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# Quantifying the partial and general equilibrium effects of sanctions on Russia

**Lisandra Flach**[1] | **Inga Heiland**[2] | **Mario Larch**[3] | **Marina Steininger**[4] | **Feodora A. Teti**[5]

[1]LMU Munich, ifo Institute, CESifo, and CEPR, Munich, Germany

[2]Department of Economics, NTNU Trondheim, CEPR, and CESifo, Norway

[3]Department of Law and Economics, University of Bayreuth, CEPII, CESifo, and GEP, Germany

[4]Google, Munich, Germany

[5]LMU Munich, ifo Institute, and CESifo, Munich, Germany

**Correspondence**
Lisandra Flach, LMU Munich, ifo Munich, CESifo and CEPR, Munich, Germany.
Email: lisandra.flach@econ.lmu.de
Feodora A. Teti, Department of Economics, LMU Munich, ifo Institute, ifo Munich, and CESifo, Munich, Germany.
Email: teti@ifo.de

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**Abstract**

This paper evaluates the effects of sanctions on Russia between 2014 and 2019 and the resulting countersanctions. We estimate their impact on trade in a gravity framework, allowing for treatment heterogeneity among pairs and sectors, and use the estimated elasticities in a general equilibrium analysis. We find that the sanctions decreased trade with Russia in key sectors, translating to a loss in real income in Russia by 0.3%. Full decoupling of the EU and its allies from Russia would increase this effect to over 4%. Our results emphasize the role of deep sanctions as a foreign policy instrument and international cooperation.

**KEYWORDS**

general equilibrium, sanctions, structural gravity, treatment heterogeneity

**JEL CLASSIFICATION**

F1, F13, F14, F5, F51, H5, N4

## 1 | INTRODUCTION

Economic sanctions have become an important foreign policy tool in recent years (Felbermayr, Kirilakha, et al., 2020; Felbermayr, Syropoulos, et al., 2020). The year 2014 marked a turning point in the foreign policy relations with Russia: The annexation of the Crimean Peninsula by

Russia and the continuing armed conflict in eastern Ukraine placed considerable harm on Russia's political relations with the European Union (EU) and with other Western countries. In the wake of the 2014 conflict, several sanctions were imposed on Russia, including not only sanctions on individuals and institutions but also on the flow of goods, which Russia responded to with countersanctions. The significant escalation of the conflict in February 2022 called for more comprehensive sanctions against Russia and even for the complete decoupling of the Russian economy.

This paper evaluates the partial and general equilibrium effects of sanctions imposed against Russia during the period 2014–2019 and the countersanctions imposed by Russia (henceforth "2014 sanctions"). We provide an ex-post evaluation of the partial trade and general equilibrium trade and welfare effects of the sanctions based on new comprehensive databases that allow us to leverage the latest developments in the empirical gravity literature, such as the inclusion of trade in services and the use of domestic trade flows, as recommended by Yotov et al. (2016). From the gravity estimation, we obtain estimates of the partial effects of the 2014 sanctions on trade, emphasizing heterogeneity across sectors, sanctioning countries, and exports versus imports. Using a multicountry multisector general equilibrium trade model with input-output linkages, we then quantify the general equilibrium trade and welfare effects corresponding to the estimated partial trade effects. Second, we contrast the 2014 sanctions with additional counterfactual scenarios to quantify the value of coordination between the EU and its allies and the effects of a potential escalation of the economic war toward a complete decoupling of Russia from the EU or a larger group of allied countries. Third, we shed light on the quantitative importance of the indirect and unintended effects of sanctions.

The sanctions imposed on Russia between 2014 and 2019 comprise a bundle of measures. The initial package of "smart sanctions", restricting the activity of individuals and entities connected to the Russian government, imposed by the G7 and allied nations (henceforth, "G7plus") in 2014 was complemented over time with restrictions on trade flows. In particular, the G7plus imposed an embargo on imports and exports from and to Crimea and Sevastopol as well as on arms and related material. Furthermore, export bans were imposed on dual-use goods and technologies, that is, items and services that may be used for civil and military purposes, and on certain vital items for Russia's energy sector. Russia responded to these sanctions with an embargo of selected food and agricultural products.

In the empirical part of the paper, we show that the sanctions were effective in terms of impeding trade, specifically in areas that are key for Russia. Imports of manufacturing goods from the EU decreased by 12% and exports of mining products to a large range of sanctioning countries declined substantially as well. The Russian countersanctions, in turn, heavily reduced imports of agricultural goods from all the G7plus countries, by about 70%. We also find a large degree of heterogeneity across countries. For example, none of the non-EU countries included in the G7plus, except Switzerland, significantly reduced their manufacturing exports to Russia. Some sanctioning countries even increased trade with Russia.

In the simulation part of the paper, we employ a model framework based on Caliendo and Parro (2015), which is a multisector version of the Ricardian trade model by Eaton and Kortum (2002) that accounts for input-output linkages, to study the impact of the 2014 sanctions on trade and welfare in general equilibrium. We calibrate the model baseline to the world in 2014 and then simulate the response to trade cost shocks that mimic the estimated partial trade effects of the 2014 sanctions. Hence, we feed the estimated trade cost shocks into the model, and can therefore account for asymmetric costs across countries and sectors. According to the simulation, the 2014 sanctions had a sizable impact on the Russian economy, decreasing income by about 0.3% at a modest cost for the G7plus countries.

We contrast the effects of the 2014 sanctions, which were relatively “shallow”, with the predictions of a counterfactual “deep” sanctions scenario, where we simulate a complete embargo on any form of trade between Russia and the G7plus. Moreover, to shed light on the value of coordinating sanctions with multiple countries, we simulate two additional scenarios with “uncoordinated” sanctions, in which the EU imposes, respectively, shallow and deep sanctions on its own but the other G7plus countries are not restricting trade with Russia. The key findings from the comparison of the four scenarios are as follows: The deep sanctions are about 10 times as harsh as the shallow sanctions. Coordination of sanctions between the EU and its allies significantly increases the burden on Russia but does not noticeably reduce the impact on the EU countries. Among the sanctioning countries, the Eastern European countries bear the largest burden; third countries unambiguously gain.

Regarding trade flows, we find that Russia is able to redirect exports to a broad set of third countries, including the developing world. On the import side, however, adjustment appears to be more difficult. The simulated changes in trade flows show that only a subset of countries, including China, India, and Mexico, can provide substitutes for the goods previously sourced from G7plus, rendering Russia more dependent on a few sourcing locations. We also find that production in Russia can only partly substitute for the loss of imported goods. The shallow sanctions stimulate value added in agriculture, which gets shielded by the countersanctions, and manufacturing, benefiting from export restrictions imposed by the G7plus, but the total domestic sales in Russia do not grow. The deep sanctions strongly hurt Russia’s comparative advantage sectors, that is, mining and other energy-related industries, but stimulate domestic production in key manufacturing industries such as machinery and motor vehicle production. Total domestic sales in Russia, however, only grow by about 2%.

Our empirical gravity-based approach controls for the effects of sanctions in the most flexible way, that is, through dummy variables, which we call the “top-down” approach following Felbermayr et al. (2015) instead of including observable measures of the tightness of sanctions, often referred to as “bottom-up” approach. Hence, we capture the de-facto impact of the sanctions on trade, including not only the effects of direct restrictions on specific products but also indirect effects such as spillovers on nonsanctioned products, sanction-circumventing measures such as product relabeling, the indirect effects of nontrade-related sanction on trade flows, as well as the general level of enforcement. To shed light on the quantitative importance of indirect effects, we exploit information on product-level (CN8-level) direct trade restrictions stipulated in the legal text underlying the sanctions to calculate bottom-up estimates of the trade-cost equivalents of these restrictions. Hence, for the bottom-up approach, we extract information on the set of targeted products using the respective legal texts of the EU and Russia. For the other G7plus countries information on the product-level are not available to us. Therefore, we identify the type of targeted products, such as for example, technologies used in the oil-extracting sector or dual-use goods, and then use the same set of targeted products indicated by the EU legal texts as a proxy. With pre-2014 trade data, we can identify the targeted trade values.

We then simulate the corresponding general equilibrium adjustments and compare the results to those obtained with the top-down approach, that is, when we also account for the indirect effects of the sanctions. Overall, we find real income effects of a similar magnitude and a strong correlation (0.89) between the real income effects predicted by the two approaches, which is consistent with the interpretation that the narrowly defined, codified trade restrictions explain a lot of what we capture with the top-down approach. However, there are also interesting differences. The predicted changes in Russia's imports are strongly positively correlated as well, but the top-down approach predicts smaller changes. Moreover, the codified restrictions on Russian exports predict very little of the de facto changes. Both findings are consistent with the notion that there is imperfect enforcement, or that sanctioned products are being substituted or relabeled.

*Related literature*

The development of reliable and accessible new databases on sanctions and a recent surge in the use of sanctions have sparked new research on the effects of sanctions (Felbermayr et al., 2021). Much of the empirical literature focuses on quantifying the economic impact of sanctions on both sanctioning countries and sanctioned countries.[1] Methodologically, we build mainly on the literature using gravity to identify the effect of sanctions, which finds a strong and negative effect on bilateral trade flows (e.g., Afesorgbor, 2019; Cheptea & Gaigné, 2020; Crozet & Hinz, 2020; Dai et al., 2021; Hufbauer & Oegg, 2003). Felbermayr et al. (2019) show that the effectiveness of sanctions is widely heterogeneous across types of sanctions. Trade sanctions, that is, embargoes that prevent trade altogether or tariff hikes, have been found to be effective, while no significant effect can be found for travel, financial, and other types of sanctions.

Regarding sanctions imposed against Russia in the context of the war on Ukraine, Crozet and Hinz (2020) quantify the effects of the first round of sanctions in 2014 and predict a 7.4% reduction in Russian exports by the end of 2015. The exports from the West to Russia are negatively affected as well, but the impact is much smaller (0.3% reduction). In a related study, Crozet et al. (2021) explore firm heterogeneity and find that sanctions significantly lower firm-level probabilities of serving the Russian market. Furthermore, when sanctions are lifted, trade does not fully recover. In the context of the 2014 sanctions, also outcomes other than trade have been studied, such as consumer prices in Russia (Hinz & Monastyrenko, 2022), the Russian stock market (Huang & Lu, 2022), and cross-border financial flows of German firms (Besedeš et al., 2017). Additional research addresses the issues of trade deflection to third countries (Crozet & Hinz, 2020; Haidar, 2017) or smuggling (Tyazhelnikov et al., 2022) and the importance of coalitions.

Chowdhry et al. (2022) demonstrate quantitatively the importance of coalitions using a similar framework as ours to simulate different scenarios of coordination among sanctioning countries. They find that coordinated sanctions lower the average welfare loss incurred from sanctions relative to unilateral implementation while increasing the welfare loss imposed on the sanctioned country. Our work exhibits parallels with Chowdhry et al. (2022) but differs in important dimensions. In terms of the estimation of the gravity model, we use ITPD-E data instead of BACI data and in this way extend the framework by accounting for two margins in the gravity estimation: we account for domestic sales, as ITPD-E consistently includes internal trade data for 170 industries and 243 countries, and for trade in services besides trade in goods. As shown by Yotov et al. (2016), domestic trade flows are important for theory-consistent structural gravity estimation. Moreover, we estimate the coefficients for broad economic sectors based on the disaggregated data for the 170 industries and estimate heterogeneous treatment effects by sanctioning country rather than a common coefficient for all coalition members. The degree of heterogeneity turns out to be very large and we carry it over to our simulation of the general equilibrium effects. Hence, our comparison of coordinated (G7plus) and uncoordinated (EU only) sanctions does not require extrapolation of the estimated partial treatment effects to not-yet-treated countries, nor does it require assuming common partial effects for the coalition countries to quantify individual contributions, since we estimate an EU-specific effect. Furthermore, we believe that our general equilibrium results are otherwise complementary: In addition to welfare effects, which are at the core of the analysis in Chowdhry et al. (2022), we provide an analysis of trade flows to and from Russia and of the industry-level production adjustments within Russia to understand how the sanctions work. Finally, we contrast the gravity-based top-down approach to quantifying the trade effects of sanctions with bottom-up estimates informed by codified trade restrictions to shed light on the importance of direct (i.e., quantifiable) trade effects and indirect or unintended effects that are also picked up by the top-down approach.

The Russian invasion of Ukraine in 2022 led to a heated public debate on the stringency of the economic sanctions; critics claimed that the scope of the EU sanctions did not go far enough as they excluded the energy sector—the most important one for the Russian economy. Policymakers in Europe feared a deep recession when imposing an embargo on Russian gas due to the limited substitutability within the energy sector. To inform this highly relevant debate, much research has been conducted with the aim to quantify the effects of a gas embargo on GDP and inflation in Europe, using various economic methods and models. These studies predict a reduction of 1.2% to 2.2% of the Euro area GDP and of 0.9% to 6.0% of the German GDP in 2022. The German Council of Economic Exports provides an excellent overview (Berger et al., 2022). Our estimated welfare effects are smaller (0.3%–0.4% for Germany in the decoupling scenario), but not directly comparable to these results because of different time horizons of interest: while the above-mentioned strand of the literature focuses on short-run outcomes, our focus is on long-run effects. Comparing our headline results to the findings of Chowdhry et al. (2022), we find much smaller losses for Russia with regard to the 2014 sanctions (−0.3% in terms of real income compared to 1.8%) but much more similar effects for the deep sanctions (4.2% compared to 5.4%).[2]

Methodologically, our paper builds on a sizable literature that has used structural gravity models for trade policy analysis.[3] We estimate partial trade elasticities of sanctions making use of the latest developments in the field of theory-consistent gravity estimation described in Yotov et al. (2016). On the sanctions side, we rely on and extend the methods and analysis of (Felbermayr, Kirilakha, et al., 2020; Felbermayr, Syropoulos, et al., 2020), Larch et al. (2022), and Grant et al. (2021), which all offer recent applications of the gravity model to study various aspects of the effects of sanctions on trade. Larch et al. (2022) show that sanctions have been effective in impeding mining trade. They use similar, but previous versions, of the same data and similar methods, but estimate the impact of sanctions on international trade in mining only, whereas we use the coefficients estimated from a structural gravity equation for the universe of sanctions on Russia (including mining) to simulate the general equilibrium effects of sanctions in a second stage.

Our quantification of the effects of sanctions in general equilibrium is based on the model by Caliendo and Parro (2015). In contrast to Caliendo and Parro (2015), who study the general equilibrium effects of observed tariff changes, we inform the model with estimated cost shocks, obtained from a model-consistent gravity estimation, and counterfactual trade cost increases representing hypothetical sanction escalation scenarios. Felbermayr et al. (2015), Aichele and Heiland (2018), Felbermayr and Steininger (2019), Felbermayr et al. (2022), among others, use similar methodology to study the effects of various trade policies using combinations of observed, estimated, and counterfactual trade policy changes.

The rest of this paper is structured as follows: Section 2 provides a discussion of the sanctions imposed against Russia since 2014. Section 3 presents the estimation framework and the empirical results. Section 4 introduces the model. Section 5 presents the results from the general equilibrium analysis, and Section 6 concludes.

## 2 | SANCTIONS BETWEEN THE G7PLUS COUNTRIES AND RUSSIA SINCE 2014

This section starts summarizing the political events leading up to the sanctions imposed against Russia since 2014 and before 2022, as well as the ensuing countersanctions. In the second part, we report some descriptive statistics about the trade sanctions in force between 2014 and 2019.

*Background*

The sanctions against Russia were highly coordinated among the G7plus. Besides the EU and the United States, also Australia, Canada, Japan, Norway, Switzerland, Iceland, and Liechtenstein imposed diplomatic and smart sanctions; Albania and Montenegro followed the European sanction regime. The sanctions are a direct result of the geopolitical conflict about the reorientation of Ukraine toward the West that escalated with the annexation of Crimea by Russia in March 2014, and the invasion of Ukraine on February 24, 2022.

