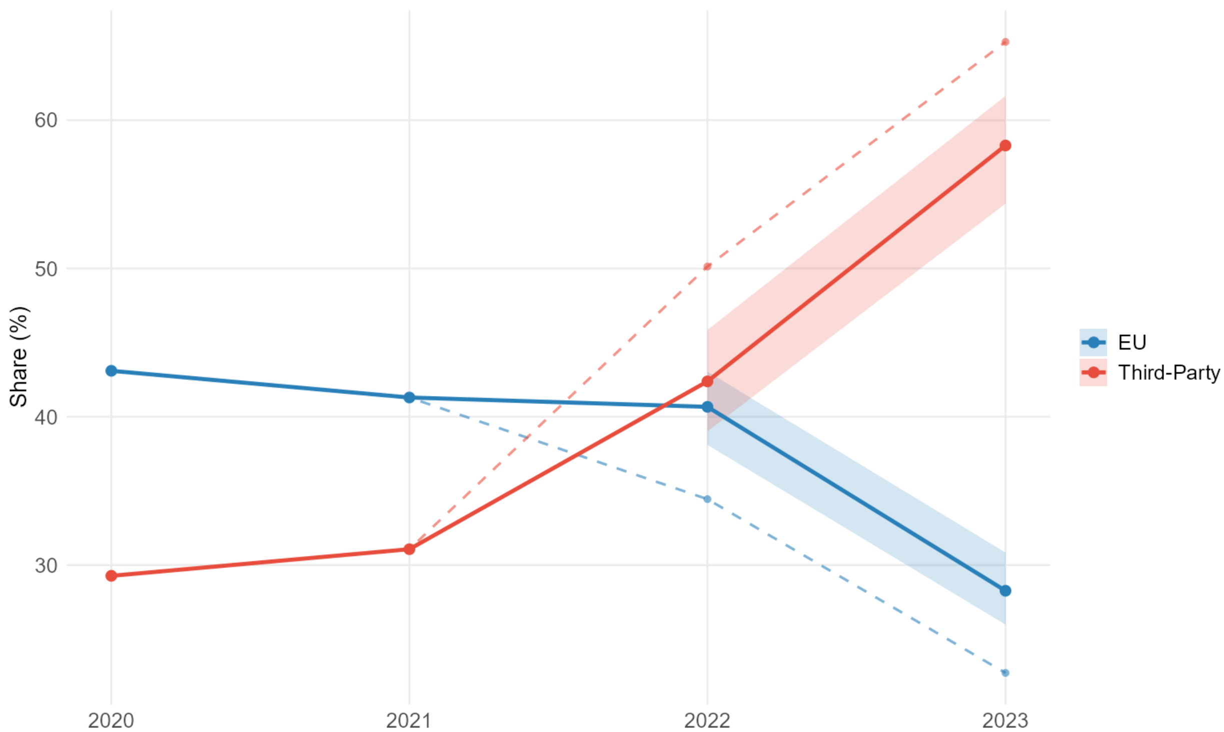

Figure 5: Shares of EU and Third-Party Countries in Russian Imports

Notes: The figure presents the shares of the EU and the sample of third-party countries in Russia's total imports. The set of third-party countries was chosen based on the sanction effect estimates, presented in Figure 2. Dashed lines show actual values, while solid lines represent the median no-sanctions counterfactual results. The shaded areas reflect the 90% confidence intervals, constructed from the 5th and the 95th percentiles.

Figure 5 shows how the shares of the EU and several non-sanctioning countries in Russian imports evolve under the benchmark and no-sanctions scenarios. Countries included in the third-party category did not impose sanctions on Russia after 2022 and, in many cases, acted as "connector" countries, helping Russia bypass the embargo. Specifically, countries with positive sanction-effect estimates identified in Section 4.2 were classified as third-party countries[15].

[15] These include India, China, Turkey, Iran, Saudi Arabia, the UAE, Georgia, Armenia, Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan.

Although the share of the EU decreased sharply in both 2022 and 2023 in the benchmark scenario, the model predicts that it would not decrease in 2022 if sanctions were not imposed. In 2023, the share of the EU would be 5 percentage points higher if sanctions were not imposed: 28 percent instead of 23 percent in the benchmark scenario. In contrast, the share of third-party countries would be about 10 percentage points smaller even in the absence of sanctions. However, it is clear that the share of these countries would still increase even if sanctions were not imposed. This dynamic is remarkably rapid – the share of third-party countries in Russian imports doubles within three years, increasing from just below 30 percent in 2020 to almost 60 percent in 2023 in the counterfactual scenario (as opposed to 65 percent in the benchmark scenario). Sanctions modelled as a price wedge therefore account for roughly 30 percent of the decline in the EU share and 20 percent of the increase in the share of third-party countries between 2021 and 2023.

The effect is even more striking for absolute trade volumes. Figure 6 shows the median sanction effect on EU imports, calculated as $\frac{V_{BM}-V_{CF}}{V_{CF}}$, where V_{BM} refers to imports in the benchmark scenario and V_{CF} refers to imports in the no-sanctions counterfactual scenario (both in absolute numbers). This amounted to a decline of 17 percent in 2022 (with the 5th and 95th percentiles at declines of 10 and 22 percent, respectively) and 21 percent in 2023 (with the 5th and 95th percentiles at 13 and 28). On the other hand, sanctions contributed to higher imports from third-party countries. Median estimates suggest that this effect amounted to 16 percent in 2022 (with the 5th and 95th percentiles at 6 and 28 percent, respectively) and 10 percent in 2023 (with the 5th and 95th percentiles at 4 and 20, respectively). Crucially, median estimates suggest that sanctions accounted for 26 percent of the total change in Russian imports from third-party countries between 2021 and 2023. The analogous metric for the EU stands at 17 percent.

These results, however, mask substantial heterogeneity across countries. Such European countries as Germany, France and Sweden experienced drastic declines in their shares of Russian imports. Although these decreases are smaller in the no-sanctions scenario, the shares still drop (Appendix Figure A12). The same is not true for several other economies, the shares of which increased in both the benchmark and counterfactual scenarios (for example, the Baltic states, Poland) or which experienced reductions in the benchmark scenario but whose shares of Russian imports would not decline in the absence of sanctions (for example, Finland). Relatedly, Hausmann et al. (2024) and Chowdhry et al. (2024) estimate the largest welfare losses from the sanctions regime for the Baltic states (or, more broadly, Eastern Europe in the case of Flach et al. (2024)). This can be explained by the difficulties associated with trade partner substitution, especially in the case of bordering states, for

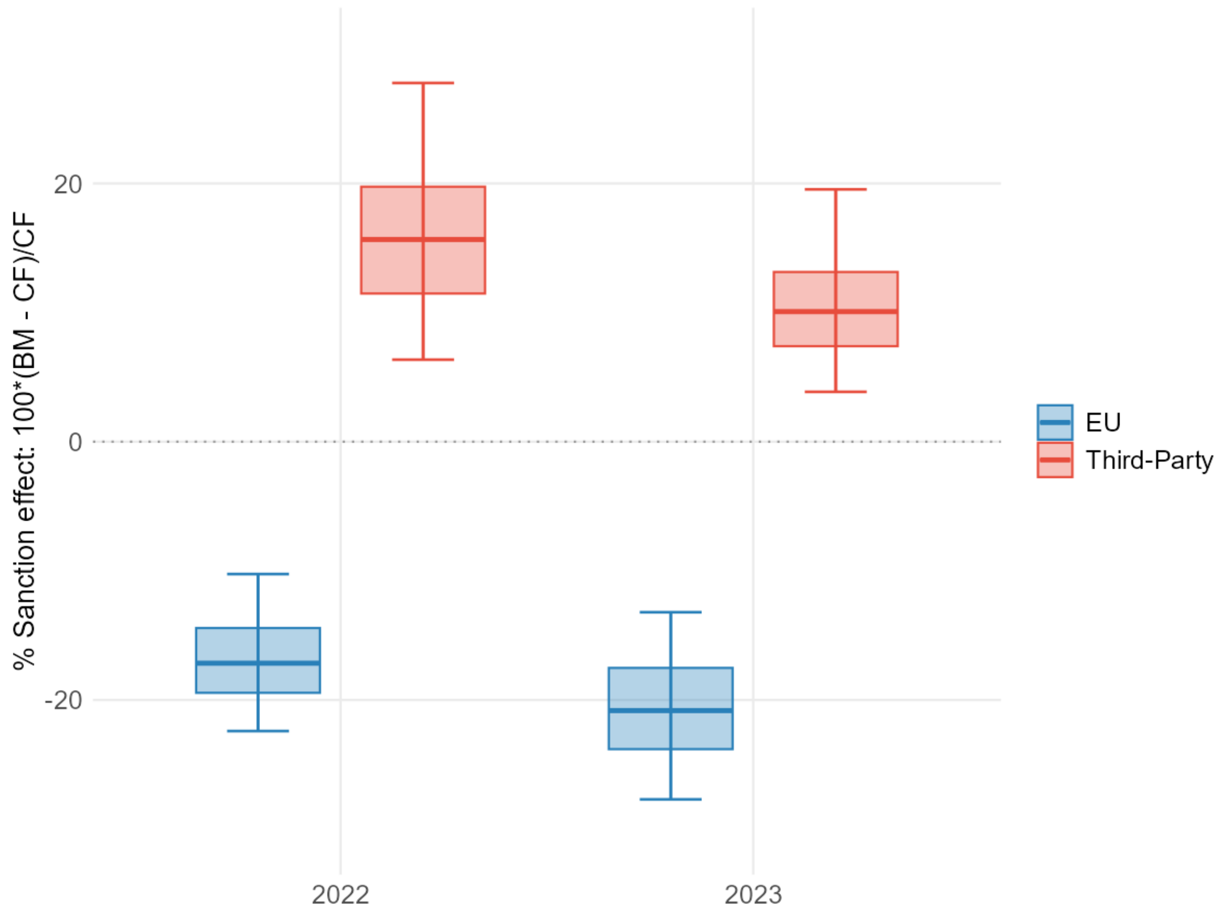

Figure 6: Sanction Effects on Imports from the EU and Third-Party Countries

Notes: The figure presents general-equilibirum sanction effects on imports from the EU and third-party countries. BM refers to actual values, while CF refers to counterfactual ones. The set of third-party countries was chosen based on the sanction effect estiamates, presented in Figure 2. The boxes show median effect values, as well as the interquartile range. The whiskers are constructed using the 5th and the 95th percentiles.

whom Russia had previously been a relatively important trading partner. Indeed, Gavoille (2025) shows that substitution appears to be problematic for firms most exposed to Russia in the Latvian case. My model predicts that Latvia's share in Russian imports would double in the no-sanctions scenario relative to the 2021 level, and that the share would decline only marginally even in 2023, notwithstanding the general EU trend.

It is clear, however, that sanctions had a negative effect on imports from sanctioning countries. Figure 7 presents the distributions of all modelling results for 2022 and 2023 combined. In general, the effect amounted to a decline of around 20 percent for most EU countries. Countries such as Latvia, whose shares in Russian imports increased in 2022, therefore captured a larger share of a shrinking import market. At the same time, the sanction effects are estimated to be significantly larger for Finland and the Baltic States in 2023 (Appendix Figure A14), which provides further evidence in favour of the delayed substitution phenomenon. It is important to note that dynamics differed for other sanctioning entities: the UK sanctions had a similar effect in 2022 but decreased to 0 percent in 2023, while the sanction effects are estimated to be substantially larger for the US, with reductions of around 30 percent in 2022 and more than 40 percent in 2023.