End of November 2013, the Ukrainian government decided not to sign the Association Agreement with the EU, which was first proposed by the EU in 2008 and can be considered the first step to full EU membership. Instead, pressured by Russia, President Yanukovych pushed for closer ties with Russia and wanted to join the Eurasian Economic Union (EEU), a customs union consisting of Russia, Armenia, Belarus, Kazakhstan, and the Kyrgyz Republic. The sudden change in foreign policy as well as the presumably Russian interference sparked nationwide protests and riots over the future political orientation of Ukraine, called “Euromaidan”. The protests went on for three months and remained largely peaceful until February 20, 2014, when snipers shot into the crowds of protesters on the Maidan. Shortly after, President Yanukovych signed a settlement agreement with the leaders of the parliamentary opposition that reduced the president’s power and called for early elections. One day later, he fled to Russia. The new government turned its back on Russia and eventually signed the association agreement with the EU.

On the Crimean Peninsula, government supporters protested the new regime. The situation escalated at the end of February 2014 when Russian troops and separatists occupied the Crimean Parliament building and other key facilities demanding a referendum on Crimea’s independence. By early March, Russian separatists had secured the entire peninsula; on March 6, the Crimean Supreme Council voted to ask to accede to Russia with the referendum taking place ten days later. Despite irregularities during the vote casting and the outraged outcry of the international community, on March 18, Crimean and Russian officials signed the Treaty of Accession of the Republic of Crimea to Russia; three days later, Crimea was formally integrated into Russia. By then, military bases throughout the peninsula had been occupied by Russian soldiers and the Ukrainian government initiated the evacuation of military personnel.

The international community reacted to the illegitimate Russian annexation of Crimea with wide-ranging sanctions: First, international relations significantly cooled down, that is, the EU-Russia summit was canceled, and Russia was excluded from the group of G8. Furthermore, multiple G7plus countries, led by the EU and the United States, implemented targeted or “smart” sanctions by issuing travel bans and asset freezes against *persons responsible for actions which undermine or threaten the territorial integrity, sovereignty and independence of Ukraine* (Official Journal of the European Union, 2014); entities that are considered to support actions against Ukraine were targeted as well by prohibiting any business transactions. The list of sanctioned persons and the number of entities has been progressively widened and by the end of 2014, the EU list contained 132 individuals and 28 entities.[4]

The number of targeted individuals and entities varied across the G7plus countries with the EU and the United States having the broadest coverage. The goal of the smart sanctions is to target the cronies of Russian President Vladimir Putin and therefore, increase pressure on the regime to make a policy change while minimizing collateral damage on the Russian population (Ashford, 2016).

Despite the sanctions by the G7plus countries, the military conflict at the border between Donetsk, Luhansk, and Ukraine escalated resulting in the crash of the Malaysian Airlines flight MH17 on July 17, 2014. The MH17 was shot down over the Donbas region killing all 298 passengers[5] and triggered another wave of sanctions. Besides financial sanctions against Russian banks, the G7plus countries started to widen the scope of the sanctions by restricting trade with Russia, as summarized in Table 1. In particular, the G7plus imposed an embargo on imports and exports from and to Crimea and Sevastopol as well as on arms and related material. Furthermore, export bans on dual-use goods and technologies, that is, items and services that may be used for civil and military purposes such as certain types of vehicles or chemicals, and on certain items for Russia's energy sector. Russia responded to these sanctions with an embargo of selected food and agricultural products. Most interestingly, Japan was not as hawkish as the rest of the G7plus countries and imposed less strict restrictions on exports to Russia, that is, the exports of oil technologies were not regulated. Russia returned the favor and did not ban Japanese imports of foodstuff; Switzerland was not affected either.

Over the next seven years, the sanctions have been renewed multiple times and broadened in scope by adding more names to the list of targeted individuals. Nevertheless, the war in eastern Ukraine went on. During the entire conflict period from April 14, 2014 to January 31 2023, the UN recorded more than 3100 conflict-related deaths (not taking into account the 298 people on board the Malaysian Airline flight), and the number of injured civilians is estimated to exceed 7000 (United Nations Human Rights, 2022). In late 2021, the United States warned its allies about Russian troops moving to Ukraine's border for a likely invasion; a few weeks later, on February 24, Russia started its armed attack against Ukraine.[6] The Russian invasion of Ukraine has prompted another wave of coordinated economic sanctions by a broad coalition of countries. Given that our focus is on the first wave of sanctions, we refer the interested reader to other excellent overviews such as the summary provided by the Peterson Institute.[7]

*Descriptive statistics*

To understand better which sectors have been affected the most by trade sanctions, we map the different regimes to CN8-product codes. To do so, we use the information provided by the EU Commission available through TARIC[8] that allows us to identify the product codes that are affected by the EU sanctions. We end up with a list of CN8-product codes for which the EU imposes sanctions on trade with Russia (either imports, exports, or both). For the other EU's allies, we do not have access to comparably high-quality data. However, the legal texts are very similar reflecting the high degree of coordination. Therefore, we feel confident to proxy the sanctions for all other allies with the data we gathered for the EU. Product-level information about the Russian countersanctions is taken from Crozet and Hinz (2020). To combine the granular details on the sanctions with international trade data, we aggregate to the six digit-level by assuming every product to be affected by the sanctions if at least one of the respective CN8-product codes is restricted.

The sanctions imposed by the G7plus countries affect 256 six-digit manufacturing products. Most sanctions regulate imports from Russia as well as exports to Russia (223 products have both an import and export ban). The Russian countersanctions affect 385 six-digit agricultural

**TABLE 1** Overview of trade sanctions between the G7plus countries and Russia over the annexation of crimea.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | Arms | Dual-Use | Oil techn. | Counter | Agri. (in %) | | Manu. (in %) | |
| Country | *im-/exports* | *exports* | *exports* | *RUS imports* | Exp. | Imp. | Exp. | Imp. |
| EU28 | Yes | Yes | Yes | Yes | 59 | 0 | 40 | 3 |
| USA | Yes | Yes | Yes | Yes | 25 | 0 | 36 | 3 |
| AUS | Yes | Yes | Yes | Yes | 5 | 0 | 25 | 1 |
| CAN | Yes | Yes | Yes | Yes | 10 | 0 | 51 | 5 |
| JPN | Yes | Yes | — | — | 0 | 0 | 61 | 8 |
| NOR | Yes | Yes | Yes | Yes | 99 | 0 | 44 | 1 |
| CHE | Yes | Yes | Yes | — | 0 | 0 | 2 | 0.01 |
| LIE | Yes | Yes | Yes | Yes | —no trade data— | | | |
| ALB | Yes | Yes | Yes | Yes | 44 | 0 | 40 | 3 |
| MNE | Yes | Yes | Yes | Yes | 96 | 0 | 6 | 34 |
| ISL | Yes | Yes | Yes | Yes | 1 | 0 | 68 | 1 |

*Sources*: The table summarizes the sanctions between the G7plus countries and Russia after the annexation of Crimea. *European Union (EU28)*: Council Regulation No 629/2014, Council Regulation No 833/2014; *United States (USA)*: E.O. 13685, UFSA; P.L. 113-272, Federal Register / Vol. 79, No. 180, Federal Register / Vol. 79, No. 151; *Australia (AUS)*: F2015L00390; *Canada (CAN)*: SOR/2014-58; *Japan (JPN)*: 2014 0728 Trade Bureau No. 1 Import Notes 26 No. 28, https://www.mofa.go.jp/press/release/press4e_000446.html; *Norway (NOR)*: LOV-2021-04-16-18-§2 Forskrift om restriktive tiltak vedrørende handlinger som undergraver eller truer Ukrainas territorielle integritet, suverenitet, uavhengighet og stabilitet; *Switzerland (CHE)*: 946.231.176.72, *Liechtenstein (LIE)*: https://www.llv.li/de/landesverwaltung/amt-fuer-auswaertige-angelegenheiten/themen/sicherheit-und-verbrechenspraevention/internationale-sanktionen; *Albania (ALB)*: https://www.europarl.europa.eu/RegData/etudes/IDAN/2022/639327/EXPO_IDA(2022)639327_EN.pdf; *Montenegro (MNE)*: https://www.europarl.europa.eu/RegData/etudes/IDAN/2022/639327/EXPO_IDA(2022)639327_EN.pdf; *Iceland (ISL)*: https://www.government.is/media/utanrikisraduneyti-media/media/MFA_pdf/MFA-Sanctions-Evaluation-of-interests.pdf; *Russian countersanctions*: http://government.ru/en/news/14199/, http://government.ru/docs/19265/. Columns (5) to (8) gives the affected trade shares of exports to ((5) and (7)) and imports from (columns (6) and (8)) from Russia for the respective G7plus country. Trade data for 2012 are from CEPII, HS-codes for sanctions of the West from Taric, and HS-codes for products that are affected by Russian countersanctions are taken from Crozet and Hinz (2020). The mining sector was not affected at all by the trade sanctions.

products. Combining the sanctions data with trade values from 2012, we calculate the affected trade shares for the three broad sectors of agriculture, mining, and manufacturing.[9] Columns (5) to (8) of Table 1 show the share of 2012 trade, that is, before the conflict started, that is affected by at least one sanction regime, that is, import or export ban by the G7plus countries or the Russian countersanctions. We immediately see large asymmetries across sectors and the direction of trade: first, the mining sector is not directly affected by any sanctions. Second, exports to Russia are stronger affected by sanctions than imports from Russia. Third, the share of affected trade varies substantially across countries. While trade between Russia, Australia, and Switzerland is barely affected by the sanctions, for the EU 59% of trade in agricultural products and 40% of manufacturing is affected. In our empirical strategy, we will explicitly model these asymmetries.

## 3 | EMPIRICAL STRATEGY, DATA AND THE PARTIAL EQUILIBRIUM EFFECTS FROM THE 2014 SANCTIONS ON RUSSIA

We capitalize on two new data sets (the ITPD-E-R02 and the GSDB Release 3) and on the latest developments in the gravity literature and some recent papers evaluating the impact of sanctions in order to obtain estimates of the impact of the 2014 sanctions on Russia. We describe our empirical strategy and the data and sources that we employ in Section 3.1 and present and discuss the results in Section 3.2.

### 3.1 | Empirical strategy and data

This section describes our estimation approach and the data used. In order to estimate the impact of the sanctions on Russia, we combine the latest developments and insights from the gravity literature on international trade with some recent contributions that evaluate the impact of sanctions on trade. We start by setting up our estimating equation and then describe its components and key features and the motivation behind each of them:

$$X^j_{in,t} = \exp\left[\delta^j_{i,t} + \chi^j_{n,t} + \mu^j_{in} + \sum_t \alpha^j_t BRDR^j_{in,t} + \mathbf{GRAV}_{in,t}\boldsymbol{\beta} + \mathbf{SANCT}_{in,t}\boldsymbol{\gamma}\right] \times \epsilon^j_{in,t}. \tag{1}$$

The estimating equation given in Equation (1) can be derived from alternative theoretical micro-foundations, compare, Anderson (2011), Arkolakis et al. (2012), Costinot and Rodríguez-Clare (2014), Head and Mayer (2014), Yotov et al. (2016), and, most importantly, is consistent with the theoretical framework used for our counterfactual analysis.

$X^j_{in,t}$ denotes nominal trade flows in industry $j$, from exporter $i$ to importer $n$ at time $t$. $X^j_{in,t}$ enters Equation (1) in levels because we estimate our specifications with the Poisson Pseudo Maximum Likelihood (PPML) estimator, compare, Silva et al. (2006, 2011). Estimating the model in levels and using the PPML estimator takes into account the heteroskedasticity of trade flow data and allows the inclusion of zero trade flows. Our trade data come from the International Trade and Production Database for Estimation (ITPD-E, Release 2), developed by Borchert et al. (2021, 2022b).[10] In terms of time coverage, ITPD-E Release 2 covers the years 1986–2019 for agriculture, the years 1988–2019 for manufacturing and mining and energy, and the years 2000–2019 for services. This predetermines the time period for our analysis. The main reason for using ITPD-E is that, in addition to international trade flows, the ITPD-E also includes consistently constructed internal trade data, that is, data on domestic sales, and it covers not only manufacturing, but also agriculture, mining, and services trade. As demonstrated by Yotov et al. (2016) and summarized in 15 reasons by Yotov (2022), the presence of domestic trade flows is important for theory-consistent structural gravity estimations of the effects of various policies. The number of countries in ITPD-E Release 2 is 265. ITPD-E covers 170 industries, of which 28 are in agriculture, 7 are in mining and energy, 118 are in manufacturing, and 17 are in services. Due to the separability property of the structural gravity model, Equation (1) holds for each individual industry in our sample, compare, Anderson and van Wincoop (2004) and Costinot et al. (2012). To obtain our main estimates we use the industry level to utilize all available information but pool the data to the four broad sectors of agriculture, mining and energy, manufacturing, or services.[11]

The exporter-industry-time ($\delta^j_{i,t}$) and importer-industry-time ($\chi^j_{n,t}$) fixed effects are included to control for all exporter-industry-time and importer-industry-time determinants of trade flows, for example, country-industry-specific productivity, output, expenditure, the structural multilateral resistances of Anderson and van Wincoop (2003). $\mu^j_{in}$ is a set of country-pair-industry fixed effects, which mitigate endogeneity concerns, compare, Baier and Bergstrand (2007) since they absorb all time-invariant bilateral determinants of sectoral trade flows, compare, Egger and Nigai (2015) and Agnosteva et al. (2019). Following Baier et al. (2019), we allow for the country-pair-industry fixed effects to be directional, that is, depending on the direction of trade flows. Following Bergstrand et al. (2015), $BRDR^j_{in,t}$ denotes a set of time-varying bilateral border dummy variables, which take a value of one for international trade, and are equal to zero for domestic trade for each year $t$ and in each industry $j$. The purpose of the border dummies is to control for industry-specific globalization trends.

The vector $\mathbf{GRAV}_{in,t}$ includes time-varying policy covariates including a dummy variable to account for the presence of regional trade agreements ($RTA_{in,t}$), which takes a value of one if there is an RTA between countries $i$ and $n$ at time $t$, and is equal to zero otherwise; and an indicator variable for membership in the World Trade Organization ($WTO_{in,t}$). The RTA data come from Mario Larch's Regional Trade Agreements Database, compare, Egger and Larch (2008)[12], and we define RTAs as the sum of Free Trade Agreements (FTAs), Customs Unions (CUs), Economic Integration Agreements (EIAs), and agreements that were a combination of CUs and EIAs and FTAs and EIAs. Data on WTO membership come from the Dynamic Gravity Database of the US International Trade Commission, compare, Gurevich and Herman (2018). Time-invariant gravity covariates (e.g., bilateral distance) are not included because they will be absorbed by the pair fixed effects.

$\mathbf{SANCT}_{in,t}$ is a vector of sanction variables that are of central interest to us. To account for the asymmetry in the sanctions regimes that have been triggered by the annexation of Crimea, we identify the effect of the sanctions between the G7plus countries and Russia. We allow the effects to vary between imports and exports since, for example, for manufacturing, the sanction regime of the G7plus countries is restricting trade, but for agriculture, the Russian countersanctions reduce market access. First, we include a dummy variable that equals one if Russia exports to (or imports from) one of the G7plus countries and zero otherwise, for the years 2015 and later.[13] As Russian imports from Japan were not affected by the Russian countersanctions we only include a sanctions variable that equals one if Russia exports to Japan. Second, we allow for even greater degrees of heterogeneity and split the effects by countries and direction. Specifically, we construct several indicator variables for the trade flows between the respective G7plus country and Russia.[14] In addition, we also control for other complete trade sanctions and other remaining trade sanctions that have been imposed between other countries in the sample during the period of investigation. The data for these control variables come from the Global Sanctions Data Base (GSDB) Release 3, see Felbermayr, Kirilakha, et al. (2020), Kirilakha et al. (Forthcoming), Syropoulos et al. (Forthcoming).[15] The GSDB covers all publicly traceable multilateral, plurilateral, as well as purely bilateral sanctions over the period 1950–2022. The GSDB includes 1325 sanction cases, which are classified by type into six categories that cover trade, financial activity, arms, military assistance, travel, and other sanctions.