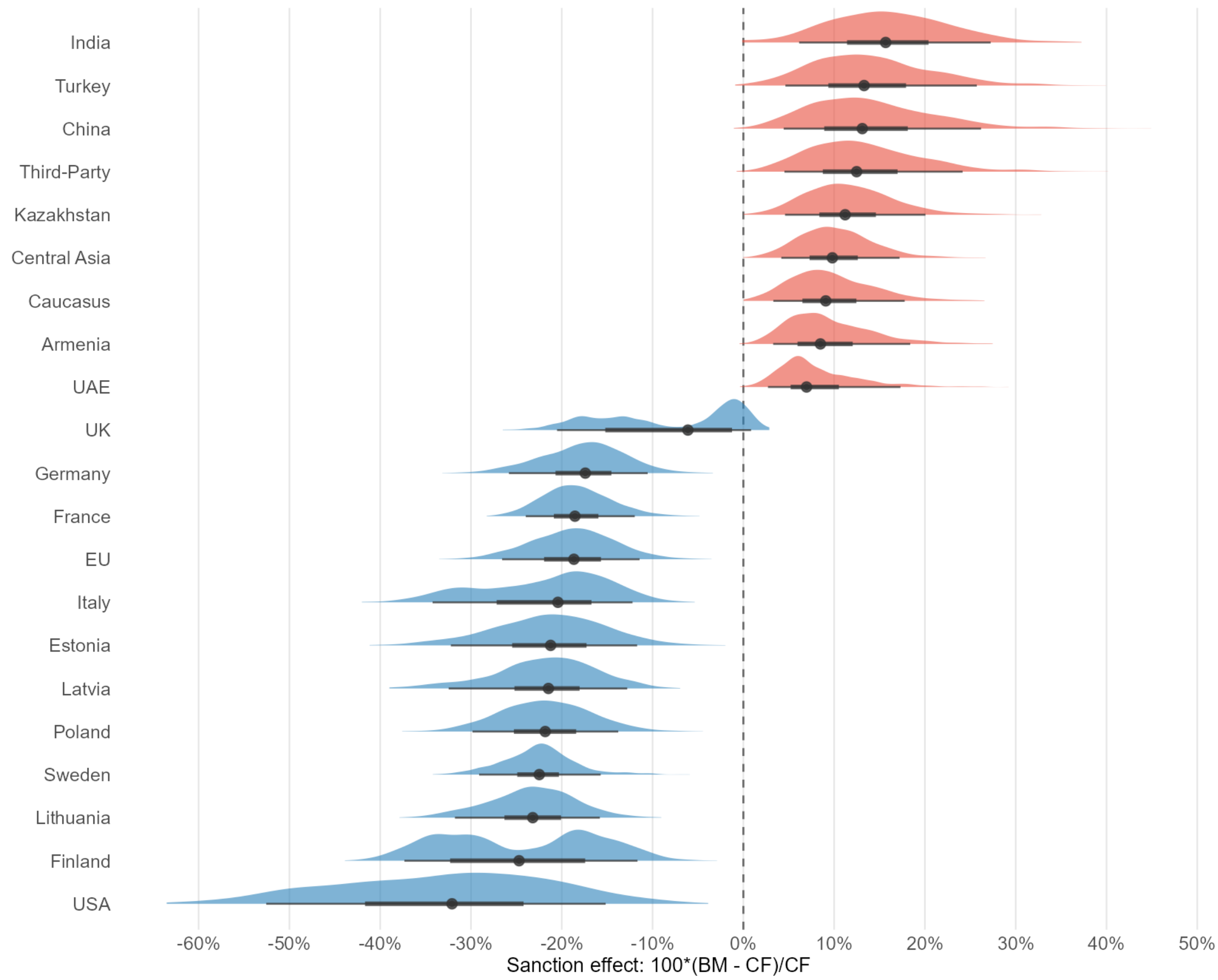

Figure 7: Sanction Effects on Imports in 2022-2023 by Country

Notes: The figure presents the distributions of general-equilibirum sanction effects on imports from different countries or regions. BM refers to actually observed values, while CF refers to counterfactual ones. When calculating counterfactual results, 500 iterations were carried out for each year to reflect the uncertainty in elasticity parameters. The distributions pool the effects for 2022 and 2023 together. Dots show the median effect, thick bars represent the interquartile range, and thin bars were constructed using the 5th and the 95th percentiles. Blue colour signifies that trade decreased due to sanctions (in the median scenario), and red signifies the opposite.

In general, the model predicts the opposite pattern for non-sanctioning countries. In the no-sanctions scenario, the shares of the South Caucasus and Central Asian countries, Turkey, the UAE and others are lower (Appendix Figure A13). The effect is especially apparent for China, whose share in Russian imports would be 5 percentage points smaller if no sanctions were imposed. The positive effect on exports to Russia appears to have been greater in 2022, with a median value of around 15 percent across the sample of non-sanctioning countries, compared to 10 percent in 2023 (Appendix Figure A15). The model predicts the largest positive sanction effects for India (with a median of 19 percent in 2022 and 14 percent in 2023), Turkey (17 and 11 percent, respectively) and China (16 percent and 11 percent, respectively), which is well aligned with previous research (Flach et al., 2024; Yalcin et al., 2025).

5.3.3 Product-level Heterogeneity

Turning to the impact of sanctions across broad product categories, the effects are modest across sectors, rarely exceeding 5 percent in absolute value (Appendix Figure A16). Crucially, this largely applies to strategic products as well: the total sanction effect on imports of high-tech products is close to zero (Appendix Figure A17). For dual-use goods, the total effect is negligible and, if anything, positive. The analogous effect on imports of economically critical products is estimated to be larger in magnitude and negative, but it must be noted that this set of products is significantly smaller. I also examine the most granular level of aggregation to assess the total impact of sanctions on two specific products – semiconductors and aircraft parts – motivated by anecdotal evidence (The Kyiv Independent, 2026; The Moscow Times, 2025). For both products, the total effect was negative in 2022 (-6 percent) and positive in 2023 (4 percent). This provides suggestive evidence that, even if Western sanctions initially succeeded in limiting Russia's access to critical products, these restrictions were more easily circumvented in 2023.

As before, aggregate results mask considerable heterogeneity across sanctioning and non-sanctioning countries. I focus in particular on the effects that sanctions had on imports of specific products from the EU and third-party countries, as defined earlier. Figure A18 in the Appendix presents the results for the EU. The median sanction negative effects on imports of food products and textiles were negligible, less than 5 percent. The effects were larger for minerals and metals, as well as materials. However, these estimates were associated with wide confidence intervals [16]. As expected, the model predicts the largest effects for chemicals, miscellaneous manufacturing products and machinery. Specifically, the median negative effect on machinery imports was estimated at 20 percent in 2022 and 34 percent

[16] This finding is most likely driven by the low precision of the σ elasticities estimated for these sectors.

in 2023 (with a 90 percent confidence interval ranging from 12 to 49 percent in 2023). This is well aligned with the results of Flach et al. (2024) who use both partial- and general-equilibrium methods and show that imports of machinery from the EU experienced the largest declines under the 2014-2019 sanctions regime.

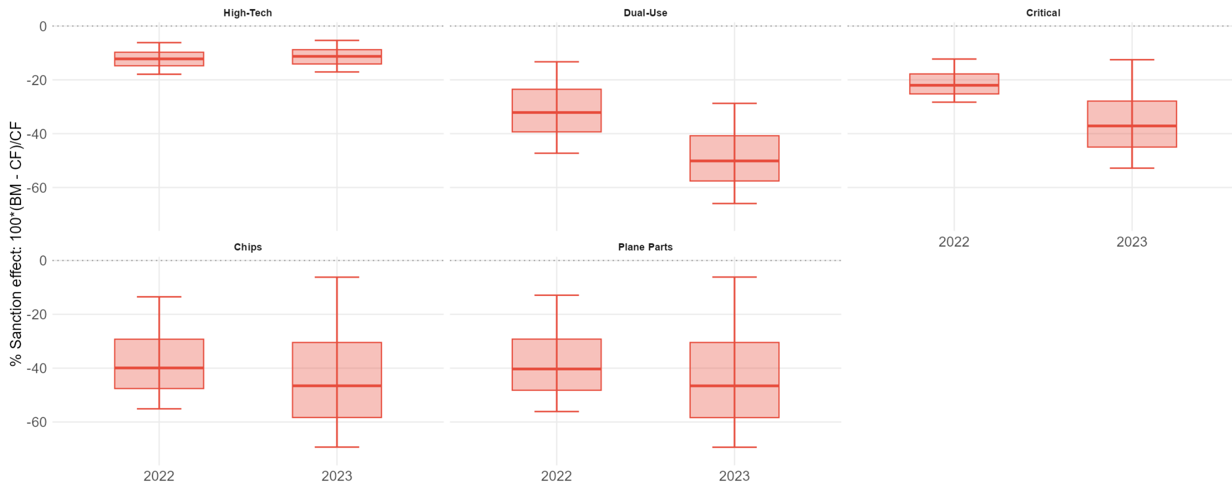

Figure 8: Sanction Effects on Russian Imports of Strategic Goods from the EU

Notes: The figure presents the results of no-sanctions counterfactual simulations for nominal Russian imports of strategic goods from the EU and plots the corresponding general-equilibrium sanction effects. High-Tech goods are classified based on the Advanced Technology Products classification developed by the US International Trade Administration. Dual-Use goods are obtained from the EU list of Common High Priority Items. The Critical category refers to the EU Economically Critical Goods list. BM refers to actually observed values, while CF refers to counterfactual ones. The boxes show median effect values, as well as the interquartile range. The whiskers are constructed using the 5th and the 95th percentiles.

Figure 8 presents the sanction effects on imports of strategic goods from the EU. For high-tech goods, the median effect amounted to a decline of only about 10 percent. However, the effects were much larger for the categories of goods explicitly targeted by the EU itself: imports of dual-use products from the EU decreased by 32 percent in 2022 and 50 percent in 2023 due to sanctions. Similarly large median effects were estimated for critical goods (declines of 22 and 37 percent, respectively), as well as semiconductors and aircraft parts (declines of 40 and 47 percent for both categories, respectively). These results provide some evidence in favour of the effectiveness of EU sanctions, as trade plummeted in product groups that were specifically targeted by sanctions.

The effects on the EU's shares in imports of specific goods are less pronounced, although still considerable (Figures A20 and A22 in the Appendix). Although counterfactual import values are higher across all product groups, the model predicts that the EU's share in sectors such as chemical and miscellaneous manufacturing would be about 5 to 10 percentage points higher. Interestingly, the EU's share in imports of dual-use goods, semiconductors and aircraft parts was close to zero by 2023, however, the model predicts shares close to zero in these product groups even in the absence of sanctions. The extraordinarily high effects for 2023 described in the previous paragraph should therefore be interpreted in light of the already low benchmark values.

The corresponding results for third-party countries reveal a mirror image (Figure A19 in the Appendix). The estimated sanction effects are small for food products, textiles, materials and minerals and metals. In contrast, the median effects are large and positive for imports of chemicals (60 percent in 2022 and 33 percent in 2023), machinery (12 and 8 percent, respectively) and miscellaneous manufacturing (22 and 20 percent, respectively). The effects are positive for imports of strategic goods and average about 10-15 percent at the median (Figure 9).Overall, the effects appear to be slightly larger in 2022, indicating that substitution from EU to third-party imports occurred at the very beginning of the embargo period.