We deliberately chose an empirical approach that controls for the effects of sanctions in the most flexible way, that is, through dummy variables (top-down approach) instead of only including observable sanctions, for example, by measuring the extent of the sanctions only by the covered trade (bottom-up approach).[16] The clear advantage of the top-down approach is that it takes into account all effects of sanctions. On the one hand, there might be unobservables that amplify the effect of observable sanctions because they include spillover effects on unrestricted products caused by uncertainty about the interpretation of the law or by uncertainty about future extensions of the sanctions package, by firms concerned about their reputation and by politically-motivated changes in consumers' choices. Moreover, the dummies capture any potential impact of nontrade-related sanctions on trade flows, such as sanctions on individuals and financial institutions. On the other hand, there might also exist other relevant channels that work against finding a negative effect of sanctions on trade, such as product relabelling or lack of enforcement. Moreover, since we study trade at the sector level and thus aggregate sanctioned and nonsanctioned products, the substitution of products within sectors on the part of the importer, stemming from changes in consumption baskets or from changes in the input mix of firms, will also ameliorate the estimated de-facto trade changes at the sector level. Our top-down methodology combines the structure of the gravity model with trade data to extract the net impact of all intended and unintended effects of the sanctions on bilateral trade, accounting for heterogeneity at the country-pair and sector level. In the general equilibrium analysis below, we will contrast the outcome of the top-down approach with predictions based on bottom-up measures of the quantifiable part of the trade sanctions that we extract from the relevant legal texts to shed light on the importance of indirect and other effects of sanctions on trade that are hard to quantify directly.

Following the recommendations of Egger et al. (2022), we estimate our specifications using consecutive-year data, as opposed to interval data as recommended by Cheng and Wall (2005). Given the rich structure of fixed effects in each of our specifications, we believe that it is safe to assume that the error term $\epsilon^{j}_{in,t}$ does no longer contain systematic information correlated with our regressors of interest. Finally, the standard errors in all sectoral specifications are clustered by country-pair-industry.

## 3.2 | Estimation results

*Main results*

We first provide evidence across broad economic sectors using a common sanction coefficient for all bilateral trade flows that were sanctioned, either because of the import or export bans imposed by the G7plus countries or because of the Russian countersanctions. Results presented in Table 2 are based on a symmetric time window (2010–2019) and are conducted using the disaggregated data for all 170 industries following the empirical specification given in Equation (1). Our baseline results in Table 2 show negative and significant effects of sanctions on both Russian imports (RUS Imports) and Russian exports (RUS Exports) using a common sanction coefficient for the countries that imposed sanctions against Russia (column 5). Across all 170 industries, Russian imports decreased by 10.85% ((exp(−0.115) − 1) × 100) and exports decreased by roughly 13%, that is, the effects on the exports and imports are of similar magnitude. Chowdhry et al. (2022) also find similar effects for the effects of sanctions on Russia on imports and exports, even though their partial effects are smaller in magnitude.

The results shown in Table 2 already indicate the importance of accounting for heterogeneous treatment. In particular Russian imports of agricultural products observe a large, negative effect, with a predicted decrease in trade of about 68.84%, but also Russian imports in manufacturing decreased by roughly 11.30%. For agriculture, as shown in column 1, the negative effect on Russian imports is large and significant, whereas the effect on exports is significant for Russian exports to Japan but not to the remaining countries that imposed sanctions. For mining (column 2), sanctions have a negative effect on trade flows only for Russian exports whereas for manufacturing the effect is negative and significant for Russian imports. Recall that the main export industries of Russia include oil, mineral, fuels, iron and steel, and cereals. On the other hand, manufacturing industries such as machinery, motor vehicles and parts, as well as pharmaceuticals are the main industries among Russian imports. Hence, results reported in columns 2 and 3 suggest that the G7plus sanctions effectively targeted the most important flows to and from Russia. The negative effect of Russian imports of agricultural products (column 1) is evidence of the effectiveness of Russia's countersanctions. Perhaps surprisingly, we find that services imports by Russia increased, as shown in column 4. With the exception of services for civil and military purposes, services were not affected by sanctions. The positive effect could reflect, for instance, the repatriation of activities of Russian-owned multinational firms, or payments for diverted trade flows that are reported as services.

As discussed in Section 2, sanctions against Russia were highly coordinated among G7plus countries. However, there are several reasons why we expect the sanctions package to affect

**TABLE 2** Impact of the 2014 sanctions on bilateral trade across broad economic sectors.

| | (1) Agriculture | (2) Mining | (3) Manufacturing | (4) Services | (5) All |
|---|---|---|---|---|---|
| RUS imports | −1.166*** | 0.434 | −0.120*** | 0.252** | −0.115*** |
| | (0.175) | (0.414) | (0.030) | (0.125) | (0.030) |
| RUS exports | −0.085 | −0.298* | −0.065 | 0.119 | −0.139* |
| | (0.145) | (0.162) | (0.081) | (0.140) | (0.083) |
| RUS exports to | −0.682* | −0.052 | 0.153* | 0.176 | 0.058 |
| Japan | (0.375) | (0.142) | (0.092) | (0.142) | (0.098) |
| *N* | 1,697,799 | 294,034 | 18,931,771 | 370,866 | 21,311,860 |

*Note*: This table reports estimates of the effects of the 2014 sanctions between Russia and the G7plus countries on trade. The dependent variable is sectoral trade in levels, 2010–2019. All estimates are obtained with the PPML estimator and each sectoral specification includes exporter-industry-time fixed effects, importer-industry-time fixed effects, country-pair-industry fixed effects, and industry-time-varying border variables. In addition to the reported estimates that are of interest to us, we also control for the impact of other complete trade sanctions and other remaining trade sanctions, RTAs, and WTO membership. These estimates are omitted for brevity. Each column of this table reports estimates for one of the following sectors, agriculture (industries 1 to 28), mining and energy (industries 29 to 33), manufacturing (industries 36 to 153), services (industries 154 to 170), and all industries (industries 1 to 170), respectively. Standard errors are clustered by country pair-industry.
$^*p < .10$; $^{**}p < .05$; $^{***}p < .01$. See text for further details.

**TABLE 3** On the impact of the 2014 sanctions on Russia.

| | (1) Agriculture | (2) Mining | (3) Manufacturing | (4) Services |
|---|---|---|---|---|
| RUS_EU_IMP | −1.188*** | 0.677** | −0.133*** | 0.228* |
| | (0.191) | (0.277) | (0.031) | (0.132) |
| RUS_EU_EXP | −0.099 | −0.302* | −0.031 | 0.167 |
| | (0.153) | (0.165) | (0.084) | (0.149) |
| RUS_JPN_EXP | −0.681* | −0.052 | 0.145 | 0.173 |
| | (0.375) | (0.142) | (0.089) | (0.141) |
| RUS_USA_IMP | −0.983*** | −0.888 | 0.010 | 0.198 |
| | (0.305) | (1.349) | (0.053) | (0.141) |
| RUS_USA_EXP | 0.400 | −0.122 | −0.134 | −0.081 |
| | (0.355) | (0.170) | (0.142) | (0.166) |
| RUS_CHE_IMP | −0.824*** | 0.980*** | −0.050 | 0.577*** |
| | (0.279) | (0.291) | (0.067) | (0.157) |
| RUS_CHE_EXP | −0.187 | 0.835*** | −0.942*** | 0.039 |
| | (0.325) | (0.294) | (0.128) | (0.276) |
| RUS_AUS_IMP | −1.032*** | 0.607** | −0.240 | 0.423** |
| | (0.371) | (0.248) | (0.364) | (0.196) |
| RUS_AUS_EXP | −0.618 | −1.221*** | 0.366 | 0.319 |
| | (0.474) | (0.196) | (0.255) | (0.281) |
| RUS_CAN_IMP | −0.801*** | 0.836*** | −0.272 | 0.162 |
| | (0.238) | (0.278) | (0.172) | (0.148) |
| RUS_CAN_EXP | 0.147 | 0.294 | 0.226 | −0.129 |
| | (0.325) | (0.238) | (0.143) | (0.187) |
| RUS_NOR_IMP | −2.895*** | 1.232*** | −0.067 | 0.397* |
| | (0.324) | (0.305) | (0.339) | (0.222) |
| RUS_NOR_EXP | 0.113 | −0.731*** | 0.291** | −0.213 |
| | (0.243) | (0.230) | (0.119) | (0.238) |
| RUS_ALB_IMP | −4.212*** | −2.473*** | 0.356*** | 0.947 |
| | (0.833) | (0.301) | (0.129) | (1.136) |
| RUS_ALB_EXP | −0.255 | −0.683 | 0.829*** | 0.485 |
| | (0.513) | (0.900) | (0.275) | (0.895) |
| RUS_ISL_IMP | −0.625 | −2.311*** | −0.592 | 0.360 |
| | (0.442) | (0.419) | (0.453) | (0.336) |
| RUS_ISL_EXP | | 4.365*** | 0.165 | 0.367* |
| | | (0.887) | (0.775) | (0.193) |
| *N* | 1,697,799 | 294,034 | 18,931,771 | 370,866 |

*Note*: This table reports estimates of the effects of the 2014 sanctions between Russia and the G7plus countries on trade. The dependent variable is sectoral trade in levels, 2010–2019. All estimates are obtained with the PPML estimator and each sectoral specification includes exporter-industry-time fixed effects, importer-industry-time fixed effects, country-pair-industry fixed effects, and industry-time-varying border variables. In addition to the reported estimates that are of interest to us, we also control for the impact of other complete trade sanctions and other remaining trade sanctions, RTAs, and WTO membership. These estimates are omitted for brevity. Each column of this table reports estimates for one of the following sectors, agriculture (industries 1 to 28), mining and energy (industries 29 to 33), manufacturing (industries 36 to 153), and services (industries 154 to 170), respectively. Standard errors are clustered by country-pair-industry.

$^{*}p < 0.10$; $^{**}p < .05$; $^{***}p < .01$. See text for further details.

trade flows between the individual G7plus countries and Russia in a heterogeneous fashion. For example, the aforementioned spillover effects or sanction-circumventing measures captured by our top-down estimates are likely to play out differently for different countries. Also, trade restrictions at the product level have country-specific effects due to the product composition of sectoral and aggregate imports and exports. Moreover, some of the sanctions that did not target trade directly, for example, the sanctioning of individuals and entities, by design affect only a subset of the sanctioning countries. Therefore, we proceed with estimating the effects of the sanctions by country (group). The results are presented in Table 3.

The coefficients shown in Table 3 confirm the presumption that the effects of the sanctions are very heterogeneous and underscore our previous result that accounting for directional effects is important. Column (1) shows the coefficients for agriculture, where we find the most homogeneous effects among the four sectors. Overall, we see that the sanctions decreased Russian imports from most of the countries involved. Russian imports from the EU are predicted to be about 70% $((\exp(-1.188) - 1) \times 100)$ lower due to the sanctions. We find significant effects of similar size also for the US, Switzerland, Australia, and Canada. Russian agricultural imports from Norway and Albania fall substantially more. For Iceland, we find negative but nonsignificant results for Russian imports. In line with the aggregate results presented in Table 2 and the design of the (counter-)sanctions laid out in Table 1, we find hardly any significant effects in terms of Russia's agricultural exports. Only Russian exports to Japan are significantly negatively affected; the implied decrease in trade is about 50%. Overall, our results are consistent with and complement the findings of Grant et al. (2021) who use the ITPD-E and the GSDB datasets to study the impact of sanctions on agricultural trade.

The estimates in column (2) are for mining. In contrast to the results for agriculture, we find diverse effects of sanctions on Russian imports and exports. Significant and negative partial effects of sanctions for Russian imports obtain only for Albania and Iceland. For Russian imports from the EU, Switzerland, Australia, Canada, and Norway we even find positive, significant effects. In terms of Russian exports, we find a decrease in exports to the EU, Australia, and Norway, while exports to Switzerland and Iceland are predicted to increase. Overall, our results are consistent with the findings of Larch et al. (2022) who use the ITPD-E and the GSDB datasets to study the impact of sanctions on trade in mining, particularly for the sanctions imposed against Russia.

The estimates in column (3) are for manufacturing, where we find very heterogeneous effects across countries as well. The results identify the EU as the driving force behind the decline in Russian manufacturing imports. Except for Switzerland, we find no significant reductions of Russian imports from sanctioning countries. Confirming the aggregate results in Table 2, Russian exports of manufacturing were barely affected. Moreover, we find three estimates that are positive and significant: Russian exports to Norway and Russian imports and exports from and to Albania actually increased relative to the other countries in our samples.

The estimates in column (4) are for services and, as for the other three sectors, quite heterogeneous. Interestingly, we find not a single, negative and significant effect and some positive significant results: Russian imports from the EU, Switzerland, Australia, and Norway increased relative to the nonsanctioning countries in our sample. For Iceland, we find a positive, significant effect on Russian exports.

Overall, our findings show that the aggregate effects in Table 2 mask important cross-sanctioning-country heterogeneity. Some sanctioning countries, including the EU, exported more (possibly nonsanctioned) products and services to Russia relative to the other countries in our sample, suggesting the prevalence of indirect and unintended (from the point of view of the G7plus) responses to the trade barriers in other sectors. In our general equilibrium analysis of the

2014 sanctions below, we will take the full degree of heterogeneity of trade effects into account, thus capturing direct and indirect effects, intended and unintended. We will inform the simulations with changes in trade barriers that are consistent with the partial trade effects displayed in Table 3, including the positive ones (but limit ourselves to the effects that are significant at the 10% level).

*Robustness checks*

Before turning to the general equilibrium analysis, we discuss the robustness of our estimates. Results in Table 3 are based on a symmetric time window (2010–2019). In Table B1 we provide results based on all data available, that is, using the years 1986–2019 for agriculture, the years 1988–2019 for manufacturing as well as mining and energy, and the years 2000–2019 for services. Results are quantitatively and qualitatively relatively robust. The most notable changes are in mining, where we were able to obtain estimates including also sectors 34 (Electricity production, collection, and distribution) and 35 (Gas production and distribution) when utilizing all years available. However, note that we mainly lose significance for some positive effects, such as for Russian imports from the EU, Switzerland, Australia, and Canada.

For our main results in Table 3 we kept the industry-level of our data. As a robustness check, we re-run our regressions when aggregating the data to one observation per pair and year for each of the broad sectors of agriculture, mining and energy, manufacturing, and services. The corresponding results are reported in Table B2. Effects that were significant in Table 3 are typically also significant and have the same sign as the aggregated data. This is especially true for agriculture and manufacturing, where results seem to be most robust.

As described above, we treated 2015 as the first year when the sanctions were in force motivated by the fact that many sanctions restricting trade came into place only in the middle or later in 2014. As a robustness check, we also provide results using 2014 as the first sanction year. When comparing the results from Table 3 with the results provided in Table B3 treating 2014 as the first year with sanctions and using the years 2008 to 2019 as data to have the same number of years before and after the sanctions came in place, we see that the results are very robust and similar to those obtained with our main specification, both in terms of the direction and magnitude. If one wants to look for differences, we no longer get significant effects for Russian imports from Australia in agriculture, but Russian exports to Canada and Norway turn significant. In mining, Russian imports from and exports to Switzerland and Russian exports to Iceland lose significance, but Russian exports to Canada turn significant. In manufacturing Russian exports to Albania lose significance, and in services, exports from Russia to Iceland lose significance.

Dropping domestic sales data leads to a very similar picture in terms of the sanction effects (see results reported in Table B4 in comparison to the results reported in Table 3). On the one hand side, this shows that the sanction effects are not heavily influenced by whether we also include domestic sales or not. Hence, in our sample with many countries and with only a few countries imposing sanctions against Russia, variation across international trade is the main, important source to identify the sanction effects. Furthermore, our specification used for the results in Table 3 includes industry-time varying border effects that control for a large part of the differences between domestic sales and international trade. The most significant changes are in services, where most notably the effects of Russian imports and exports to and from Albania turn negative and significant.

Overall, based on these estimates we conclude that the 2014 sanctions on Russia have been effective in impeding Russian trade, specifically in areas that are key for Russia. Imports of manufacturing goods from the EU and exports of mining products to a larger range of sanctioning countries declined substantially. The Russian countersanctions, in turn, heavily reduced imports of agricultural goods from all the G7plus countries.

## 4 | THEORETICAL FRAMEWORK FOR QUANTIFYING THE GENERAL EQUILIBRIUM EFFECTS OF SANCTIONS

To quantify the general equilibrium effects from sanctions, we use a computable general equilibrium framework, which gives rise to a theoretical foundation of the gravity equation. The theoretical framework is based on Caliendo and Parro (2015), who provide a multisector version of the Ricardian trade model by Eaton and Kortum (2002) with input-output linkages. In addition, we follow previous work (see Aichele & Heiland, 2018; Felbermayr et al., 2022; and Felbermayr & Steininger, 2019) and include services trade, nontariff barriers, and treatment heterogeneity in this framework. The model is static and assumes that technology is fixed. The comparative statics exercises we conduct compare the baseline equilibrium to counterfactual long-run equilibria featuring different levels of trade barriers. Short-run effects and the adjustment path are thus not considered. In this section, we present a nontechnical summary of the model environment and the adjustment mechanisms that are at work in our general equilibrium analysis of counterfactual trade cost changes. Analytical details, which closely track Caliendo and Parro (2015), are relegated to Appendix A.

The model features multiple countries and multiple industries that are connected via input-output linkages. Each country produces varieties of each sectoral good using labor and a bundle of intermediate inputs, and an aggregate good in every sector that combines domestic and imported varieties. The intermediate input bundle contains the aggregate goods from other sectors, with input shares that reflect the sectoral input-output linkages in each economy and vary by country and sector of demand as well as by sector of supply. The aggregate sectoral goods are also sold to domestic consumers that spend a constant share of their income on each sectoral good.

Demand for imported varieties in each sector follows a gravity equation. As in Eaton and Kortum (2002), import shares reflect the relative competitiveness of a source country in producing and shipping varieties to a specific destination, which is determined by a source-country and sector-specific average productivity level and bilateral sector-specific trade costs.

The model is closed with an income-equals-expenditure condition that pins down the wage in every country. The model allows for unbalanced trade, treating trade surpluses as transfers. Following Caliendo and Parro (2015), we hold trade surpluses constant in the counterfactual equilibrium.

### 4.1 | Comparative statics in general equilibrium

We are interested in the effects of sanctions on Russia on trade flows, wages, sectoral value-added, and real income (as our measure of welfare). Hence, we need to quantify the comparative static effects of changes in nontariff barriers on endogenous quantities such as trade flows, wages, sectoral value-added, production, and tariff income. Following Caliendo and Parro (2015) and Dekle et al. (2008), we solve the model in global changes using "hat algebra".[17]

The direct and indirect effects induced by trade cost shocks are manifold. Consider an increase in bilateral trade costs between origin $i$ and destination $n$ for varieties of $j$, $\kappa_{in}^{j}$. As a direct consequence, country $i$'s relative competitiveness in serving market $n$ with sector $j$ goods is reduced.

Hence, the trade share declines. Furthermore, there are multiple indirect adjustments. First, higher prices for imported intermediate inputs raise the production cost of all sectors in the importing country. These cost increases are passed on further along the value chain to all sectors in all countries, with the strength of the effect determined by the intensity of the input-output relationship. The resulting differential cost changes feed back into relative competitiveness changes of all sectors from all countries in all destination markets. Second, countries experiencing greater losses in competitiveness experience a decline in demand for their goods, widening their trade deficit. The corresponding decline in demand for labor reduces wages. Exports increase as lower wages partly restore competitiveness and imports decline due to lower incomes until the initial deficit is restored. Third, income changes and output changes caused by changes in relative competitiveness spill over to other countries via changes in demand for imports. Given the richness of direct and indirect mechanisms, general equilibrium adjustments to a trade cost shock are very diverse. Yet, as a general tendency, a country experiencing a positive trade cost shock sees wages decline in order to restore competitiveness. Third countries benefit from greater market access but tend to lose if they rely strongly on inputs or demand from the affected countries.

### 4.2 | Model calibration

We calibrate the baseline equilibrium for our simulations to the year 2014 using the World Input–Output Tables from the World Input–Output Database (WIOD) (Timmer et al., 2015). We match the consumption, production, and trade patterns of 43 countries (plus an aggregate region representing the rest of the world) and 50 sectors.[18] Specifically, we perfectly match bilateral sectoral trade flows, sectoral value added, sectoral final goods expenditure shares, and cross-sectoral intermediate input coefficients in all countries. Moreover, we use tariffs from the WITS database for the calibration of the baseline trade shares including tariffs and initial tariff revenues. Finally, in line with the extant literature, we set the trade cost elasticity $-1/\theta$ equal to $-5$.

## 5 | GENERAL EQUILIBRIUM EFFECTS OF SANCTIONS ON RUSSIA

In this section, we present the results from the evaluation of the general equilibrium effects of sanctions based on the theoretical framework described in Section 4. We analyze the following four scenarios.

*Scenario 1 (S1)–EU uncoordinated shallow sanctions on Russia*

We evaluate the effects of the sanctions imposed by the EU on Russia in 2014 and the countersanctions imposed by Russia. We implement the scenario by converting the estimated partial trade effects for the EU–Russia trade relationships in Table 3 into country-pair-sector-specific trade cost shifters and then simulate the general equilibrium responses to these shocks in our model.[19]

*Scenario 2 (S2)–Coordinated shallow sanctions on Russia*

We evaluate the effects of the sanctions against Russia that the G7plus countries imposed in a coordinated fashion in 2014 and the countersanctions imposed by Russia. G7plus countries are defined here as the EU, US, Japan, Australia, Switzerland, and Norway, which are the countries that imposed sanctions against Russia in 2014 and are covered by our sample. As in S1, we use the estimated partial trade effects—converted to cost shifters—as input for the simulation, but add the estimated effects for the EU's allies. S2 corresponds to a counterfactual analysis of the consequences of the actual 2014 sanctions. S1 informs us about how much the EU could have achieved on its own.

*Scenario 3 (S3)–EU uncoordinated deep sanctions on Russia (full embargo)*
We evaluate the effect of a counterfactual decoupling of Russia from the EU. In this scenario, we increase nontariff barriers between the EU and Russia such that the higher trade costs approximate the situation of a full embargo.

*Scenario (S4)–Coordinated deep sanctions on Russia (full embargo)*
We evaluate the effect of sanctions against Russia when the G7plus countries coordinate the sanctions and jointly embargo any trade with Russia. In this scenario, we increase nontariff barriers between the G7plus countries and Russia such that the higher trade costs approximate the situation of a full embargo.

Since our model is built on the assumption that production factors are perfectly mobile across sectors, the simulated counterfactual changes are best interpreted as long-run consequences of the different sanction scenarios. Our model is static and we simulate effects on flow variables, such as periodic (say, annual) income. Hence, a predicted income loss of $x\%$ means that in every year in which the sanctions are in place, income is $x\%$ smaller compared to the baseline equilibrium without sanctions.

## 5.1 | Effect on real income

Figure 1 compares the effects of the four scenarios on changes in real income, which is our preferred measure of welfare. We provide the detailed numbers as well the results for real GDP in Table B5, Appendix B. For the baseline results, we assume a trade elasticity of −5. We provide robustness checks using elasticities of −4 and −6 in Table B6.

The simulation of the four scenarios reveals six headline results on the real income effects of sanctions against Russia: (i) The deep sanctions are about 10 times as harsh as the shallow sanctions. (ii) The negative impact on Russia is multiple times larger than the impact on the sanctioning countries. (iii) Eastern European countries bear the largest burden among the sanctioning countries. (iv) Coordination of sanctions between the EU and its allies significantly increases the burden on Russia but does not noticeably reduce the impact on the EU countries. (v) Third countries gain. (vi) Some EU countries and some allies also gain.

Results (i) (deep sanctions are about 10 times as harsh as the shallow sanctions) and (ii) (comparably large impact on Russia) emanate from the comparison of S1 with S3 and S2 with S4. Focusing on the coordinated scenarios (S2 and S4) we find negative real income effects for the G7plus countries that range between +0.01% for Cyprus and −0.15% for Lithuania in the shallow sanctions regime and +0.01% for Australia and −1.77% for Lithuania in the deep sanctions regime. Comparing the cost imposed on Russia (0.3% in S2 and 4.23% in S4) to the losses of the EU countries and its allies, we find that the effect on Russia is about two times the effect on Lithuania, the most negatively impacted EU country, and about 10 times the effect on most of the large western EU countries (Result (ii)). Besides Lithuania, the other Baltic countries, the Czech Republic, and Poland account for the largest losses (Result (iii)). This result can be explained by the close

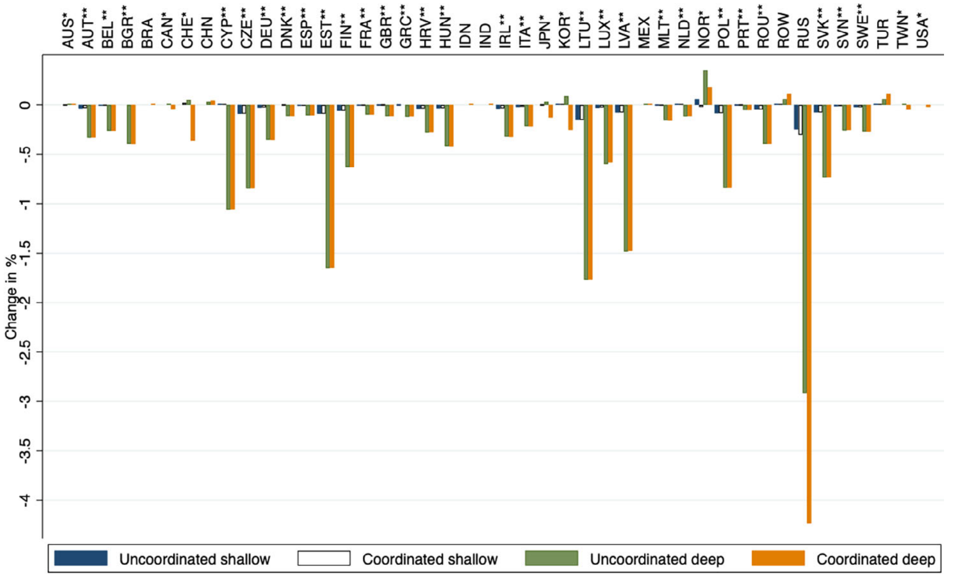


**FIGURE 1** Effect of sanctions against Russia on real income (in Δ%). ∗∗ denotes EU countries, ∗ denotes the EU's allies [Colour figure can be viewed at wileyonlinelibrary.com]

trade relations of the Eastern European countries with Russia and by their role in distributing Russian energy fuels to other countries.

Result (iv) (Coordinated sanctions increase the burden on Russia but do not lower the cost for the EU countries) can be seen by comparing S1 with S2 and S3 with S4. Taking the allies on board increases the cost on Russia by 20% in the shallow sanctions regime and by 40% in the deep sanctions regime. The disproportionate increase in the impact of the sanctions reflects the fact that it becomes increasingly harder for Russia to substitute source countries and destination markets as more countries close their borders for Russian goods. Hence, the more countries join in on the effort, the more effective the sanctions of every individual member of the coalition become. On the cost side, we find that coordination makes little difference for the EU countries. Some of them experience marginally higher real income losses, others lose marginally less. A priori, the impact on cost is unclear. EU countries lose relatively less in terms of global competitiveness as their allies impose trade barriers as well. Yet, their allies are often also their most important export destination markets and import source countries. Hence, decreasing real income and increasing production cost in the allied countries affects their trading partners negatively. Overall, the marginal differences on the cost side and the major difference in terms of impact on the receiving country highlight the value of international cooperation on the issue of sanctions.

Result (v) (Third countries and some EU countries and allies gain) is visible in the simulated effects in all scenarios. Across the board, third countries (Brazil, China, India, Indonesia, Mexico, Turkey, and the Rest of the World) unambiguously gain, albeit by small amounts (about or less than 0.01%, with a few exceptions). Likewise, the EU's allies gain in the counterfactual scenarios where the EU imposes sanctions on its own (S1 and S3). These gains come about through general equilibrium adjustments: Countries that do not experience increases in trade barriers gain in relative competitiveness, and, depending on their proximity to the sanctioning countries and on their productivity in the respective sectors, they step in as suppliers and buyers of affected products. Norway is a case in point: As imports of mining products from Russia are reduced, EU demand turns to Norway as the best alternative sourcing location. In the case of deep sanctions implemented by the EU only (S3), real income in Norway increases by 0.35%. Even in S4, where Norway joins the sanctions alliance (and is subjected to Russia's countersanctions), the real income gains still amount to 0.18%.

Remarkably, some sanctioning EU countries also gain (Result vi). In the shallow sanctions scenarios S1 and S2, Cyprus, Bulgaria, The Netherlands, and Denmark experience small increases in real income. This can be explained by the very heterogeneous de-facto partial impact on trade for some sectors and countries that we estimate in Section 3.2. For example, for the EU countries the estimated partial trade effect for exports of services and raw materials from the mining sector to Russia is positive, consistent with unintended indirect effects of sanctions. Positive partial trade increases enter the simulation as a de-facto trade cost decrease. In line with the presumption that the positive partial trade effects are behind the real income gains for some EU countries, we find that these gains disappear when we turn to the deep sanctions scenario where a counterfactual full embargo of trade with Russia in all sectors is enforced. Similarly, we show below that the positive income effects for sanctioned and sanctioning countries disappear when we restrict the analysis to partial trade effects that can be directly related to de-jure sanctioned products, suggesting strongly that the indirectly positive effects of sanctions on some trade flows rather than the general equilibrium mechanisms captured in the model are the driving force behind Result (vi).

## 5.2 | Effects on bilateral trade

Tables 4 and 5 show changes in bilateral trade flows with Russia in the two coordinated scenarios with both shallow (2014 sanctions) and deep (decoupling) sanctions. Trade flows are impacted by changes in bilateral trade costs, which are informed by the estimates in Table 3, as well as by a multitude of general equilibrium effects captured in our model as described in Section 4.1. We summarize our findings in the form of three results: (vii) In the shallow sanctions scenario, trade between Russia and most sanctioning countries declines. Yet, the effects are very heterogeneous and even positive in some cases. Trade with third countries increases. (viii) In the deep sanctions scenario, Russian exports are diverted to countries all over the world, whereas Russian imports are mainly sourced from a few particular alternative countries. (ix) Domestic sales in Russia change very little.

Result (vii) on the trade effects of shallow sanctions emanates from columns (2) and (5) of Tables 4 and 5. Bilateral trade flows between Russia and the sanctioning countries decrease by a large amount. For instance, Russian exports to Australia decrease by 40%, and exports to most EU countries decrease by up to 11%. Yet, in accordance with the heterogeneous partial trade effects shown in Table 3, Russian exports to some sending countries increase (e.g., Cyprus, Denmark, The Netherlands, Canada, Norway, US). Russia's exports to third countries increase throughout, albeit by relatively small amounts compared to the decline in trade with the sanctioning countries. On the import side, we find that Russian imports from all EU countries except Cyprus, Malta, and Bulgaria decline, by 25% for Greece at the maximum and by about 5%–10% for most of the others. Imports from other sanctioning countries like Australia and the US increase, whereas they decline by a huge amount for Norway (71%). Imports from third countries unambiguously increase.