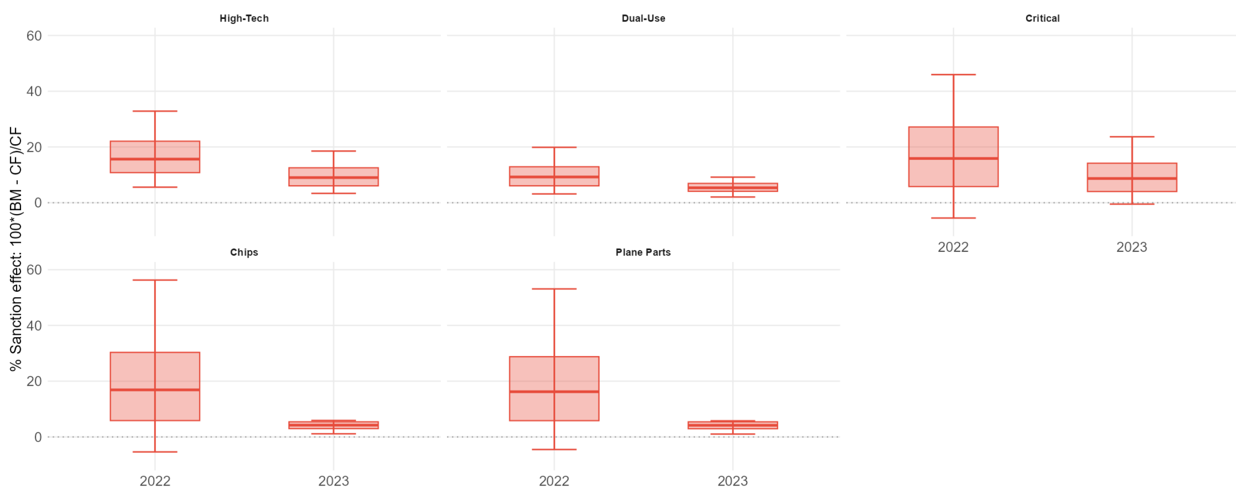

Figure 9: Sanction Effects on Russian Imports of Strategic Goods from Third-Party Countries

Notes: The figure presents the results of no-sanctions counterfactual simulations for nominal Russian imports of strategic goods from third-party countries and plots the corresponding general-equilibrium sanction effects. High-Tech goods are classified based on the Advanced Technology Products classification developed by the US International Trade Administration. Dual-Use goods are obtained from the EU list of Common High Priority Items. The Critical category refers to the EU Economically Critical Goods list. BM refers to actually observed values, while CF refers to counterfactual ones. The boxes show median effect values, as well as the interquartile range. The whiskers are constructed using the 5th and the 95th percentiles.

It is also worth noting that the shares of third-party countries increased particularly rapidly from 2021 to 2023 in imports of minerals and metals, materials, machinery and textiles (Figures A21 and A23 in the Appendix). This effect is especially stark for machinery imports, as the share of these countries increased from around 30 percent in 2020 to 81 percent in the benchmark scenario and 74 percent in the counterfactual scenario. Similar dynamics were observed for imports of dual-use and critical goods. This pattern is equally striking for imports of airacraft parts: although only 15 percent of these imports originated from third-party countries in 2021, the share rose to almost 80 percent in 2023 in both benchmark and counterfactual scenarios. Once again, this shows that, even though nominal trade declined, these countries captured a larger share of a shrinking pie, and sanctions contributed to this process.

These findings underscore Russia's dependence on imports from third-party countries. Indeed, Flach et al. (2024) use a CGE framework to simulate deep and coordinated sanctions in 2014-2019 and find that Russia's import dependence on China and India increases disproportionately, especially in high-tech goods. However, my modelling results also suggest that a significant part of such substitution would happen even if sanctions were not imposed. There are a couple of possible explanations for this. It could reflect rapid technological advances in developing countries that have occurred in recent years in industries ranging from photovoltaics to shipbuilding (McMorrow et al., 2026). Likewise, however, this could also be explained by war-induced price shocks and the loss of European competitiveness. Another explanation relates to geopolitical realignment pushing Russia to establish closer trade ties with China, in line with what Kleinman et al. (2024) dub international "friends" and "enemies". Although identifying precise mechanisms behind these dynamics is far beyond the scope of this paper, the results presented here are notable in their own right.

However, several caveats apply to the interpretation of these results. Results obtained in Section 4 suggest significant changes in bilateral trade frictions between Russia and its trade partners. However, as the CGE models are calibrated to match observed benchmark flows, changes in trade frictions are absorbed into the calibration. The counterfactual then removes the price-based sanction wedge while retaining the calibrated parameters, implicitly assuming that, absent sanctions, third-party countries would still have developed supply-chain links with Russia. The consequence of this is that counterfactual values overstate third-party imports in the no-sanctions scenario. This biases the estimated positive sanction effects downward and, symmetrically, it likely also compresses the estimated negative effect on Western sanctions. In this regard, the effects presented here can be considered conservative.

Additionally, some of these results may be sensitive to the choice of elasticity parameters and specific modelling decisions, such as the definition of counterfactual scenarios and the use of an experimental sanctions variable. These issues are investigated in the next subsection.

5.3.4 Robustness Checks

This subsection examines the robustness of the main findings described in previous sections. I first check the sensitivity of my results to alternative ways of specifying the no-sanctions counterfactual. I then assess whether alternative elasticity parameter values significantly affect the main findings.

As mentioned in Section 3, the use of a disaggregated sanctions variable obtained from Alta.ru and used in counterfactual scenarios represents an inherently experimental approach and may provide imperfect product coverage. I therefore estimate the same model using an aggregated sanctions variable from GSDB.

One prior expectation of this alternative specification is that it would yield larger sanction effects. As reported in Appendix Table A6, this prediction is indeed confirmed. Although the effect is less apparent for total trade, the median sanction effect in 2023 is estimated at -33 percent for the EU (12 percentage points larger in absolute value) and 17 percent for third-party countries (7 percentage points larger). Consequently, the effects on shares in Russian imports are also larger. Interestingly, the sanction effect for imports of dual-use goods from the EU is estimated to be smaller, whereas the same does not apply to third-party countries. Overall, these estimates are likely to be inflated due to uneven sanctions coverage in 2022-2023 (Scheckenhofer et al., 2026), and the use of a disaggregated variable is important for captuing sanction measures more precisely. Even if the Alta.ru data are imperfect, the sanction estimates obtained using them can be considered conservative.

It is also possible that Russia retaliated against sanctions not only through counter-sanctions, but also by raising tariffs on specific imports from sanctioning countries. Alternatively, Russia could have lowered tariffs on goods from third-party countries in order to promote import substitution. The latter is more plausible, as Russia established new strategic partnerships with Iran, Kazakhstan, Venezuela, China, North Korea and others after 2022. If one assumes these increases in tariffs to be endogenous to the adoption of sanctions, then the estimated sanction effects in the baseline specification may be biased.

I examine this by setting tariffs to their pre-war values in the counterfactual scenarios, in addition to removing the effect of sanctions. As shown in Appendix Table A6, this approach yields virtually the same results as in the main specification. Hence, I conclude that tariffs were not an important instrument of Russian trade policy in 2022-2023.

I then turn to examining the sensitivity of my results to alternative elasticity values. The stability of my main findings is presented in Appendix Table A7.

A surprising finding is that the sanction effect on total Russian imports is estimated to be very low. This could be driven by a small η elasticity. I check the stability of these results using a higher value of ε^S equal to 0.74, which is the estimate obtained by Gianella and Chanteloup (2006) for Russia's non-fuel exports. As expected, this has no impact on country shares. Although these results suggest slightly greater reorientation towards domestic production in general, the effect on total imports still does not exceed 5 percent. The main findings of this paper therefore remain unaffected.

When estimating values of σ, I also allow this elasticity to vary by sector, which in some cases substantially reduces precision. As a robustness check, I test whether setting one σ value (as estimated in column (8) of Table 2) for all product groups affects the results. This leads to slightly lower sanction effects on both shares and trade volumes. The impact, however, is limited and does not materially affect the main findings.

Furthermore, when estimating σ for different years, I obtain much lower estimates for 2022 and 2023, as reported in A10. Indeed, it might be reasonable to assume that import substitution was especially difficult in 2022-2023, which would necessitate a lower elasticity parameter. I impose one common σ with a point estimate of 0.76, which corresponds to the short-term value reported by Boehm et al. (2023). As expected, the estimated sanction effects are substantially lower: -10 percent for the EU and 3 percent for third-party countries. However, the sanction effect on total imports remains low. Similarly, total imports of dual-use goods appear to be almost unaffected by sanctions. These results therefore suggest that, even if the original parameterisation of the model overstates sanction effects for sanctioning and non-sanctioning countries, substitution away from imports from sanctioning countries towards imports from non-sanctioning countries nevertheless persists. It is worth noting, however, that such a low value of σ is unlikely, especially considering sanction bypass efforts (Itskhoki & Ribakova, 2024).

Finally, I check the stability of my results by setting a "low" and "high" value of γ (0.5 and 2, respectively). As expected, this has almost no impact on estimated sanction effects on import shares or total trade. A lower value of γ yields slightly smaller effects on EU and third-party trade, whereas a higher value of γ increases the estimated effects modestly. Nevertheless, these changes do not affect the validity of my main findings.

Overall, the robustness checks do not undermine the main findings of this paper. Although a lower σ value diminishes substitution due to the sanctions themselves, all alternative parameterisations still indicate a limited effect on total imports and a high degree of substitution from imports originating in sanctioning countries to imports from non-sanctioning countries.

6 Conclusions

After the outbreak of the full-scale Russian invasion of Ukraine in 2022, the Western-led coalition imposed sanctions on Russian trade that were unprecedented in scale. Thereafter, Russia's trade with the sanctioning coalition collapsed, albeit unevenly across geography and over time. At the same time, Russia expanded its ties with non-sanctioning states, seeing large increases in trade with countries, some of which had represented but a small share of Russian trade prior to the war (for example, India).

What was the effect of sanctions and were they effective? It is clear that trade dynamics were affected by a multitude of factors, including the effects of the war itself, geopolitical re-alignment, government intervention, industrial policy and Russia's counter-sanctions, among others. Isolating the effects of sanctions per se therefore represents a daunting task. In this study, I contribute to this literature by implementing two frameworks that estimate changes in Russia's bilateral trade frictions and the price-driven substitution effects of sanctions. For the latter, I focus on Russian imports, which are crucial for sustaining Russian military capacity and may have greater implications for Russian welfare than sanctions on Russian exports (Itskhoki & Mukhin, 2025).

Gravity-based estimates presented in Section 4 suggest significant increases in trade costs for sanctioning countries and an average decline in bilateral trade with Russia of 72 percent due to sanctions. For the EU specifically, the estimated sanction effect amounts to a decline of 46 percent for sanctions overall and 48 percent for sanctions targeting Russian imports in particular. However, equally striking are the positive effects estimated for countries outside of the sanctions coalition, such as India, the UAE and Armenia. Yet, these estimates represent only a reduced-form measure of the sanction effect. I therefore focus on sanctions on Russian imports and examine the price-driven trade diversion that occurred after 2022. Section 5 presents the results of modelling several no-sanctions counterfactuals, using CGE techniques and an experimental disaggregated sanctions variable. Conservative estimates suggest a very low sanction effect on total Russian imports, generally below 5 percent. Although the negative effects on imports from sanctioning countries are substantial in specific product groups (for example, dual-use goods), they are mostly balanced by increases in imports from third-party countries. Countries with the largest positive increases of around 15-20 percent include India, Turkey and China.

How can these results be reconciled? Although my empirical framework does not permit a clean decomposition, one can think of these findings in similar terms. Given the results obtained in Section 4, it is important to note that the CGE approach isolates the price-channel effect of sanctions by removing only the formal sanction “markup” while holding other trade frictions fixed at observed values. The gap between a greater sanction effect documented in the gravity framework and a relatively smaller one predicted by CGE modelling can then be interpreted as the non-price component. Specifically, median CGE estimates of the sanction effect suggest that these measures accounted for a quarter of the total change in Russian imports for third-party countries and around a fifth for the EU. A possible interpretation of my results is therefore that price-based substitution explains only about half of the observed sanction-induced trade collapse for sanctioning countries and likely even less than that for the expansion in trade with third-party countries. The residual could reflect other bilateral factors, such as financial sanctions, voluntary corporate withdrawal, war-induced frictions, government-facilitated trade deepening, geopolitical realignment and evasion infrastructure.

Although complete substitution might paint a pessimistic picture of the effectiveness of sanctions as a policy tool, the non-price effects are likely to be endogenous to the adoption of these measures themselves. This study therefore underscores the importance of such factors. The direct implication for policymakers is that limiting these efforts is crucial for maintaining the effectiveness of the sanctions regime. In particular, enforcement against “connector” countries, coalition breadth and the coordination of trade and financial measures appear to be binding constraints on sanction effectiveness. Indeed, recent evidence on Cuban sanctions suggests that preserving a sufficiently large sanctioning coalition and “carrying a big stick” in the form of secondary sanctions were crucial for the success of the embargo (Kwon et al., 2024).