Result (viii) on the effects of deep sanctions follows from columns (3) and (6) of Tables 4 and 5. By construction, deep sanctions bring trade flows between Russia and the sanctioning countries down to zero. Consequently, the diversion of Russian trade to third countries is much

**TABLE 4** Change of Russian bilateral exports—Results for coordinated scenarios with shallow and deep sanctions.

| | Russian exports | | | Russian exports | |
|---|---|---|---|---|---|
| | Shallow S2 | Deep S4 | | Shallow S2 | Deep S4 |
| Importer | in % | in % | Importer | in % | in % |
| AUS* | −40.2 | −100.0 | IRL** | −10.5 | −100.0 |
| AUT** | −8.8 | −100.0 | ITA** | −8.7 | −100.0 |
| BEL** | −2.4 | −100.0 | JPN* | −1.9 | −100.0 |
| BGR** | −0.0 | −100.0 | KOR* | 1.6 | −100.0 |
| BRA | 1.3 | 10.7 | LTU** | −9.9 | −100.0 |
| CAN* | 1.1 | −100.0 | LUX** | −2.5 | −100.0 |
| CHE* | −4.1 | −100.0 | LVA** | −2.7 | −100.0 |
| CHN | 1.6 | 16.1 | MEX | 1.2 | 11.0 |
| CYP** | 0.7 | −100.0 | MLT** | −2.3 | −100.0 |
| CZE** | −9.2 | −100.0 | NLD** | 1.4 | −100.0 |
| DEU** | −4.8 | −100.0 | NOR* | 9.6 | −100.0 |
| DNK** | 0.7 | −100.0 | POL** | −8.8 | −100.0 |
| ESP** | −8.2 | −100.0 | PRT** | −0.4 | −100.0 |
| EST** | 1.2 | −100.0 | ROU** | −10.1 | −100.0 |
| FIN** | −7.6 | −100.0 | ROW | 1.5 | 15.2 |
| FRA** | −4.3 | −100.0 | RUS | −0.0 | 2.2 |
| GBR** | −4.1 | −100.0 | SVK** | −11.2 | −100.0 |
| GRC** | 1.4 | −100.0 | SVN** | 1.5 | −100.0 |
| HRV** | −11.3 | −100.0 | SWE** | −9.0 | −100.0 |
| HUN** | −2.4 | −100.0 | TUR | 1.5 | 14.0 |
| IDN | 1.5 | 13.3 | TWN* | 1.2 | −100.0 |
| IND | 1.4 | 12.1 | USA* | 1.6 | −100.0 |

*Note*: This table shows the changes of Russian exports from its trading partners for the coordinated scenarios with shallow sanctions (2014 sanctions) and deep sanctions (decoupling from western countries).
∗∗ denotes EU countries, ∗ denotes the EU's allies.

stronger in the case of deep sanctions. Russian exports to third countries increase relatively evenly. Exports to China increase the most (16%), followed by the Rest of World (comprising most of the developing countries, 15%), Turkey (14%), Indonesia (13%), India (12%), and Brazil and Mexico (both 11%). Adjustments on the import side are much more diverse, suggesting that only particular countries can provide substitutes for the goods that Russia sourced from the sending countries. For example, Russian imports from Mexico, India, and China increase by 85%, 51%, and 41%, respectively. Whereas imports from Turkey, Indonesia, and the developing world increase much less. Taken together, the results suggest that the diversion possibilities for Russian exports are manyfold, including the developing world, but that alternative

**TABLE 5** Change of Russian bilateral imports—Results for coordinated scenarios with shallow and deep sanctions.

| | Russian imports | | | Russian imports | |
|---|---|---|---|---|---|
| | Shallow S2 | Deep S4 | | Shallow S2 | Deep S4 |
| Exporter | Δ in % | Δ in % | Exporter | Δ in % | Δ in % |
| AUS* | 8.3 | −100.0 | IRL** | −9.3 | −100.0 |
| AUT** | −6.3 | −100.0 | ITA** | −7.8 | −100.0 |
| BEL** | −5.2 | −100.0 | JPN* | 3.8 | −100.0 |
| BGR** | 1.0 | −100.0 | KOR* | 3.5 | −100.0 |
| BRA | −0.2 | −1.1 | LTU** | −5.3 | −100.0 |
| CAN* | 2.3 | −100.0 | LUX** | −4.6 | −100.0 |
| CHE* | 8.6 | −100.0 | LVA** | −5.6 | −100.0 |
| CHN | 2.4 | 41.4 | MEX | 2.3 | 84.7 |
| CYP** | 2.2 | −100.0 | MLT** | 5.8 | −100.0 |
| CZE** | −6.8 | −100.0 | NLD** | −3.5 | −100.0 |
| DEU** | −7.7 | −100.0 | NOR* | −71.3 | −100.0 |
| DNK** | −3.2 | −100.0 | POL** | −1.3 | −100.0 |
| ESP** | −6.0 | −100.0 | PRT** | −10.2 | −100.0 |
| EST** | −8.7 | −100.0 | ROU** | −4.8 | −100.0 |
| FIN** | −9.7 | −100.0 | ROW | 3.6 | 26.4 |
| FRA** | −5.7 | −100.0 | RUS | −0.0 | 2.2 |
| GBR** | −0.4 | −100.0 | SVK** | −6.3 | −100.0 |
| GRC** | −25.4 | −100.0 | SVN** | −6.0 | −100.0 |
| HRV** | −8.2 | −100.0 | SWE** | −3.4 | −100.0 |
| HUN** | −8.6 | −100.0 | TUR | 2.0 | 33.7 |
| IDN | 1.3 | 10.0 | TWN* | 2.5 | −100.0 |
| IND | 3.5 | 50.5 | USA* | 0.5 | −100.0 |

*Note*: This table shows the changes of Russian imports from its trading partners for the coordinated scenarios with shallow sanctions (2014 sanctions) and deep sanctions (decoupling from western countries).
∗∗ denotes EU countries, ∗ denotes the EU's allies.

sources for the supposedly technology-intensive imports from the G7plus countries are harder to find.

Result (ix) follows from the simulated changes in Russia's domestic sales (by construction identical in Tables 4 and 5). Alike third countries, Russian producers become relatively more competitive with regard to their home market, as exporters from the sanctioned countries are cut off. However, domestic sourcing barely changes in the shallow sanctions scenario and increases much less than imports from third countries in the deep sanctions scenario. Apparently, domestic producers cannot fill the sourcing gap created by the sanctioning countries. Together with the previous finding, result (ix) implies that Russia becomes significantly more dependent on goods imports from a small set of countries including China and India.

## 5.3 | Effect on sectoral value-added

Production in Russia is affected by several channels, pulling in opposite directions. The most straightforward channels are the reduction in foreign demand due to the embargo of exports and the increase in domestic demand thanks to the embargo on imports—which work against each other. The relative strength of the two effects depends on the direct impact of the sanctions on exports and imports in a given sector and the extent to which diversion to other export markets and substitution of imported goods with domestic production or imports from other sources is possible. In addition to the demand effects, sectors dependent on intermediates from sanctioning countries will experience cost increases and lose competitiveness as they turn to the next best sources. Moreover, cost changes and demand changes are passed on further along global and national value chains to upstream and downstream sectors. Sectors that are not directly exposed to the sanctions via export or import restrictions, but produce inputs for exposed sectors, will suffer indirectly from an export ban and gain indirectly from an import ban. Finally, all sectors in Russia suffer from a decline in demand caused by the real income loss for the country as a whole, the largest share of which falls on domestic producers.

Table 6 shows the net changes in value added for all sectors of the Russian economy, caused by the shallow and deep sanctions.[20] The two key results are as follows: (x) The shallow sanctions hurt mining and services production in Russia, but stimulate value added in agriculture and manufacturing. (xi) Deep sanctions strongly hurt Russia's comparative advantage sectors, that is, mining and other energy-related industries, but stimulate domestic production in key manufacturing sectors such as machinery and motor vehicle production.

Columns 3 and 7 show result (x). The shallow sanctions lead to an increase in agricultural value added (0.7%) and manufacturing value added (ranging between 0.4% and 3.5%), whilst value added in mining contracts by 2.8% and by 0.1%–0.9% in the services sectors. This is in accordance with the estimated effects in Tables 2 and 3, showing that Russia imported fewer agricultural and manufacturing goods, which is to the benefit of domestic production, and an increase in services imports and a decrease in exported mining sector output, which harms domestic production in these sectors.

Result (xi) is found in Columns 4 and 8. The deep sanctions scenario draws a clearer picture of which sectors manage to redirect exports and substitute for imports, since all sectors receive equal sanctions, symmetrically on the import and export side. We find that value added in the agricultural sector declines by 2.6%, value added in mining declines by 19.5%, and value-added in the services sectors declines by 0.02 to 11.5%. In manufacturing, the pattern is very diverse. The sector "Coke, Refined Petroleum" shrinks as much as the mining sector, likely due to the fact that the sheer amount of exports from energy-producing sectors that previously went to the EU is difficult to redirect to other markets or to absorb domestically. We find a negative effect also on value added in the other sectors that process raw materials and distribute energy, that is, "Wood & Cork", "Paper", "Basic Metals", and "Electricity & Gas". In contrast, domestic value added grows strongly in the sectors "Motor vehicles" (84%), "Machinery & Equipment" (44%), and "Textiles, Apparel, Leather" (25%). The positive growth effects imply that a significant part of imports is substituted with domestic production and/or that goods produced in these sectors are absorbed domestically or redirected to third countries.

**TABLE 6** Change in Russian sectoral value added—Results for coordinated scenarios with shallow and deep sanctions.

| Sector | | Δ Sectoral VA, in % | | Sector | | Δ Sectoral VA, in % | |
|---|---|---|---|---|---|---|---|
| ID | Name | Shallow S2 | Deep S4 | ID | Name | Shallow S2 | Deep S4 |
| 1 | Crops and animals | 0.7 | −2.6 | 26 | Construction | −0.5 | −4.2 |
| 2 | Forestry and logging | . | . | 27 | Trade and repair of motor vehicles | −0.8 | −2.5 |
| 3 | Fishing and aquaculture | . | . | 28 | Wholesale trade | −0.5 | −3.2 |
| 4 | Mining and quarrying | −2.8 | −19.5 | 29 | Retail trade | −0.4 | −0.2 |
| 5 | Food, beverages, and tobacco | 0.5 | 3.6 | 30 | Land transport | −0.1 | −11.5 |
| 6 | Textiles, apparel, and leather | 2.6 | 25.9 | 31 | Water transport | −0.9 | 3.6 |
| 7 | Wood and cork | 1.1 | −1.0 | 32 | Air transport | −0.4 | −5.8 |
| 8 | Paper | 0.4 | −13.4 | 33 | Aux. transportation services | −0.5 | −5.4 |
| 9 | Recorded media reproduction | . | . | 34 | Postal and courier | . | . |
| 10 | Coke, refined petroleum | 0.6 | −20.0 | 35 | Accommodation and food | −0.4 | −3.8 |
| 11 | Chemicals | 1.2 | 8.3 | 36 | Publishing | . | . |
| 12 | Pharmaceuticals | . | . | 37 | Media services | . | . |
| 13 | Rubber and plastics | 0.6 | 6.8 | 38 | Telecommunications | −0.9 | −1.1 |
| 14 | Other nonmetallic mineral | 0.4 | 2.2 | 39 | Computer and information services | . | . |
| 15 | Basic metals | 1.1 | −6.6 | 40 | Financial services | −0.4 | −4.3 |
| 16 | Fabricated metal | . | . | 41 | Insurance | . | . |
| 17 | Electronics and optical products | 1.4 | 14.6 | 42 | Real estate | −0.4 | −4.5 |
| 18 | Electrical equipment | . | . | 43 | Legal and accounting | . | . |
| 19 | Machinery and equipment | 3.5 | 44.0 | 44 | Business services | . | . |
| 20 | Motor vehicles | 3.1 | 84.4 | 45 | Research and development | . | . |
| 21 | Other transport equipment | . | . | 46 | Admin. and support services | −0.4 | −4.1 |
| 22 | Furniture and other manufacturing | 1.0 | 8.2 | 47 | Public and social services | −0.4 | −4.2 |
| 23 | Electricity and gas | −0.2 | −5.3 | 48 | Education | −0.5 | −4.4 |
| 24 | Water supply | . | . | 49 | Human health and social work | −0.4 | −4.8 |
| 25 | Sewerage and waste | . | . | 50 | Other services, households | −0.5 | −4.4 |

*Note*: This table shows the sectoral value added effects for all Russian sectors for the two cooperation scenarios, with shallow and deep sanctions.

## 5.4 | Top-down versus bottom-up approach to quantifying the effects of sanctions

Our main simulations of the effects of the 2014 sanctions are informed by the estimated partial trade effects reported in Table 3. As discussed in Section 3, the top-down estimates represent de-facto partial trade adjustments, that are a combination of intended trade restrictions on specific products and a multitude of indirect and unintended effects. In this section, we disentangle the different effects by comparing the predictions about the effect of the 2014 sanctions obtained with the top-down catch-all estimates to the predictions based on bottom-up estimates of the trade barriers that can be directly inferred from the legal texts which stipulate restrictions on

**TABLE 7** Change of Russian bilateral imports—Results for actual shallow sanctions and simulated direct effects.

| | Russian Imports | | | Russian Imports | |
|---|---|---|---|---|---|
| | shallow S2 | direct S5 | | shallow S2 | direct S5 |
| Exporter | Δ in % | Δ in % | Exporter | Δ in % | Δ in % |
| AUS* | 8.3 | −12.2 | IRL** | −9.3 | −12.4 |
| AUT** | −6.3 | −9.8 | ITA** | −7.8 | −11.3 |
| BEL** | −5.2 | −9.8 | JPN* | 3.8 | −36.5 |
| BGR** | 1.0 | −10.0 | KOR* | 3.5 | 11.7 |
| BRA | −0.2 | 3.8 | LTU** | −5.3 | −12.6 |
| CAN* | 2.3 | −24.3 | LUX** | −4.6 | −19.4 |
| CHE* | 8.6 | 1.3 | LVA** | −5.6 | −13.4 |
| CHN | 2.4 | 5.9 | MEX | 2.3 | 9.9 |
| CYP** | 2.2 | −13.6 | MLT** | 5.8 | −10.0 |
| CZE** | −6.8 | −7.7 | NLD** | −3.5 | −11.4 |
| DEU** | −7.7 | −8.8 | NOR* | −71.3 | −84.3 |
| DNK** | −3.2 | −11.3 | POL** | −1.3 | −10.8 |
| ESP** | −6.0 | −11.4 | PRT** | −10.2 | −13.1 |
| EST** | −8.7 | −12.1 | ROU** | −4.8 | −8.7 |
| FIN** | −9.7 | −11.5 | ROW | 3.6 | 7.4 |
| FRA** | −5.7 | −10.1 | RUS | −0.0 | 0.8 |
| GBR** | −0.4 | −9.2 | SVK** | −6.3 | −6.4 |
| GRC** | −25.4 | −26.4 | SVN** | −6.0 | −9.9 |
| HRV** | −8.2 | −10.8 | SWE** | −3.4 | −8.1 |
| HUN** | −8.6 | −10.9 | TUR | 2.0 | 5.9 |
| IDN | 1.3 | 4.7 | TWN* | 2.5 | 7.6 |
| IND | 3.5 | 7.8 | USA* | 0.5 | −22.2 |

*Note*: This table shows the changes of Russian imports from its trading partners for the coordinated scenarios with shallow sanctions (2014 sanctions, estimated trade effects, also shown in Table 3) and for the scenarios with shallow sanctions and text-inferred direct trade effects (summarized in Table 1).
∗∗ denotes EU countries, ∗ denotes the EU's allies.

certain products. Specifically, we use the share of the sectoral trade value accounted for by targeted products in 2012 for each country-pair-sector triple (cf. Table 1) to calculate the changes in trade barriers that, according to our model, would correspond to this targeted relative loss in trade.[21] The calculated changes in trade barriers then serve as input for Scenario 5, defined as follows.

### *Scenario 5 (S5)–2014 sanctions on Russia (coordinated, bottom-up approach)*

We evaluate the effects of the restrictions imposed by the G7plus on Russia in 2014 and the countersanctions imposed by Russia. We implement this scenario by calculating changes in trade

**TABLE 8** Change of Russian bilateral exports—Results for actual shallow sanctions and simulated direct effects.

| | Russian exports | | | Russian exports | |
|---|---|---|---|---|---|
| | **Shallow S2** | **Direct S5** | | **Shallow S2** | **Direct S5** |
| **Importer** | **in %** | **in %** | **Importer** | **in %** | **in %** |
| AUS* | −40.2 | −1.5 | IRL** | −10.5 | −2.3 |
| AUT** | −8.8 | −2.8 | ITA** | −8.7 | −3.4 |
| BEL** | −2.4 | −5.4 | JPN* | −1.9 | −3.4 |
| BGR** | −0.0 | −6.6 | KOR* | 1.6 | −1.5 |
| BRA | 1.3 | −2.0 | LTU** | −9.9 | −2.5 |
| CAN* | 1.1 | −11.4 | LUX** | −2.5 | −4.4 |
| CHE* | −4.1 | −1.6 | LVA** | −2.7 | −5.1 |
| CHN | 1.6 | −1.5 | MEX | 1.2 | −2.2 |
| CYP** | 0.7 | −4.6 | MLT** | −2.3 | −4.8 |
| CZE** | −9.2 | −2.3 | NLD** | 1.4 | −6.7 |
| DEU** | −4.8 | −4.4 | NOR* | 9.6 | −3.0 |
| DNK** | 0.7 | −5.4 | POL** | −8.8 | −2.1 |
| ESP** | −8.2 | −3.6 | PRT** | −0.4 | −6.4 |
| EST** | 1.2 | −7.2 | ROU** | −10.1 | −2.6 |
| FIN** | −7.6 | −3.3 | ROW | 1.5 | −1.5 |
| FRA** | −4.3 | −4.9 | RUS | −0.0 | 0.8 |
| GBR** | −4.1 | −4.9 | SVK** | −11.2 | −2.4 |
| GRC** | 1.4 | −6.1 | SVN** | 1.5 | −6.5 |
| HRV** | −11.3 | −2.1 | SWE** | −9.0 | −2.6 |
| HUN** | −2.4 | −5.6 | TUR | 1.5 | −1.6 |
| IDN | 1.5 | −1.7 | TWN* | 1.2 | −2.2 |
| IND | 1.4 | −1.9 | USA* | 1.6 | −8.0 |

*Note*: This table shows the changes of Russian exports from its trading partners for the coordinated scenarios with shallow sanctions 2014 sanctions, estimated trade effects, also shown in Table 3 and for the scenarios with shallow sanctions and text-inferred direct trade effects (summarized in Table 1).
** denotes EU countries, * denotes the EU's allies.

cost equivalents of the codified ("intended") trade restrictions and then simulate the general equilibrium responses to these shocks.

Figure 2 shows the real income effects of the 2014 sanctions obtained with the bottom-up estimates (S5) in comparison to the effects obtained with the top-down estimates (S2). Table B5 contains the details. Tables 7 and 8 present the trade effects. We highlight two results: (xii) Overall, the intended trade effects of the sanctions dominate the de-facto outcome. (xiii) De-facto reductions in Russian imports are systematically smaller than the effects predicted by the codified restrictions, de-facto changes in export deviate strongly from the codified restrictions.

Result (xii) is implied by the high correlation between the predicted real income effects in the two scenarios (0.89), which is also visible in Figure 2. Moreover, Table 7 shows that the changes in Russia's imports predicted based on the codified restrictions follow a pattern that is similar to the predictions for S2. In particular, the sizable impact on imports from Norway and Greece, but also the large effects for most other EU countries are predicted in both scenarios, as well as the growth in imports from third countries. The positive correlation between the predictions for the two scenarios suggests that the intended effects of the sanction package are dominating the de-facto outcome.[22]

However, there are some interesting differences between the two scenarios that we summarize in result (xiii). De-facto changes in imports are systematically smaller (in absolute terms), which is consistent with sanction-avoiding behavior, like substitution of sanctioned goods with nonsanctioned goods, product relabelling, or limited enforcement. Moreover, Russian exports respond very differently in the two scenarios. The codified trade restrictions predict a decline across the board, whereas the de-facto partial trade changes imply that exports to several countries (sanctioning and nonsanctioning) went up. As noted above, these export increases come with predicted real income increases for some of the EU countries, which also vanish in scenario S5. The stark differences between codified restrictions and de-facto trade changes for some countries imply that unintended and other indirect effects are important to explain the heterogeneity

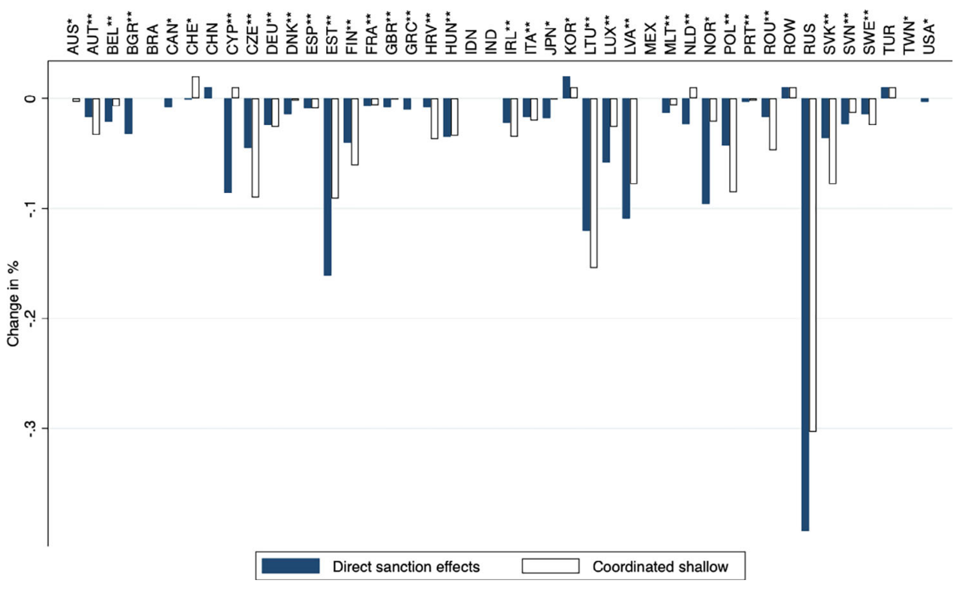


FIGURE 2 Effect of sanctions against Russia on real income (in Δ%).

of the effects among the sanctioning countries, as well as the adjustments in Russian exports to the 2014 sanctions.

## 6 | CONCLUSIONS

This article evaluates the partial and general equilibrium effects of sanctions on Russia. In the wake of the 2014 conflict in eastern Ukraine and the annexation of the Crimean Peninsula by Russia in 2014, several sanctions were imposed against Russia, including sanctions on individuals and institutions and restrictions on the flow of goods. The major escalation of the conflict in February 2022 called for deeper sanctions and even a full embargo on Russia.

Our partial equilibrium analysis offers an ex-post evaluation of the sanctions imposed on Russia by the EU and its allies during the period 2014–2019 and the countersanctions imposed by Russia, leveraging new data and the latest developments in the empirical gravity literature. We find that the sanctions were effective in terms of reducing trade flows to and from Russia. In contrast to the existing literature on the subject, we zoom in on the effects of the sanctions not only on the sector level but also on the country level. The analysis of heterogeneous treatment effects reveals that the sanctions were particularly effective in the areas that are essential for Russia, that is, manufacturing imports from the EU and mining exports from Russia to several countries. We also find strong evidence for the effectiveness of Russia's countersanctions, that targeted agricultural exports from the EU and its allies. However, our analysis of treatment heterogeneity also suggests that not all sanctions were effective. For several of the sanctioning countries, we do not find reductions in trade with Russia, some even appear to have been trading more in certain industries (relative to nonsanctioning countries). Our findings imply that treatment heterogeneity among sanctioning countries is large, limiting the scope for the extrapolation of estimated partial effects for treated countries to other potential members of sanction alliances.

Based on the estimated partial trade effects, we quantify the total trade and welfare effects of the 2014 sanctions in a computable general equilibrium model featuring multiple countries, sectors, and rich input–output linkages and compare the findings to three alternative scenarios: uncoordinated sanctions, defined as shallow sanctions as in 2014 but imposed by the EU alone, and deep sanctions, defined as a full decoupling from the Russian economy and imposed in a coordinated fashion by the EU and its allies or in an uncoordinated fashion by the EU alone. In terms of the cost imposed on Russia, we find that the 2014 sanctions had a sizable effect (−0.3% in terms of real income). Relative to the cost borne by the sanctioning countries, the effect on Russia is quite large. Moreover, deep sanctions have the potential to increase the cost imposed on Russia by an order of magnitude, but also the cost borne by the sanctioning countries. Coordination, in turn, also has the potential to increase the cost on Russia significantly, both by impeding trade with the marginal sanctioning country and by limiting Russia's substitution possibilities for flows that are already sanctioned. In fact, we find that Russia's alternative import sources are limited. In our scenario with deep and coordinated sanctions, Russia turns primarily to China, India, and Mexico as alternative sources for the technology-intensive goods imported from Europe. On the export side, substitution seems easier: We find that Russian exports are diverted relatively evenly across the nonsanctioning world. Our findings thus highlight the importance of international coordination on sanctions for their effectiveness.

Finally, we contrast our gravity-based top-down approach to quantifying the effects of sanctions, which capture not only the direct impact of trade restrictions but also other intended and unintended effects of the sanctions (package) on bilateral trade, such as positive and negative spillovers on nonsanctioned products, with an alternative bottom-up approach, where we quantify the impact of codified product-level trade restrictions on sector-level trade directly. The two approaches yield similar predictions with regard to the welfare effects of sanctions in the aggregate, but at the more detailed level, especially with regard to exports from Russia, we find that indirect effects are important to explain the pattern in the data. We discuss several mechanisms that could be behind the indirect effects, but we do not attempt to identify the relevant channels here. We believe that this is an important issue for future research concerned with the efficient design of sanctions.

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## DATA AVAILABILITY STATEMENT

We combine standard data sources from the literature that are publicly available. The calibration of the model is based on data provided by the World Input-Output Database (WIOD) as described by Timmer et al. (2015). The analysis in partial equilibrium combines the ITPD-E and the GSDB databases. The authors will provide the information necessary, including programming files, for other researchers willing to replicate the empirical results.

## ORCID

*Lisandra Flach* https://orcid.org/0000-0003-2000-6445
*Mario Larch* https://orcid.org/0000-0001-9355-2004
*Feodora A. Teti* https://orcid.org/0000-0001-9865-1896

## ENDNOTES

[1] In contrast to political scientists, for economists sanctions are "effective" if they reduce economic activity in the sanctioned countries and sector, compare, Felbermayr et al. (2021) for a discussion of the different perceptions of "successful" sanctions across fields.

[2] One possible explanation for the large differences in the case of shallow sanctions is that we find smaller partial elasticities. Moreover, we account for the heterogeneity of the partial effects of sanctions across countries within the coalition, which are statistically zero in many cases, including for large countries like the U.S. Another possible factor is that we carry all statistically significant estimates over to the simulation, rather than restricting the partial trade effects to be negative.

[3] See Baldwin and Taglioni (2006), Head and Mayer (2014) and Yotov et al. (2016) for surveys of the empirical gravity literature.

[4] https://www.consilium.europa.eu/media/21990/145967.pdf.

[5] https://www.bbc.com/news/world-europe-28357880.

[6] https://www.nytimes.com/2021/11/19/us/politics/russia-ukraine-biden-administration.html.

[7] https://www.piie.com/blogs/realtime-economics/russias-war-ukraine-sanctions-timeline.

[8] https://ec.europa.eu/taxation_customs/dds2/taric/taric_consultation.jsp?Lang=de.

[9] The correspondence between HS6 and the broad ITPD-E-sectors is available on request and can be found in the replication package. The trade data are from CEPII and at the HS6-level (Gaulier & Zignago, 2010).

[10] We refer the reader to these papers for details on the data sources and procedures for the construction of the ITPD-E. The ITPD-E is hosted by the US International Trade Commission at https://www.usitc.gov/data/gravity/itpde.htm.

[11] Borchert et al. (2022a) are the first to take advantage of the ITPD-E in order to test the database for gravity estimations and to confirm some stylized facts while challenging others. We refer the reader to (Borchert et al., 2021; Borchert et al., 2022a) for further details on the ITPD-E and its use for gravity estimations.
[12] Available at https://www.ewf.uni-bayreuth.de/de/forschung/RTA-daten/index.html.
[13] The sanctions on Russia were imposed starting in August 2014. In order to allow for adjustment of the trading parties, we define the sanction as starting in 2015. We check the robustness of our results when we obtain estimates with 2014 as the starting year of the sanctions.
[14] These are the sanctions on Russian imports from the European Union (*RUS_EU_IMP*), Russian exports to the European Union (*RUS_EU_EXP*), Russian exports to Japan (*RUS_JPN_EXP*), Russia imports from the United States (*RUS_USA_IMP*), Russian exports to the United States (*RUS_USA_EXP*), Russia imports from Switzerland (*RUS_CHE_IMP*), Russian exports to Switzerland (*RUS_CHE_EXP*), Russia imports from Australia (*RUS_AUS_IMP*), Russian exports to Australia (*RUS_AUS_EXP*), Russia imports from Canada (*RUS_CAN_IMP*), Russian exports to Canada (*RUS_CAN_EXP*), Russia imports from Norway (*RUS_NOR_IMP*), Russian exports to Norway (*RUS_NOR_EXP*), Russia imports from Albania (*RUS_ALB_IMP*), Russian exports to Albania (*RUS_ALB_EXP*), Russia imports from Iceland (*RUS_ISL_IMP*), and Russian exports to Iceland (*RUS_ISL_EXP*).
[15] We refer the reader to Felbermayr, Kirilakha, et al. (2020), Felbermayr, Syropoulos, et al. (2020), Larch et al. (2022), and Grant et al. (2021) as recent papers that use the GSDB for gravity analysis of trade flows.
[16] See for the use of the terminology of top-down and bottom-up approach in the context of RTAs Felbermayr et al. (2015).
[17] This has the advantage of certain constant parameters, like the elasticity of substitution between varieties, dropping out. The only deep parameter that needs to be calibrated is the sectoral trade elasticity. Moreover, the data requirements for calibrating the baseline and for solving the model in changes are modest; we only need initial trade flows, tariffs, final goods expenditure shares, input-output coefficients, and sectoral value-added. We do not need to calibrate productivity levels, initial prices, or wages, nor do we need to know the initial levels of nontariff barriers.
[18] We aggregate a subset of the 56 sectors in the original database, since for several of them reported value added is zero in many countries. Note that WIOD talks about sectors, whereas ITPD-E talks about industries. We stick to the labeling, that is, we talk about industries and broad sectors for our partial estimates using ITPD-E, and we talk about sectors in our general equilibrium analysis using WIOD.
[19] Partial trade effects are converted to cost shocks $\hat{\kappa}^j_{in}$ using the following model-consistent formula: $\hat{\kappa}^j_{in} = \exp\left(-\gamma^j_{in}\theta\right)$, where $\gamma^j_{in}$ is the partial trade effect of the sanction estimated with Equation (1).
[20] Missing values refer to sectors with zero reported value added in Russia.
[21] In our model (or, in fact, any structural sectoral gravity model), the *partial* change in bilateral exports from $i$ to $n$ in sector $j$, $\hat{\hat{X}}^j_{in}$, that is, the sectoral bilateral trade change net of origin-sector and destination-sector fixed effects (as in Equation (1)) is given by $\hat{\hat{X}}^j_{in} = \left(\hat{\hat{\kappa}}^j_{in}\right)^{-1/\theta}$, where $\kappa^j_{in}$ measures the trade friction and $-1/\theta$ is the trade cost elasticity. Hence, for a targeted share of $x^j_{in}$ of the export value, the implied change in trade barriers is $\hat{\kappa}^j_{in} = \left(1 - x^j_{in}\right)^{-\theta}$. See Appendix A.2 for details.
[22] The strong correlation is also reassuring insofar as we obtain similar predictions with two very different methods for computing the partial effects of the sanctions, which constitute the crucial input in the simulations. The top-down approach uses trade data pre and post 2014 and a structural estimation equation with sanction dummies to estimate the partial impacts, whereas the bottom-up approach extracts information on the set of targeted products from legal texts and pre-2014 trade data to identify the targeted trade values.
[23] Convergence requires $1 + \theta^j > \eta^j$.
[24] Our exposition differs from Caliendo and Parro (2015) in that they use total expenditure on composite goods instead of total production of varieties as endogenous variable. So in Caliendo and Parro (2015) the value of gross production comprises all foreign varieties that are bundled into the composite good without generation of value added.
[25] Instead of the goods market clearing condition, one can also use the expenditure equation $X^j_i = \left(\sum_{k=1}^{J}\gamma^{j,k}_i(1-\beta^k_i)(F^k_iX^k_i + S^k_i) + \alpha^j_i I_i\right)$ as in Caliendo and Parro (2015).

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## APPENDIX A. THEORETICAL MODEL

There are $N$ countries indexed by $i$ and $n$, as well as $J$ sectors indexed by $j$ and $k$. Sectoral goods are either used as inputs in production or consumed, with the representative consumer having Cobb-Douglas preferences over consumption $C_n^j$ of sectoral final goods with expenditure shares $\alpha_n^j \in (0, 1)$ and $\sum_j \alpha_n^j = 1$.