Furthermore, my findings highlight how sanctions increased Russia’s dependence on other states, particularly China. Although this has served to alleviate the negative impact of sanctions in the short term, the implications for sanction effectiveness and the welfare of Western countries in the longer term are less clear. Although this dependence may introduce market distortions and political-economy dynamics detrimental to Russia’s welfare, growth and hence military capacity, it may also encourage deeper political, economic and strategic integration and ultimately increase the likelihood of a more confrontational bipolar world order. However, assessing the contribution of sanctions to these developments, as well as the magnitude of such effects, lies beyond the scope of this paper.

Both my partial- and general-equilibrium results suggest positive sanction effects for trade with non-sanctioning countries, yet a critical question that I cannot address concerns the quality of substitute imports. If imports from third-party countries reflect a larger share of lower-quality products, then the decreases in trade with Western countries may have successfully prevented Russia from accessing higher-quality goods. Indeed, Emlinger and

Lefebvre (2025) provide some evidence in favour of this hypothesis. The authors reason that, because Russia preferred imports from the West prior to the sanctions, switching to imports from non-sanctioning countries necessarily represents a second-best arrangement. Large negative sanction effects for Russian imports of strategic goods from the EU can therefore be interpreted as evidence in favour of sanction effectiveness in terms of preventing Russia's access to high-quality products used for military purposes.

This paper contributes to an emerging literature that attempts to quantify the effects of sanctions in a general-equilibrium setting. Although I obtain detailed results for the effects on Russian imports, it would be natural to extend this analysis by considering the effects of sanctions on Russian exports. Examining welfare costs for Western countries would also be a valuable extension in a framework that accounts for the granular nature of sanctions. Moreover, a significant limitation of this study is my inability to trace sanction bypass and trade through "connector" countries. The use of re-export data may be beneficial in this regard, but would considerably limit country coverage, so alternative regression-based or machine-learning methods could potentially prove useful. It would also be interesting to extend this analysis to later, more "mature" stages of the sanctions regime in 2024-2026, when greater reorientation towards domestic production may have occurred. All of these considerations represent fruitful avenues for future research.

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Appendix

Data Appendix

This section provides additional detail on the construction of variables not mentioned in the main text:

- **Non-tariff measures** (NTMs):
  Using the UNCTAD classification, I group NTMs into sanitary and phytosanitary measures (group A), technical barriers to trade (group B), pre-shipment inspection and other formalities (group C), antidumping measures (group D1), safeguard measures (group D3), licensing (group E1), quotas (group E2), prohibitions (group E3), tariff-rate quotas (group E6), additional charges (group F) and special preferences (group H). Some of these are excluded from the regression analysis due to low variation (for example, in the case of additional charges, which apply to 99% of all observations) or perfect multicollinearity (for example, in the case of tariff-rate quotas, which are also included in tariff data). As the latest data collection round took place in 2020, I assume that those measures that were in place in 2020 continued until 2023.

- **Bilateral exchange rates**:
  I obtain data on bilateral exchange rates against the US dollar from the Bank for International Settlements and infer bilateral rates against the Russian rouble from them. When no data are available for a specific exporter, I impute the national currency exchange rate with respect to RUB from other country's exchange rates. Specifically, I impute the US dollar rates to Ecuador, Cuba, El Salvador, Zimbabwe, Somalia, British Virgin Islands, North Korea, Syria, Timor-Leste, Venezuela, Afghanistan, Marshall Islands and Palau. Moreover, I impute euro rates for Andorra and Guinea-Bissau, South African rand rates for Namibia, Israeli shekel rates for Palestine, Australian dollar rates for Nauru and Tuvalu, as well as the New Zealand dollar rates for Cook Islands.

- **Disaggregated sanctions data**:
  I obtain granular product-level data on goods whose exports to Russia were sanctioned from web-archived versions of Alta.ru, which maintains an up-to-date list of sanctioned products. Because only a limited number of historical snapshots of the website are available, coverage is incomplete. For 2022, the retrieval dates for each sanctioning entity (all in 2022 unless otherwise noted) are as follows: the EU (October 10), Australia

(April 13), the UK (November 7), the United States (March 3, 2023), Canada (April 13), Switzerland (April 13), Japan (April 13), and South Korea (May 25, 2023). For 2023, the corresponding retrieval dates are: the EU (December 28), Australia (April 13, 2022), the UK (November 7, 2022), the United States (May 25), Canada (April 13, 2022), Switzerland (November 14), Japan (April 7), and South Korea (May 25, 2023).

- **GDP** and **total imports data** needed for CGE modelling were obtained from the World Bank World Development Indicators dataset.

The following table summarises all product classifications used in CGE analysis:

Table A3: Product Classifications

Description	**HS 4-digit codes**	**HS Sections**
Panel A: Product Group Classifications		
Foods (incl. Live Animals)	0101–2404	I–IV
Minerals & Metals	2501–2716, 7201–8311	V, XV
Chemicals, Plastics & Rubber	2801–4017	VI, VII
Leather & Textiles	4101–4304, 5001–6704	VIII, XI, XII
Materials	4401–4911, 6801–7118	IX, X, XIII, XIV
Machinery & Vehicles	8401–8908	XVI, XVII
Miscellaneous Manufactured Goods	9001–9706	XVIII–XXI
Panel B: Targeted Products Classifications		
High-Tech Goods	2844–2845, 2914, 2918, 2921–2922, 2924, 2928, 2931–2934, 2937, 2940, 3002, 3004, 3818, 8401, 8411–8412, 8427–8428, 8443, 8456–8462, 8465, 8470–8471, 8473, 8479, 8486, 8504, 8515, 8517, 8519, 8521–8523, 8525–8529, 8534, 8537, 8540–8544, 8701, 8703–8704, 8802–8803, 8805, 9001–9002, 9005–9007, 9011–9015, 9017–9019, 9021–9022, 9024, 9027, 9029–9032, 9301, 9304–9306	
Dual-Use Goods	8457–8459, 8466, 8471, 8482, 8486, 8504, 8517, 8525–8526, 8529, 8532, 8534, 8536, 8541–8543, 8548, 8803, 9013–9014, 9027, 9030	
Economically Critical Goods	7308, 8409, 8412–8413, 8419, 8421, 8424, 8428, 8477, 8479, 8481, 8502, 8507, 8537–8538, 8701, 8708, 8716, 8904	

Notes: The table lists all product classifications used in the paper. Panel A contains seven mutually exclusive sectoral groups that together cover all distinct traded goods at the HS 4-digit level. Panel B contains cross-cutting thematic groups, which are target by sanctions. High-tech good classification corresponds to the Advanced Technology Products classification developed by the US International Trade Administration. The lists of dual-use goods and economically critical goods are recovered from the European Commission. HS codes are reported as ranges (e.g. 8401–8484 indicates all consecutive 4-digit codes from 8401 to 8484 inclusive).

Robustness Checks - Gravity Equations

Table A4: Structural Gravity Equation Estimation Robustness Checks

	(1)	(2)	(3)	(4)	(5)
Any sanction	-0.139***	-0.134***	-0.132***	-0.132***	-0.118***
	(0.032)	(0.032)	(0.034)	(0.017)	(0.030)
Observations	818,276	20,764,372	20,705,583	20,705,583	110,963,366
Controls	Yes	Yes	Yes	Yes	Yes
Level of Aggregation	Full	HS-2	HS-2	HS-2	HS-4
S.E. Clustering	Directional Dyad	Directional Dyad	Directional Dyad	Directional Dyad-Product	Directional Dyad
Importer-year FE	Yes	Yes	No	No	Yes
Importer-product-year FE	No	No	Yes	Yes	No
Exporter-year FE	Yes	Yes	No	No	Yes
Exporter-product-year FE	No	No	Yes	Yes	No
Directional dyad FE	Yes	Yes	Yes	Yes	Yes

Notes: The table presents different robustness checks of regressions outputs for the baseline specification of Model (1), reported in Table 1 and estimated using PPML. The outcome variable in all models is bilateral trade flows. All specifications control for EU, WTO and RTA membership. Column (1) reports exactly the same estimates, as in Table 1. Columns (2)-(4) estimate the same equation using HS-2 level data. Specifications of columns (1) and (2) use importer-year, exporter-year and directional dyad FE. Column (3) and (4) report the coefficients obtained using importer-product-year, exporter-product-year, as well as directional dyad FE. Column (5) reports the results of exactly the same specification, as in columns (1) and (2), but using HS-4 level data. All standard errors are clustered at the directional dyad level, except for (4), where errors are clustered at the directional dyad-product level. The sample includes the whole universe of countries in 1995–2023. Standard errors (in parentheses) are clustered by directional dyad. *, ** and *** denote statistical significance at 10%, 5% and 1%, respectively.

CGE Elasticity Estimations

Table A5: Baseline σ Estimations

	(1) OLS	(2) PPML	(3) PPML	(4) PPML	(5) PPML
Log of (1+tariff)	-3.060***	-1.413**	-1.675**	-1.675**	-1.675**
	(0.324)	(0.568)	(0.581)	(0.738)	(0.722)
Log of total exports	0.816***	0.944***	0.983***	0.983***	0.983***
	(0.015)	(0.017)	(0.016)	(0.019)	(0.021)
N	1,348,479	1,348,479	4,028,520	4,028,520	4,028,520
Panel structure	Unbalanced	Unbalanced	Balanced	Balanced	Balanced
Sector-exporter-year FE	Yes	Yes	Yes	Yes	Yes
Product-year FE	Yes	Yes	Yes	Yes	Yes
S.E. clustering level	country	country	country	country, product	country, product, year

Notes: The table presents different methods of estimating equation 9. The outcome variable in all models is imports to Russia by product, exporter and year. All specifications include sector-exporter-year FE and product-year FE, where sector is defined at the HS-2 level. Column (1) is estimated using OLS. Columns (2)–(5) are estimated using PPML, transforming equation 9 into the multiplicative form prior to that. Column (2) uses the unbalanced panel, while columns (3)–(5) balance the panel, imputing zeroes for missing trade observations. Columns (1)–(3) cluster standard errors at the country (exporter) level, while column (4) experiments with clustering at the country and product level and column (5) – at the country, product and year level. The sample includes all exporters to Russia in 2013–2023 and products at the HS-6 level. Standard errors reported in parentheses. *, ** and *** denote statistical significance at 10%, 5% and 1%, respectively.

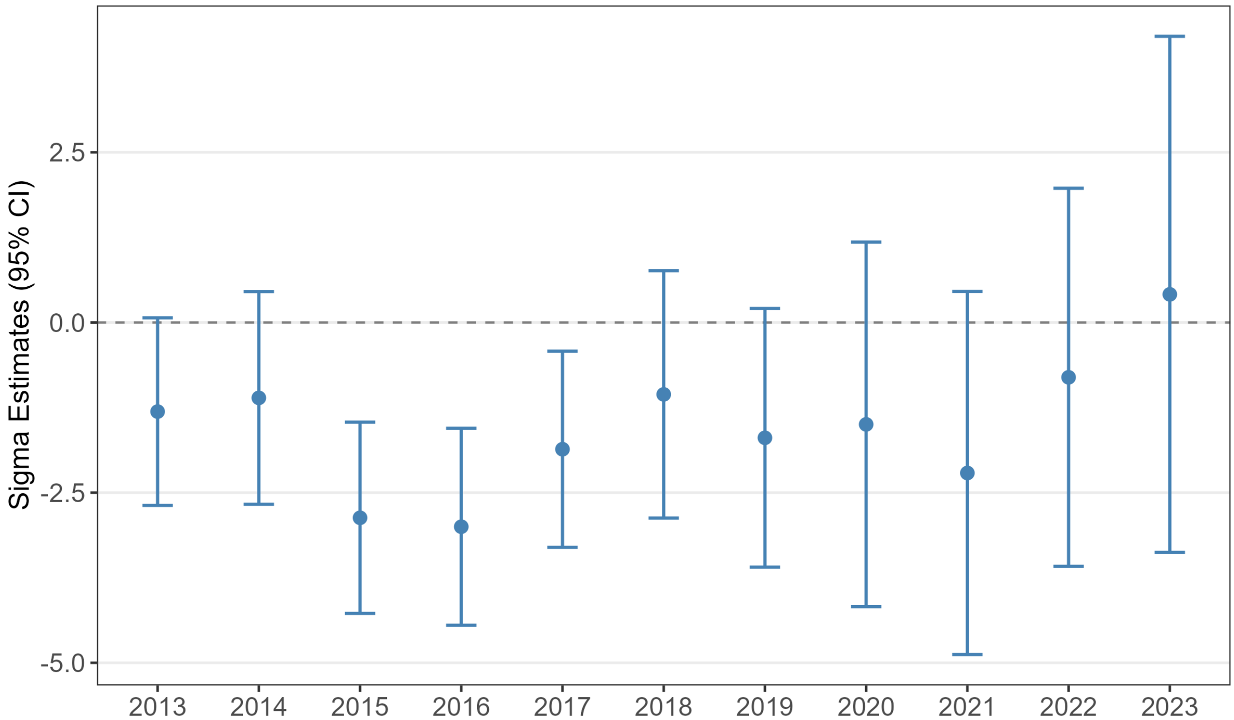

Figure A10: Estimations of Trade Elasticity (σ) by Year

Notes: The figure presents the results of trade elasticity estimations for Russia by year. All coefficients have been estimated using PPML and the specification of Model (8) in Table 2. Confidence intervals were constructed using standard errors obtained from the same regression.

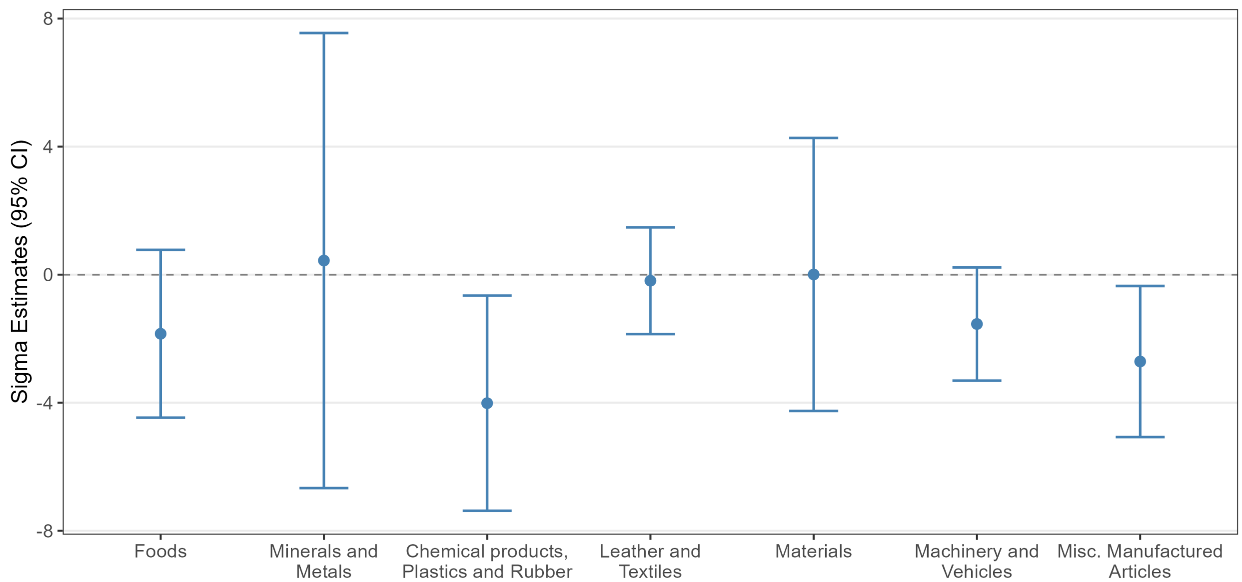

Figure A11: Estimations of Trade Elasticity (σ) by Sector

Notes: The figure presents the results of trade elasticity estimations for Russia for each of the 7 sectors, as defined in Appendix Table A3. All coefficients have been estimated using PPML and the specification of Model (8) in Table 2. Confidence intervals were constructed using standard errors obtained from the same regression.

Additional CGE Results

The following figures present additional results from the CGE counterfactual simulations discussed in Section 5.

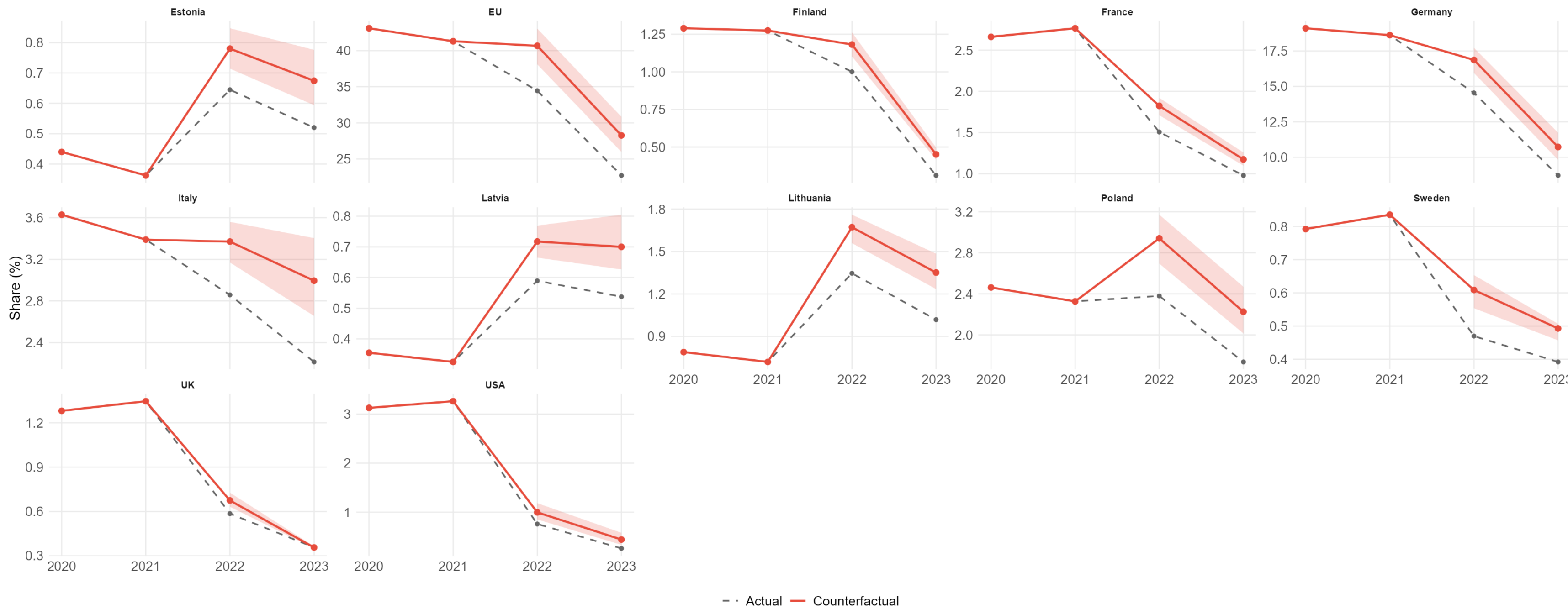

Figure A12: Shares of Sanctioning Countries in Russia's Imports

Notes: The figure presents the results of no-sanctions counterfactual simulations for shares of sanctioning countries in Russia's imports. The red line represents the counterfactual median results, while the shaded area reflects the 90% confidence interval, constructed from the 5th and the 95th percentiles. The dashed line shows actually observed values. Caucasus combines the shares of Georgia, Armenia and Azerbaijan. Central Asia reports the total share of Kazakhstan, Turkmenistan, Tadjikistan, Uzbekistan and Kyrgyzstan.

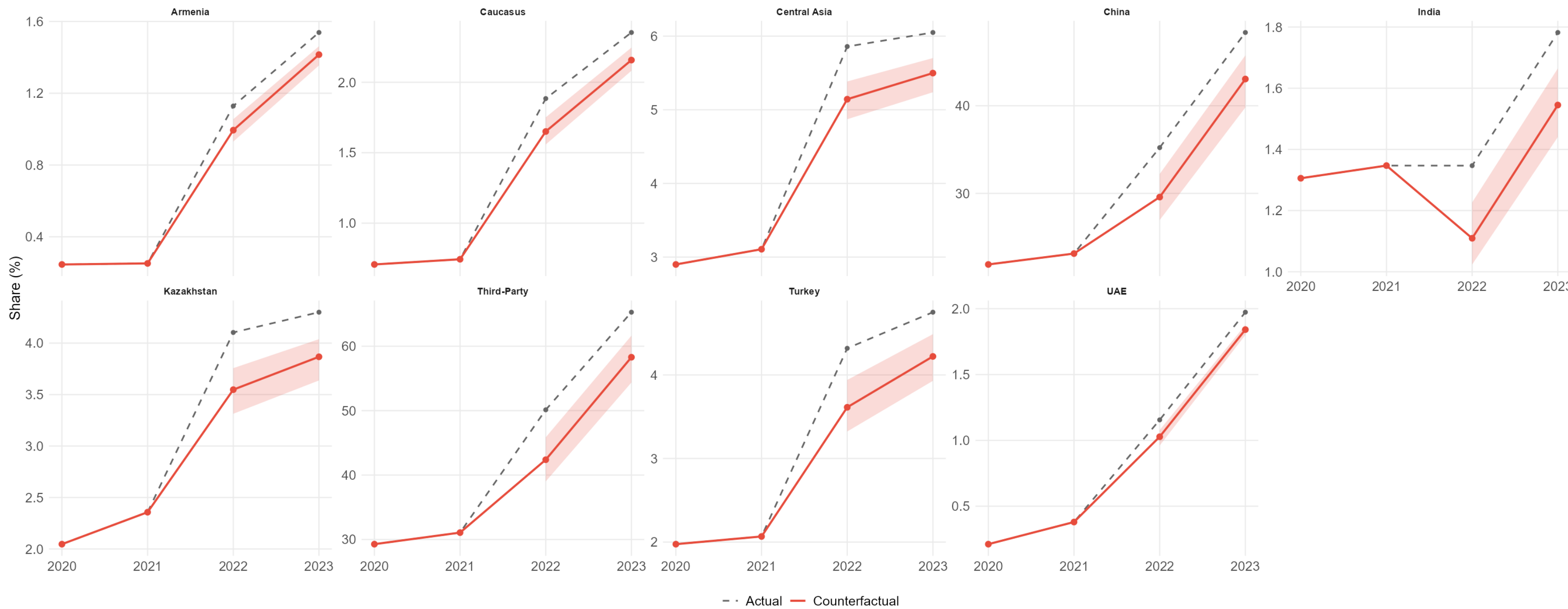

Figure A13: Shares of Third-Party Countries in Russia's Imports

Notes: The figure presents the results of no-sanctions counterfactual simulations for shares of non-sanctioning countries in Russia's imports. The red line represents the counterfactual median results, while the shaded area reflects the 90% confidence interval, constructed from the 5th and the 95th percentiles. The dashed line shows actually observed values. Caucasus combines the shares of Georgia, Armenia and Azerbaijan. Central Asia reports the total share of Kazakhstan, Turkmenistan, Tadjikistan, Uzbekistan and Kyrgyzstan.

Figure A14: Sanction Effects on Imports from Sanctioning Countries

Notes: The figure presents the results of no-sanctions counterfactual simulations for nominal exports of sanctioning countries to Russia and plots the corresponding general-equilibrium effects of sanctions. BM refers to benchmark scenario values, while CF refers to counterfactual ones. The boxes show median effect values, as well as the interquartile range. The whiskers are constructed using the 5th and the 95th percentiles. EU includes all countries in the European Union as of 2022.