In each sector $j$, there is a continuum of intermediate goods producers indexed $\omega^j \in [0, 1]$ who combine labor and composite intermediate input and who differ with respect to their productivity $z_i^j(\omega^j)$. Intermediate goods are aggregated into sectoral composites using CES production functions with elasticity $\eta^j$. There is perfect competition and labor $L_n$ is mobile across sectors but not between countries.

A firm in country $i$ can supply its output at price

$$p_{in}^j(\omega^j) = \kappa_{in}^j \frac{c_i^j}{z_i^j(\omega^j)} \quad \text{with} \quad c_i^j = \Upsilon_i^j (w_i)^{\beta_i^j} \left[ \prod_{k=1}^{J} \left(p_i^k\right)^{\gamma_i^{k,j}} \right]^{(1-\beta_i^j)}. \tag{A1}$$

The minimum cost of an input bundle is $c_i^j$, where $\Upsilon_i^j$ is a constant, $w_i$ is the wage rate in country $i$, $p_i^k$ is the price of a composite intermediate good from sector $k$, $\beta_i^j \geq 0$ is the value added share in sector $j$ in country $i$ and $\gamma_i^{k,j}$ denotes the cost share of source sector $k$ in sector $j$'s intermediate costs, with $\sum_{k=1}^{J} \gamma_i^{k,j} = 1$. $\kappa_{in}^j$ denotes trade costs of delivering sector $j$ goods from country $i$ to country $n$ such that

$$\kappa_{in}^j = (1 + t_{in}^j) D_{in}^{\rho^j} e^{\delta^j \mathbf{Z}_{in}}, \tag{A2}$$

where $t_{in}^j \geq 0$ denotes ad-valorem tariffs, $D_{in}$ is bilateral distance, and $\mathbf{Z}_{in}$ is a vector collecting trade cost shifters (such as FTAs or other trade policies).

Productivity of intermediate goods producers follows a Fréchet distribution with a location parameter $\lambda_n^j \geq 0$ that varies by country and sector (a measure of absolute advantage) and shape parameter $\theta^j$ that varies by sector (and captures comparative advantage).[23]

Producers of sectoral composites in country $n$ search for the supplier with the lowest cost such that $p_n^j = \min_i \left\{ p_{in}^j(\omega^j); i = 1, \ldots, N \right\}$. Caliendo and Parro (2015) show that it is possible to derive a closed form solution of composite intermediate goods price

$$p_n^j = A^j \left( \sum_{i=1}^{N} \lambda_i^j \left( c_i^j \kappa_{in}^j \right)^{\frac{-1}{\theta^j}} \right)^{-\theta^j}, \tag{A3}$$

where $A^j = \Gamma\left[1 + \theta^j (1 - \eta^j)\right]^{\frac{1}{1-\eta^j}}$ is a constant.

Similarly, a country $n$'s expenditure share $\pi_{in}^j$ for source country $i$'s goods in sector $j$ is

$$\pi_{in}^j = \frac{\lambda_i^j \left[ c_i^j \kappa_{in}^j \right]^{\frac{-1}{\theta^j}}}{\sum_{i=1}^{N} \lambda_i^j \left[ c_i^j \kappa_{in}^j \right]^{\frac{-1}{\theta^j}}}, \tag{A4}$$

which forms the core of a gravity equation.

### A.1 General equilibrium

Let $Y_n^j$ denote the value of gross production of varieties in sector $j$. For each country $n$ and sector $j$, $Y_n^j$ has to equal the value of demand for sectoral varieties from all countries $i = 1, \ldots, N$.[24] The goods market clearing condition is given by

$$Y_n^j = \sum_{i=1}^{N} \frac{\pi_{ni}^j}{\left(1 + t_{ni}^j\right)} X_i^j \qquad \text{with} \qquad X_i^j = \sum_{k=1}^{J} \gamma_i^{j,k} \left(1 - \beta_i^k\right) Y_i^k + \alpha_i^j I_i, \tag{A5}$$

where national income consists of labor income, tariff rebates $R_i$ and the (exogenous) trade surplus $S_i$, that is, $I_i = w_i L_i + R_i - S_i$ and $X_i^j$ is country $i$'s expenditure on sector $j$ goods. The first term on the right-hand side gives demand of sectors $k$ in all countries $i$ for intermediate usage of sector $j$ varieties produced in country $n$, the second term denotes final demand. Tariff rebates are $R_i = \sum_{j=1}^{J} X_i^j \left( 1 - \sum_{n=1}^{N} \frac{\pi_{ni}^j}{(1+t_{ni}^j)} \right)$.[25]

The second equilibrium condition requires that for each country $n$, the value of total imports, domestic demand and the trade surplus has to equal the value of total exports including domestic sales, which is equivalent to total output $Y_n$:

$$\sum_{j=1}^{J} \sum_{i=1}^{N} \frac{\pi_{in}^j}{\left(1 + t_{in}^j\right)} X_n^j + S_n = \sum_{j=1}^{J} \sum_{i=1}^{N} \frac{\pi_{ni}^j}{\left(1 + t_{ni}^j\right)} X_i^j = \sum_{j=1}^{J} Y_n^j \equiv Y_n. \tag{A6}$$

Conditions (A5) and (A6) close the model.

Following Caliendo and Parro (2015) and Dekle et al. (2008), we solve the model in changes. Let $z$ denote the initial level of a variable and $z'$ its counterfactual level. Then, trade cost shocks are given by $\hat{\kappa}_{in}^j = \frac{1+t_{in}^{j\prime}}{1+t_{in}^j} e^{\delta^j (Z_{in}' - Z_{in})}$.

The change in real income, our measure of welfare, is given by

$$\hat{W}_n = \frac{\hat{I}_n}{\prod_{j=1}^{J} (\hat{p}_n^j)^{\alpha_n^j}}. \tag{A7}$$

## A.2 Calculating implied changes in trade barriers

Let $\hat{X}_{dr}^j = \hat{\pi}_{dr}^j X_r^j$ denote the change in the value of exports from $d$ to $r$ of goods from sector $j$ from the baseline equilibrium to a counterfactual equilibrium where a share $x_{dr}^j$ of the products exported gets sanctioned. Then, relative to a benchmark origin $c$ that does not sanction exports to $r$ and relative to a benchmark destination that does not sanction imports from $d$, the change in trade from $d$ to $r$ is log-proportional to the change in the bilateral trade friction

$$\hat{\hat{X}}_{dr}^j = \frac{\hat{X}_{dr}^j / \hat{X}_{dd}^j}{\hat{X}_{cr}^j / \hat{X}_{cc}^j} = \left(\hat{\kappa}_{dr}^j\right)^{-\frac{1}{\theta}}. \tag{A8}$$

Setting $\hat{\hat{X}}_{dr}^j = (1 - x_{dr}^j)$, we obtain the ad-valorem equivalent of the partial sanction on sector $j$ as

$$\hat{\kappa}_{dr}^{j,sanction} = \left(1 - x_{dr}^j\right)^{-\theta}$$

for each sanctioned trade flow in our quantitative setting.

# APPENDIX B. SENSITIVITY ANALYSIS AND ROBUSTNESS CHECKS

**TABLE B1** On the impact of the 2014 sanctions on Russia using all years.

| | (1) Agriculture | (2) Mining | (3) Manufacturing | (4) Services |
|---|---|---|---|---|
| RUS_EU_IMP | −1.265*** | 0.022 | −0.215*** | 0.229* |
| | (0.180) | (0.309) | (0.037) | (0.132) |
| RUS_EU_EXP | −0.141 | −0.400** | 0.010 | 0.185 |
| | (0.206) | (0.163) | (0.087) | (0.134) |
| RUS_JPN_EXP | −0.837** | 0.245 | 0.312*** | −0.110 |
| | (0.334) | (0.192) | (0.102) | (0.192) |
| RUS_USA_IMP | −0.956*** | −1.165 | 0.009 | 0.144 |
| | (0.356) | (1.010) | (0.071) | (0.173) |
| RUS_USA_EXP | 0.533 | 0.009 | 0.027 | −0.025 |
| | (0.484) | (0.194) | (0.109) | (0.146) |

**TABLE B1** (Continued)

| | (1) Agriculture | (2) Mining | (3) Manufacturing | (4) Services |
|---|---|---|---|---|
| RUS_CHE_IMP | −0.680*** | −0.215 | −0.097 | 0.653*** |
| | (0.240) | (0.421) | (0.081) | (0.244) |
| RUS_CHE_EXP | 0.224 | −0.613** | −1.424*** | 0.063 |
| | (0.388) | (0.271) | (0.170) | (0.244) |
| RUS_AUS_IMP | −0.375 | 0.017 | −0.284 | 0.215 |
| | (0.317) | (0.237) | (0.440) | (0.231) |
| RUS_AUS_EXP | 0.029 | −0.847*** | 0.457*** | −0.221 |
| | (0.534) | (0.202) | (0.157) | (0.481) |
| RUS_CAN_IMP | −1.054*** | −0.414 | −0.240* | 0.077 |
| | (0.261) | (0.275) | (0.142) | (0.144) |
| RUS_CAN_EXP | 0.544* | −0.463* | 0.135 | −0.497 |
| | (0.299) | (0.241) | (0.145) | (0.311) |
| RUS_NOR_IMP | −2.695*** | 1.270*** | −0.278 | 0.426 |
| | (0.381) | (0.251) | (0.491) | (0.363) |
| RUS_NOR_EXP | −0.397 | −0.922** | 0.195 | −0.393 |
| | (0.438) | (0.376) | (0.173) | (0.310) |
| RUS_ALB_IMP | −4.144*** | −5.829*** | 0.590*** | −0.716 |
| | (0.697) | (0.258) | (0.188) | (1.884) |
| RUS_ALB_EXP | 0.110 | −0.323 | 0.023 | −0.731 |
| | (0.523) | (0.689) | (0.424) | (1.330) |
| RUS_ISL_IMP | −2.066*** | −8.233*** | −0.398 | 0.075 |
| | (0.425) | (0.357) | (0.349) | (0.397) |
| RUS_ISL_EXP | −0.490 | 0.909 | −0.658 | −0.174 |
| | (0.916) | (0.932) | (0.712) | (0.201) |
| *N* | 6,766,737 | 1,059,863 | 63,109,423 | 820,306 |

*Note*: This table reports estimates of the effects of the 2014 sanctions between Russia and the G7plus countries on trade using all years available. The dependent variable is sectoral trade in levels. All estimates are obtained with the PPML estimator and each sectoral specification includes exporter-industry-time fixed effects, importer-industry-time fixed effects, country-pair-industry fixed effects, and industry-time-varying border variables. In addition to the reported estimates that are of interest to us, we also control for the impact of other complete trade sanctions and other remaining trade sanctions, RTAs, and WTO membership. These estimates are omitted for brevity. Each column of this table reports estimates for one of the following sectors, agriculture (industries 1 to 28 without industry 9 to obtain convergence), mining and energy (industries 29 to 35), manufacturing (industries 36 to 153), and services (industries 154 to 170), respectively. Standard errors are clustered by country-pair-industry. * $p < 0.10$; ** $p < .05$; *** $p < .01$. See text for further details.

**TABLE B2** On the impact of the 2014 sanctions on Russia aggregating all trade flows for each broad sector.

| | (1) Agriculture | (2) Mining | (3) Manufacturing | (4) Services |
|---|---|---|---|---|
| RUS_EU_IMP | −0.847*** | 0.298 | −0.258* | 0.093 |
| | (0.188) | (0.340) | (0.148) | (0.137) |
| RUS_EU_EXP | −0.086 | −0.504*** | −0.198 | 0.191 |
| | (0.122) | (0.146) | (0.130) | (0.167) |
| RUS_JPN_EXP | −0.407*** | −0.157 | 0.099 | −0.779*** |
| | (0.089) | (0.107) | (0.145) | (0.162) |
| RUS_USA_IMP | −0.795*** | −2.298*** | −0.135 | 0.126 |
| | (0.071) | (0.196) | (0.162) | (0.108) |
| RUS_USA_EXP | 0.524*** | −0.261** | −0.486*** | −0.078 |
| | (0.088) | (0.121) | (0.115) | (0.133) |
| RUS_CHE_IMP | −0.471*** | −0.286 | −0.117 | 0.529*** |
| | (0.167) | (0.370) | (0.192) | (0.114) |
| RUS_CHE_EXP | 0.466*** | 1.025*** | −0.824*** | −0.027 |
| | (0.103) | (0.301) | (0.131) | (0.137) |
| RUS_AUS_IMP | −0.250*** | −0.009 | −0.302 | 0.255* |
| | (0.079) | (0.169) | (0.194) | (0.141) |
| RUS_AUS_EXP | −0.669*** | −1.294*** | 0.425*** | 0.291** |
| | (0.097) | (0.125) | (0.137) | (0.140) |
| RUS_CAN_IMP | −0.471*** | 0.175 | −0.521** | 0.023 |
| | (0.070) | (0.181) | (0.211) | (0.123) |
| RUS_CAN_EXP | 0.653*** | −0.325 | 0.180 | −0.202 |
| | (0.085) | (0.232) | (0.161) | (0.144) |
| RUS_NOR_IMP | −2.870*** | 0.725*** | −0.215 | 0.120 |
| | (0.229) | (0.181) | (0.166) | (0.129) |
| RUS_NOR_EXP | 0.150 | 0.082 | 0.185 | −0.342** |
| | (0.117) | (0.152) | (0.119) | (0.152) |
| RUS_ALB_IMP | −4.006*** | −2.909*** | 0.476*** | 3.311*** |
| | (0.105) | (0.280) | (0.155) | (0.634) |
| RUS_ALB_EXP | −0.351*** | −1.072*** | 0.699*** | 1.650*** |
| | (0.126) | (0.337) | (0.117) | (0.327) |
| RUS_ISL_IMP | −0.175 | −2.479*** | −0.779*** | −0.508*** |
| | (0.240) | (0.546) | (0.168) | (0.155) |
| RUS_ISL_EXP | 0.875*** | 0.523 | −0.056 | 0.131 |
| | (0.182) | (0.883) | (0.127) | (0.169) |
| *N* | 232,708 | 174,417 | 412,048 | 45,523 |

*Note*: This table reports estimates of the effects of the 2014 sanctions between Russia and the G7plus countries on trade aggregating all trade flows for each of the four broad sectors. The dependent variable is sectoral trade in levels, 2010–2019. All estimates are obtained with the PPML estimator and each sectoral specification includes exporter-industry-time fixed effects, importer-industry-time fixed effects, country-pair-industry fixed effects, and industry-time-varying border variables. In addition to the reported estimates that are of interest to us, we also control for the impact of other complete trade sanctions and other remaining trade sanctions, RTAs, and WTO membership. These estimates are omitted for brevity. Each column of this table reports estimates for one of the following sectors, agriculture, mining and energy, manufacturing, and services, respectively. Standard errors are clustered by country-pair-industry.
* $p < 0.10$; ** $p < .05$; *** $p < .01$. See text for further details.