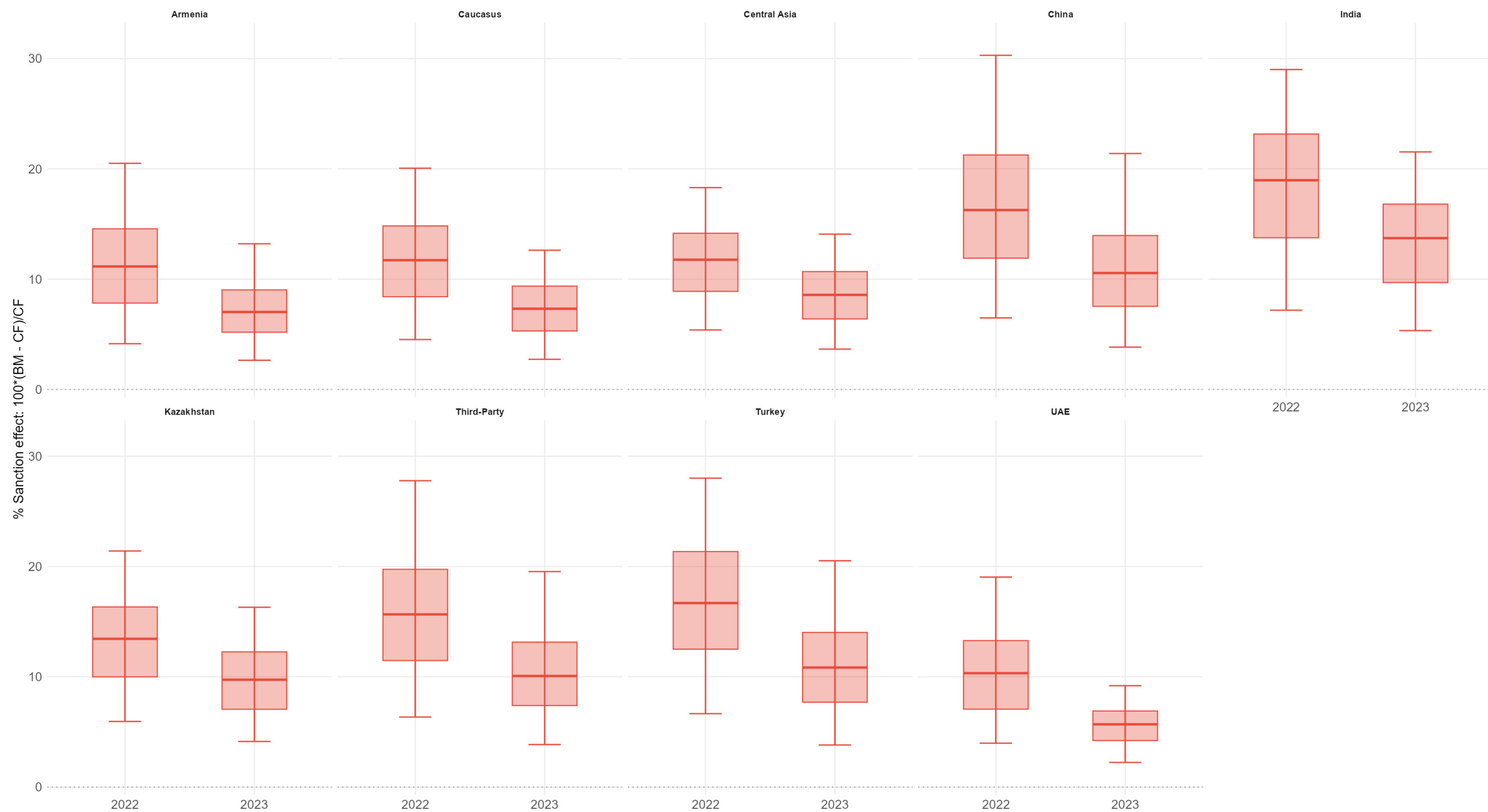

Figure A15: Sanction Effects on Imports from Non-Sanctioning Countries

Notes: The figure presents the results of no-sanctions counterfactual simulations for nominal exports of non-sanctioning countries to Russia and plots the corresponding general-equilibrium effects of sanctions. BM refers to benchmark scenario values, while CF refers to counterfactual ones. The boxes show median effect values, as well as the interquartile range. The whiskers are constructed using the 5th and the 95th percentiles. Caucasus combines the shares of Georgia, Armenia and Azerbaijan. Central Asia reports the total share of Kazakhstan, Turkmenistan, Tadjikistan, Uzbekistan and Kyrgyzstan.

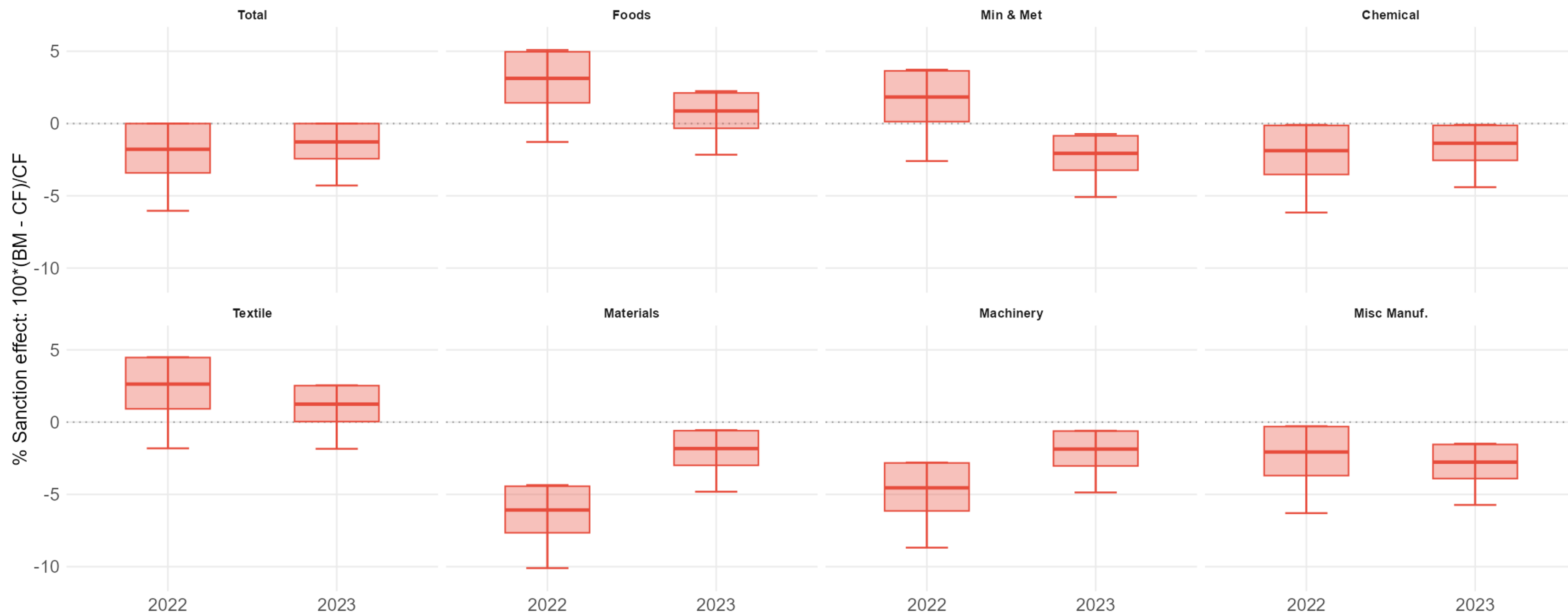

Figure A16: Sanction Effects on Total Imports of Standard-Sector Goods

Notes: The figure presents the results of no-sanctions counterfactual simulations for nominal Russian imports by sector, as defined in the Appendix Table A3, and plots the corresponding general-equilibrium sanction effects. BM refers to benchmark scenario values, while CF refers to counterfactual ones. The boxes show median effect values, as well as the interquartile range. The whiskers are constructed using the 5th and the 95th percentiles.

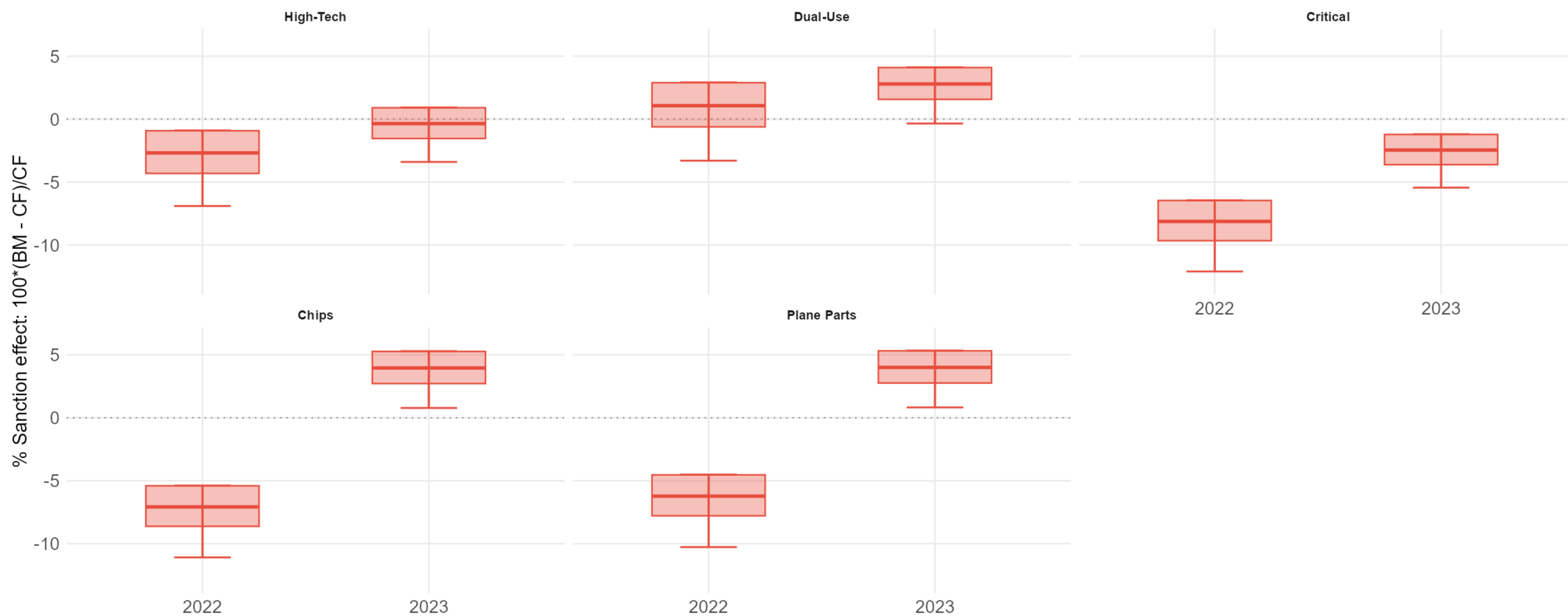

Figure A17: Sanction Effects on Total Imports of Strategic Goods

Notes: The figure presents the results of no-sanctions counterfactual simulations for nominal Russian imports of strategic goods and plots the corresponding general-equilibrium sanction effects. High-Tech goods are classified based on the Advanced Technology Products classification developed by the US International Trade Administration. Dual-Use goods are obtained from the EU list of Common High Priority Items. The Critical category refers to the EU Economically Critical Goods list. BM refers to benchmark scenario values, while CF refers to counterfactual ones. The boxes show median effect values, as well as the interquartile range. The whiskers are constructed using the 5th and the 95th percentiles.

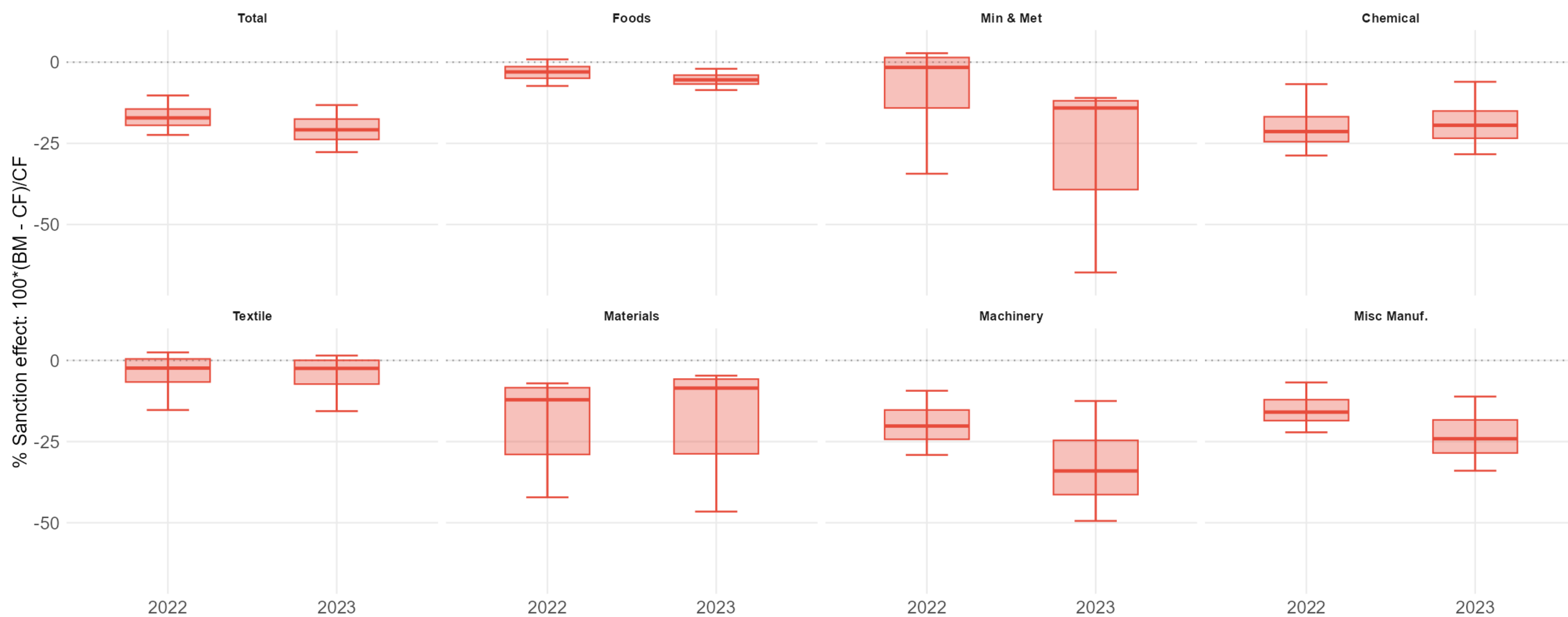

Figure A18: Sanction Effects on Russian Imports of Standard-Sector Goods from the EU

Notes: The figure presents the results of no-sanctions counterfactual simulations for nominal Russian imports from the EU by sector, as defined in the Appendix Table A3, and plots the corresponding general-equilibrium sanction effects. BM refers to benchmark scenario values, while CF refers to counterfactual ones. The boxes show median effect values, as well as the interquartile range. The whiskers are constructed using the 5th and the 95th percentiles.

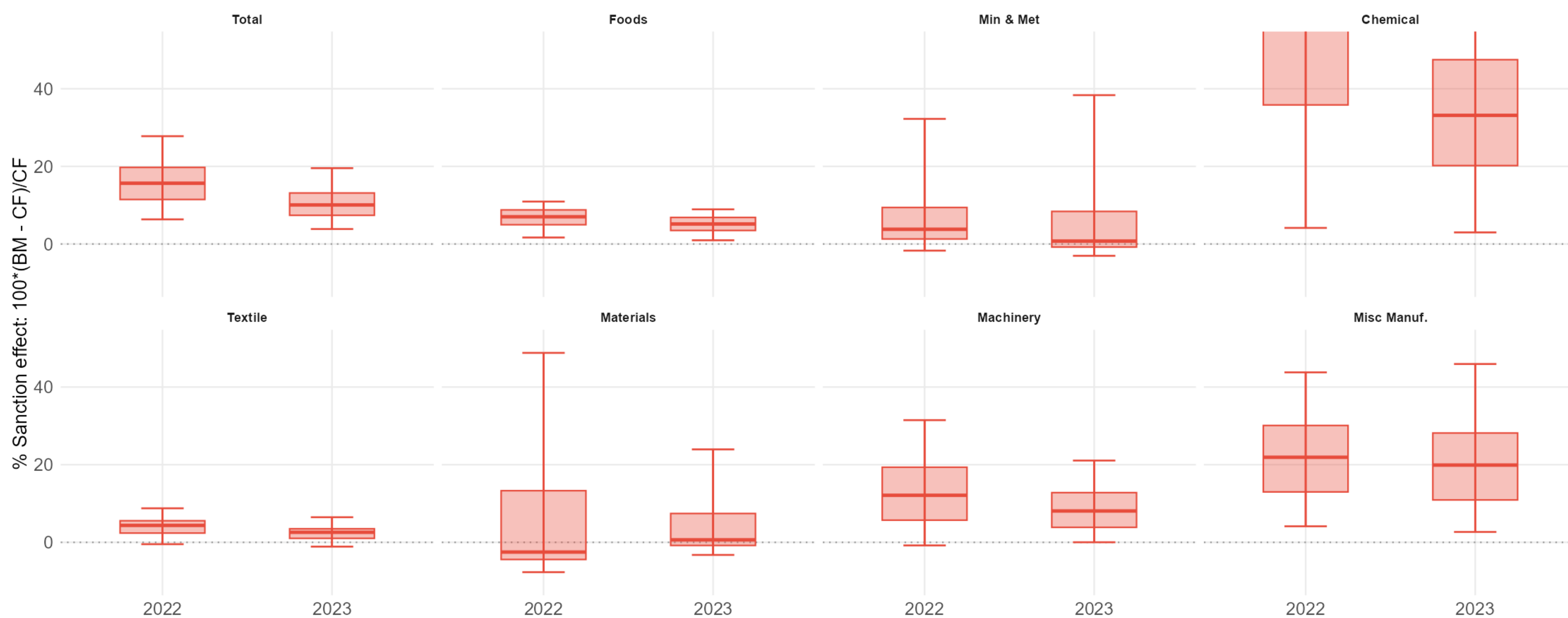

Figure A19: Sanction Effects on Russian Imports of Standard-Sector Goods from Third-Party Countries

Notes: The figure presents the results of no-sanctions counterfactual simulations for nominal Russian imports from third-party countries by sector, as defined in the Appendix Table A3, and plots the corresponding general-equilibrium sanction effects. BM refers to benchmark scenario values, while CF refers to counterfactual ones. The boxes show median effect values, as well as the interquartile range. The whiskers are constructed using the 5th and the 95th percentiles.

High effect values for the Chemical sector distorted the axis and therefore are not shown. In 2022, the 5th percentile amounted to 4%, median - 61%, 95th percentile - 144%. The same values for 2023 were 3%, 33% and 75%, respectively.

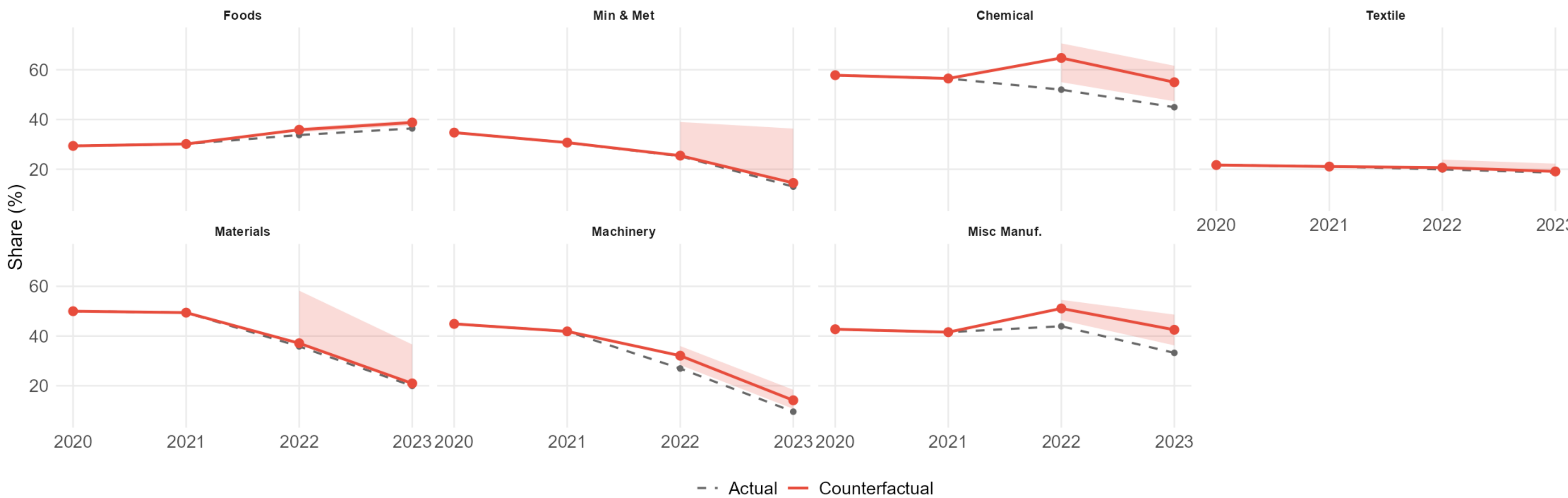

Figure A20: Shares of the EU in Russian Imports of Standard-Sector Goods

Notes: The figure presents the results of no-sanctions counterfactual simulations for shares of the EU in Russian imports of goods by sector, as defined in the Appendix Table A3. The red line represents the counterfactual median results, while the shaded area reflects the 90% confidence interval, constructed from the 5th and the 95th percentiles. The dashed line shows actually observed values.

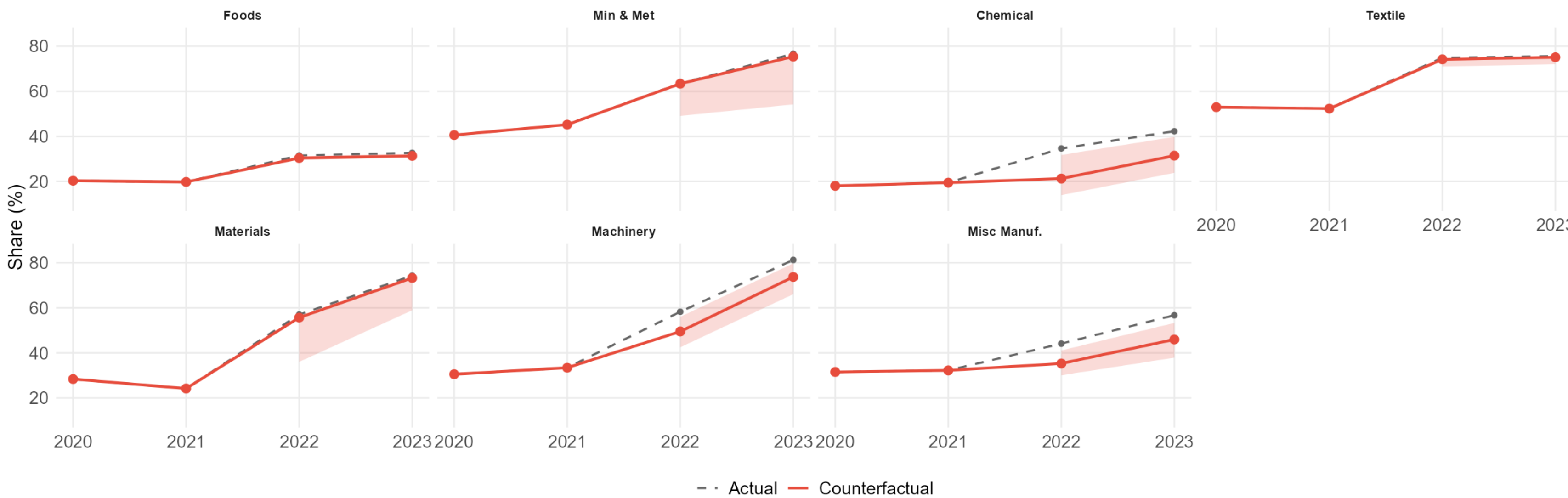

Figure A21: Shares of Third-Party Countries in Russian Imports of Standard-Sector Goods

Notes: The figure presents the results of no-sanctions counterfactual simulations for shares of third-party countries in Russian imports of goods by sector, as defined in the Appendix Table A3. The red line represents the counterfactual median results, while the shaded area reflects the 90% confidence interval, constructed from the 5th and the 95th percentiles. The dashed line shows actually observed values.

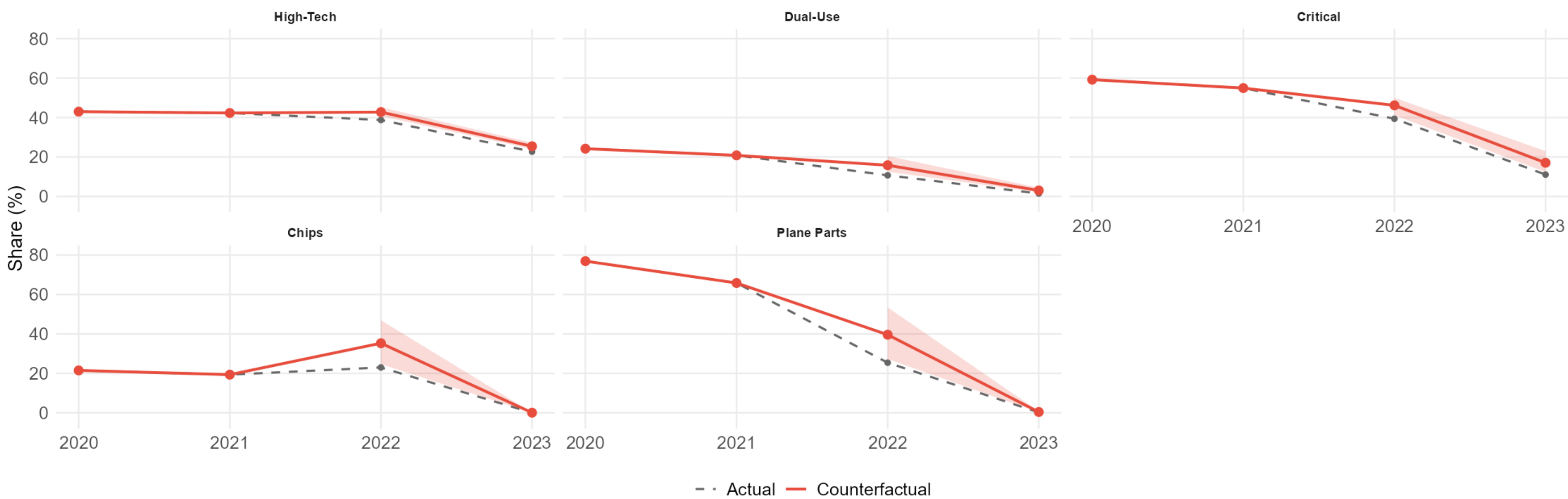

Figure A22: Shares of the EU in Russian Imports of Strategic Goods

Notes: The figure presents the results of no-sanctions counterfactual simulations for shares of the EU in Russian imports of strategic goods. High-Tech goods are classified based on the Advanced Technology Products classification developed by the US International Trade Administration. Dual-Use goods are obtained from the EU list of Common High Priority Items. The Critical category refers to the EU Economically Critical Goods list. The red line represents the counterfactual median results, while the shaded area reflects the 90% confidence interval, constructed from the 5th and the 95th percentiles. The dashed line shows actually observed values.

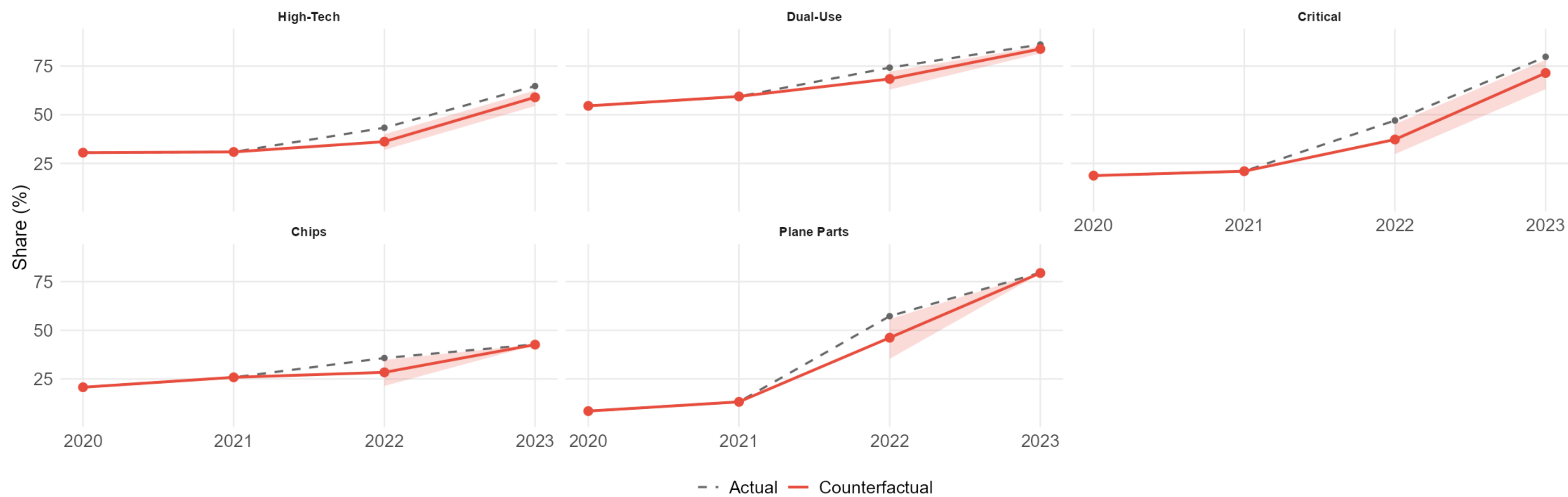

Figure A23: Shares of Third-Party Countries in Russian Imports of Strategic Goods

Notes: The figure presents the results of no-sanctions counterfactual simulations for shares third-party countries in Russian imports of strategic goods. High-Tech goods are classified based on the Advanced Technology Products classification developed by the US International Trade Administration. Dual-Use goods are obtained from the EU list of Common High Priority Items. The Critical category refers to the EU Economically Critical Goods list. The red line represents the counterfactual median results, while the shaded area reflects the 90% confidence interval, constructed from the 5th and the 95th percentiles. The dashed line shows actually observed values.

Robustness Checks - CGE

The following tables report robustness checks for the CGE results under alternative counterfactual specifications and elasticity parameters.

Table A6: CGE Robustness Checks: Sanction Effects in Different Counterfactual Specifications

Variable	**Original**	**Aggregate sanctions**	**2021 tariffs**
Sanction effect on trade values (%) in 2023			
Total Trade (%)	-1.27	-3.23	-1.29
	[-4.29; -0.00]	[-10.69; -0.00]	[-4.32; -0.00]
Total Trade — EU (%)	-20.82	-32.72	-20.53
	[-27.70; -13.21]	[-39.34; -25.67]	[-27.44; -12.84]
Total Trade — Third-Party (%)	10.07	17.02	9.98
	[3.86; 19.54]	[6.88; 29.10]	[3.77; 19.47]
Total Trade — EU, Dual-Use (%)	-50.13	-43.87	-50.33
	[-65.95; -28.74]	[-60.06; -21.64]	[-66.16; -28.90]
Total Trade — Third-Party, Dual-Use (%)	5.36	12.03	5.44
	[2.05; 9.18]	[3.84; 17.66]	[2.10; 9.28]
Sanction effect on import shares (percentage points) in 2023			
Import Share — EU (pp)	-5.54	-9.94	-5.43
	[-8.11; -3.26]	[-12.35; -7.22]	[-8.02; -3.15]
Import Share — Third-Party (pp)	6.99	11.67	6.95
	[3.65; 10.91]	[8.14; 15.25]	[3.61; 10.84]
Import Share — EU, Dual-Use (pp)	-1.54	-1.38	-1.56
	[-2.93; -0.65]	[-2.54; -0.61]	[-2.96; -0.66]
Import Share — Third-Party, Dual-Use (pp)	2.28	1.87	2.29
	[0.88; 4.54]	[0.77; 3.61]	[0.87; 4.58]

Notes: All results are reported for counterfactual year 2023. Sanction effects on trade values are calculated as $100 \times (\text{BM} - \text{CF})/\text{CF}$, where BM refers to the benchmark scenario actually observed and CF refers to the no-sanctions scenario. Sanction effects on import shares are calculated as $\text{BM} - \text{CF}$. Column 'Original' refers to the baseline results, described in the main text. Column 'Aggregate sanctions' uses the aggregate sanctions variable obtained from GSDB. Column '2021 tariffs' sets Russian tariffs on imports to their 2021 values, in addition to removing the effect of sanctions. Point estimates are reported as medians, with confidence intervals (5th and 95th percentiles across 500 model iterations) shown in brackets on the line below each estimate.

Table A7: CGE Robustness Checks: Sanction Effects with Different Elasticity Parameters

Variable	**Original**	$\varepsilon^S = 0.74$	$\sigma = -1.538$	$\sigma = -0.76$	$\gamma = 0.5$	$\gamma = 2$
Sanction effect on trade values (%) in 2023						
Total Trade (%)	-1.27	-4.04	-1.20	-1.13	-1.25	-1.31
	[-4.29; -0.00]	[-4.69; -3.09]	[-4.23; -0.00]	[-3.84; -0.00]	[-4.21; -0.00]	[-4.45; -0.00]
Total Trade — EU (%)	-20.82	-23.34	-17.02	-9.89	-19.32	-24.28
	[-27.70; -13.21]	[-29.39; -15.80]	[-21.83; -11.78]	[-12.47; -8.37]	[-26.16; -11.77]	[-31.10; -16.56]
Total Trade — Third-Party (%)	10.07	8.11	7.41	2.98	9.29	12.31
	[3.86; 19.54]	[1.97; 14.78]	[3.18; 13.18]	[0.24; 4.61]	[3.34; 18.44]	[5.25; 22.71]
Total Trade — EU, Dual-Use (%)	-50.13	-52.48	-44.21	-24.93	-49.97	-49.88
	[-65.95; -28.74]	[-66.40; -30.59]	[-59.10; -25.50]	[-28.58; -20.66]	[-66.14; -28.49]	[-65.09; -27.27]
Total Trade — Third-Party, Dual-Use (%)	5.36	2.90	5.10	3.92	2.71	11.68
	[2.05; 9.18]	[1.10; 5.54]	[1.91; 8.03]	[1.20; 5.28]	[-0.48; 6.21]	[7.97; 16.34]
Sanction effect on import shares (percentage points) in 2023						
Import Share — EU (pp)	-5.54	-5.72	-4.25	-2.21	-5.04	-6.81
	[-8.11; -3.26]	[-8.11; -3.27]	[-5.75; -2.83]	[-2.42; -2.00]	[-7.54; -2.83]	[-9.55; -4.28]
Import Share — Third-Party (pp)	6.99	7.20	5.37	2.62	6.51	8.08
	[3.65; 10.91]	[3.65; 10.91]	[3.17; 8.02]	[2.30; 2.97]	[3.26; 10.35]	[4.54; 12.22]
Import Share — EU, Dual-Use (pp)	-1.54	-1.63	-1.23	-0.54	-1.46	-1.69
	[-2.93; -0.65]	[-2.92; -0.66]	[-2.22; -0.56]	[-0.64; -0.45]	[-2.85; -0.60]	[-3.13; -0.73]
Import Share — Third-Party, Dual-Use (pp)	2.28	2.43	1.90	0.82	2.18	2.46
	[0.88; 4.54]	[0.89; 4.48]	[0.79; 3.52]	[0.66; 0.99]	[0.83; 4.42]	[0.99; 4.78]

Notes: All results are reported for counterfactual year 2023. Sanction effects on trade values are calculated as $100 \times (\text{BM} - \text{CF})/\text{CF}$, where BM refers to the benchmark scenario actually observed and CF refers to the no-sanctions scenario. Sanction effects on import shares are calculated as BM – CF. Column 'Original' refers to the baseline parameter values, as described in Section 5.2. Each robustness check column uses alternative parameter values as labelled, changing only one parameter value per check. Point estimates are reported as medians, with confidence intervals (5th and 95th percentiles across 500 model iterations) shown in brackets on the line below each estimate.