**TABLE B3** On the impact of the 2014 sanctions on Russia treating 2014 as the first sanction year.

| | (1) Agriculture | (2) Mining | (3) Manufacturing | (4) Services |
|---|---|---|---|---|
| RUS_EU_IMP | −1.021*** | 0.696** | −0.127*** | 0.312** |
| | (0.143) | (0.294) | (0.031) | (0.124) |
| RUS_EU_EXP | 0.146 | −0.375** | 0.091 | 0.154 |
| | (0.191) | (0.172) | (0.094) | (0.129) |
| RUS_JPN_EXP | −0.599* | 0.210 | 0.135 | 0.086 |
| | (0.361) | (0.165) | (0.101) | (0.132) |
| RUS_USA_IMP | −0.725*** | −1.134 | 0.108 | 0.270* |
| | (0.270) | (1.079) | (0.085) | (0.155) |
| RUS_USA_EXP | 0.441 | −0.453** | −0.039 | −0.134 |
| | (0.415) | (0.195) | (0.150) | (0.138) |
| RUS_CHE_IMP | −0.610* | 0.101 | −0.019 | 0.682*** |
| | (0.324) | (0.279) | (0.098) | (0.233) |
| RUS_CHE_EXP | 0.089 | 0.240 | −0.556*** | −0.046 |
| | (0.515) | (0.265) | (0.116) | (0.248) |
| RUS_AUS_IMP | −0.457 | 0.657** | −0.349 | 0.355* |
| | (0.338) | (0.271) | (0.459) | (0.214) |
| RUS_AUS_EXP | −0.341 | −0.350* | 0.334 | 0.145 |
| | (0.448) | (0.183) | (0.270) | (0.343) |
| RUS_CAN_IMP | −0.973*** | 1.824*** | −0.201 | 0.198 |
| | (0.288) | (0.319) | (0.126) | (0.131) |
| RUS_CAN_EXP | 0.599** | −0.638*** | 0.108 | −0.449 |
| | (0.249) | (0.223) | (0.117) | (0.328) |
| RUS_NOR_IMP | −1.596*** | 1.722*** | −0.153 | 0.482* |
| | (0.356) | (0.324) | (0.401) | (0.269) |
| RUS_NOR_EXP | 0.747*** | −0.983*** | 0.271* | −0.280 |
| | (0.221) | (0.249) | (0.154) | (0.233) |
| RUS_ALB_IMP | −0.742 | −5.771*** | 0.707** | 0.585 |
| | (0.681) | (0.304) | (0.354) | (1.029) |
| RUS_ALB_EXP | 0.107 | −0.478 | 0.096 | 0.067 |
| | (0.506) | (0.897) | (0.346) | (0.860) |
| RUS_ISL_IMP | 1.198 | −2.710*** | −0.106 | 0.221 |
| | (1.045) | (0.414) | (0.206) | (0.320) |
| RUS_ISL_EXP | 0.847 | −0.454 | 0.234 | 0.183 |
| | (1.049) | (0.831) | (0.964) | (0.190) |
| *N* | 2,139,595 | 393,799 | 23,663,703 | 490,255 |

*Note*: This table reports estimates of the effects of the 2014 sanctions between Russia and the G7plus countries on trade treating 2014 as the first sanction year. The dependent variable is sectoral trade in levels, 2008–2019 (in order to keep pre- and post-treatment number of years equal). All estimates are obtained with the PPML estimator and each sectoral specification includes exporter-industry-time fixed effects, importer-industry-time fixed effects, country-pair-industry fixed effects, and industry-time-varying border variables. In addition to the reported estimates that are of interest to us, we also control for the impact of other complete trade sanctions and other remaining trade sanctions, RTAs, and WTO membership. These estimates are omitted for brevity. Each column of this table reports estimates for one of the following sectors, agriculture (industries 1 to 28), mining and energy (industries 29 to 35), manufacturing (industries 36 to 153), and services (industries 154 to 170), respectively. Standard errors are clustered by country-pair-industry.

* $p < 0.10$; ** $p < .05$; *** $p < .01$. See text for further details.

TABLE B4 On the impact of the 2014 sanctions on Russia excluding all domestic sales observations.

| | (1) Agriculture | (2) Mining | (3) Manufacturing | (4) Services |
|---|---|---|---|---|
| RUS_EU_IMP | −1.264*** | 0.026 | −0.150*** | 0.086 |
| | (0.193) | (0.234) | (0.032) | (0.130) |
| RUS_EU_EXP | −0.305* | −0.370** | −0.037 | 0.054 |
| | (0.165) | (0.149) | (0.088) | (0.146) |
| RUS_JPN_EXP | −0.726** | −0.107 | 0.115 | −0.028 |
| | (0.354) | (0.122) | (0.099) | (0.173) |
| RUS_USA_IMP | −1.212*** | −1.623 | −0.019 | 0.208 |
| | (0.269) | (1.310) | (0.054) | (0.138) |
| RUS_USA_EXP | 0.157 | −0.256* | −0.149 | −0.066 |
| | (0.466) | (0.147) | (0.140) | (0.180) |
| RUS_CHE_IMP | −0.838*** | 0.588** | −0.060 | 0.472*** |
| | (0.284) | (0.261) | (0.064) | (0.154) |
| RUS_CHE_EXP | −0.067 | 0.814*** | −0.962*** | −0.069 |
| | (0.357) | (0.297) | (0.130) | (0.277) |
| RUS_AUS_IMP | −1.117*** | 0.044 | −0.244 | 0.321 |
| | (0.370) | (0.184) | (0.339) | (0.195) |
| RUS_AUS_EXP | −0.655 | −1.105*** | 0.324 | 0.207 |
| | (0.423) | (0.196) | (0.247) | (0.292) |
| RUS_CAN_IMP | −1.074*** | 0.260 | −0.301* | 0.133 |
| | (0.269) | (0.202) | (0.173) | (0.138) |
| RUS_CAN_EXP | 0.045 | 0.516* | 0.228 | −0.146 |
| | (0.289) | (0.307) | (0.155) | (0.184) |
| RUS_NOR_IMP | −2.925*** | 0.118 | −0.292 | 0.187 |
| | (0.319) | (0.244) | (0.329) | (0.244) |
| RUS_NOR_EXP | 0.016 | −0.854** | 0.299** | −0.384 |
| | (0.256) | (0.339) | (0.118) | (0.261) |
| RUS_ALB_IMP | −4.237*** | −3.081*** | 0.389*** | −2.043* |
| | (0.849) | (0.216) | (0.128) | (1.137) |
| RUS_ALB_EXP | −0.275 | −0.795 | 0.852*** | −2.843* |
| | (0.561) | (0.797) | (0.270) | (1.515) |
| RUS_ISL_IMP | −0.655 | −2.760*** | −0.876* | 0.198 |
| | (0.443) | (0.395) | (0.527) | (0.288) |
| RUS_ISL_EXP | 0.582 | 4.297*** | 0.152 | 0.189 |
| | (1.009) | (0.902) | (0.775) | (0.214) |
| *N* | 1,674,870 | 309,390 | 18,891,318 | 355,669 |

*Note*: This table reports estimates of the effects of the 2014 sanctions between Russia and the G7plus countries on trade excluding all domestic sales data. The dependent variable is sectoral trade in levels, 2010–2019 (in order to keep pre- and post-treatment number of years equal). All estimates are obtained with the PPML estimator and each sectoral specification includes exporter-industry-time fixed effects, importer-industry-time fixed effects, and country-pair-industry fixed effects. In addition to the reported estimates that are of interest to us, we also control for the impact of other complete trade sanctions and other remaining trade sanctions, RTAs, and WTO membership. These estimates are omitted for brevity. Each column of this table reports estimates for one of the following sectors, agriculture (industries 1 to 28), mining and energy (industries 29 to 35), manufacturing (industries 36 to 153), and services (industries 154 to 170), respectively. Standard errors are clustered by country-pair-industry.

* $p < 0.10$; ** $p < .05$; *** $p < .01$. See text for further details.

**TABLE B5** Change in real income and real GDP, all scenarios.

| | Real income (in %) | | | | | Real GDP (in %) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Shallow | | Deep | | Direct | Shallow | | Deep | | Direct |
| Country | S1: Unc. | S2: Coor. | S3: Unc. | S4: Coor. | S5 | S1: Unc. | S2: Coor. | S3: Unc. | S4: Coor. | S5 |
| AUS* | 0.00 | −0.00 | 0.01 | 0.01 | 0.00 | 0.00 | −0.00 | 0.01 | 0.01 | 0.00 |
| AUT** | −0.03 | −0.03 | −0.33 | −0.33 | −0.02 | −0.03 | −0.03 | −0.27 | −0.27 | −0.01 |
| BEL** | −0.01 | −0.01 | −0.27 | −0.27 | −0.02 | −0.01 | −0.01 | −0.21 | −0.21 | −0.01 |
| BGR** | 0.00 | 0.00 | −0.40 | −0.40 | −0.03 | 0.00 | 0.00 | −0.35 | −0.35 | −0.03 |
| BRA | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| CAN* | 0.00 | 0.00 | 0.01 | −0.04 | −0.01 | 0.00 | 0.00 | 0.01 | −0.02 | −0.00 |
| CHE* | 0.00 | 0.02 | 0.05 | −0.37 | −0.00 | 0.00 | 0.02 | 0.05 | −0.24 | 0.00 |
| CHN | 0.00 | 0.00 | 0.03 | 0.04 | 0.01 | 0.00 | 0.00 | 0.02 | 0.03 | 0.00 |
| CYP** | 0.01 | 0.01 | −1.06 | −1.06 | −0.09 | 0.01 | 0.01 | −1.02 | −1.02 | −0.09 |
| CZE** | −0.09 | −0.09 | −0.84 | −0.84 | −0.04 | −0.08 | −0.07 | −0.68 | −0.68 | −0.03 |
| DEU** | −0.03 | −0.03 | −0.36 | −0.36 | −0.02 | −0.02 | −0.02 | −0.26 | −0.26 | −0.01 |
| DNK** | 0.00 | −0.00 | −0.11 | −0.11 | −0.01 | 0.00 | −0.00 | −0.08 | −0.08 | −0.01 |
| ESP** | −0.01 | −0.01 | −0.11 | −0.11 | −0.01 | −0.01 | −0.01 | −0.09 | −0.09 | −0.01 |
| EST** | −0.09 | −0.09 | −1.65 | −1.65 | −0.16 | −0.08 | −0.08 | −1.39 | −1.39 | −0.13 |
| FIN** | −0.06 | −0.06 | −0.63 | −0.63 | −0.04 | −0.05 | −0.05 | −0.53 | −0.53 | −0.03 |
| FRA** | −0.01 | −0.01 | −0.10 | −0.10 | −0.01 | −0.01 | −0.00 | −0.09 | −0.09 | −0.01 |
| GBR** | −0.00 | −0.00 | −0.11 | −0.11 | −0.01 | −0.00 | −0.00 | −0.10 | −0.10 | −0.01 |
| GRC** | −0.00 | 0.00 | −0.12 | −0.12 | −0.01 | −0.00 | −0.00 | −0.10 | −0.10 | −0.01 |
| HRV** | −0.04 | −0.04 | −0.28 | −0.28 | −0.01 | −0.03 | −0.03 | −0.24 | −0.24 | −0.01 |
| HUN** | −0.03 | −0.03 | −0.42 | −0.42 | −0.03 | −0.03 | −0.03 | −0.32 | −0.33 | −0.02 |
| IDN | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| IND | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.00 |
| IRL** | −0.04 | −0.03 | −0.32 | −0.32 | −0.02 | −0.02 | −0.02 | −0.21 | −0.21 | −0.01 |
| ITA** | −0.02 | −0.02 | −0.21 | −0.22 | −0.02 | −0.02 | −0.02 | −0.18 | −0.18 | −0.01 |
| JPN* | 0.00 | −0.00 | 0.03 | −0.13 | −0.02 | 0.00 | 0.00 | 0.03 | −0.11 | −0.02 |

**TABLE B5** (Continued)

| Country | Real income (in %) | | | | | Real GDP (in %) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Shallow | | Deep | | Direct | Shallow | | Deep | | Direct |
| | S1: Unc. | S2: Coor. | S3: Unc. | S4: Coor. | S5 | S1: Unc. | S2: Coor. | S3: Unc. | S4: Coor. | S5 |
| KOR* | 0.01 | 0.01 | 0.09 | −0.26 | 0.02 | 0.00 | 0.00 | 0.06 | −0.18 | 0.01 |
| LTU** | −0.15 | −0.15 | −1.77 | −1.77 | −0.12 | −0.13 | −0.13 | −1.53 | −1.53 | −0.10 |
| LUX** | −0.03 | −0.03 | −0.60 | −0.58 | −0.06 | −0.02 | −0.02 | −0.34 | −0.33 | −0.03 |
| LVA** | −0.08 | −0.08 | −1.48 | −1.48 | −0.11 | −0.08 | −0.08 | −1.40 | −1.39 | −0.10 |
| MEX | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.00 |
| MLT** | −0.00 | −0.01 | −0.16 | −0.16 | −0.01 | −0.00 | −0.01 | −0.16 | −0.16 | −0.01 |
| NLD** | 0.01 | 0.01 | −0.12 | −0.11 | −0.02 | 0.01 | 0.01 | −0.07 | −0.06 | −0.01 |
| NOR* | 0.06 | −0.02 | 0.35 | 0.18 | −0.10 | 0.03 | −0.01 | 0.19 | 0.09 | −0.05 |
| POL** | −0.09 | −0.09 | −0.84 | −0.84 | −0.04 | −0.07 | −0.07 | −0.71 | −0.71 | −0.03 |
| PRT** | −0.00 | −0.00 | −0.05 | −0.05 | −0.00 | −0.00 | −0.00 | −0.04 | −0.05 | −0.00 |
| ROU** | −0.05 | −0.05 | −0.40 | −0.40 | −0.02 | −0.04 | −0.04 | −0.35 | −0.35 | −0.01 |
| ROW | 0.01 | 0.01 | 0.06 | 0.11 | 0.01 | 0.01 | 0.01 | 0.06 | 0.10 | 0.01 |
| RUS | −0.25 | −0.30 | −2.92 | −4.23 | −0.39 | −0.22 | −0.26 | −2.61 | −3.78 | −0.41 |
| SVK** | −0.08 | −0.08 | −0.73 | −0.73 | −0.04 | −0.07 | −0.07 | −0.62 | −0.61 | −0.03 |
| SVN** | −0.01 | −0.01 | −0.26 | −0.26 | −0.02 | −0.01 | −0.01 | −0.21 | −0.21 | −0.02 |
| SWE** | −0.02 | −0.02 | −0.27 | −0.27 | −0.01 | −0.02 | −0.02 | −0.21 | −0.21 | −0.01 |
| TUR | 0.01 | 0.01 | 0.06 | 0.11 | 0.01 | 0.00 | 0.01 | 0.05 | 0.09 | 0.01 |
| TWN* | 0.00 | 0.00 | 0.01 | −0.05 | 0.00 | 0.00 | −0.00 | 0.01 | −0.03 | 0.00 |
| USA* | 0.00 | 0.00 | 0.00 | −0.02 | −0.00 | 0.00 | 0.00 | 0.00 | −0.02 | −0.00 |

*Note*: This table shows the real income and effects and real GDP effects of all scenarios.
** denotes EU countries, * denotes the EU's allies.

TABLE B6 Change in real income and real GDP, all scenarios.

| | S2: Coordinated shallow | | S4: Coordinated deep | |
|---|---|---|---|---|
| **Trade cost elasticity** | **−4** | **−6** | **−4** | **−6** |
| AUS* | −0.00 | −0.00 | 0.01 | 0.01 |
| AUT** | −0.03 | −0.03 | −0.40 | −0.28 |
| BEL** | −0.01 | −0.01 | −0.32 | −0.23 |
| BGR** | 0.00 | 0.00 | −0.47 | −0.34 |
| BRA | 0.00 | 0.00 | 0.01 | 0.01 |
| CAN* | 0.00 | 0.00 | −0.05 | −0.04 |
| CHE* | 0.01 | 0.02 | −0.44 | −0.31 |
| CHN | 0.00 | 0.00 | 0.05 | 0.04 |
| CYP** | 0.01 | 0.01 | −1.27 | −0.91 |
| CZE** | −0.09 | −0.09 | −1.02 | −0.72 |
| DEU** | −0.02 | −0.03 | −0.43 | −0.31 |
| DNK** | −0.00 | −0.00 | −0.14 | −0.10 |
| ESP** | −0.01 | −0.01 | −0.13 | −0.09 |
| EST** | −0.09 | −0.09 | −1.97 | −1.43 |
| FIN** | −0.06 | −0.06 | −0.75 | −0.54 |
| FRA** | −0.01 | −0.01 | −0.12 | −0.08 |
| GBR** | −0.00 | −0.00 | −0.14 | −0.10 |
| GRC** | 0.00 | 0.00 | −0.14 | −0.10 |
| HRV** | −0.04 | −0.04 | −0.34 | −0.24 |
| HUN** | −0.03 | −0.03 | −0.51 | −0.36 |
| IDN | 0.00 | 0.00 | 0.02 | 0.01 |
| IND | 0.00 | 0.00 | 0.01 | 0.01 |
| IRL** | −0.03 | −0.04 | −0.39 | −0.28 |
| ITA** | −0.02 | −0.02 | −0.26 | −0.19 |
| JPN* | −0.00 | 0.00 | −0.15 | −0.11 |
| KOR* | 0.01 | 0.01 | −0.31 | −0.22 |
| LTU** | −0.15 | −0.15 | −2.13 | −1.51 |
| LUX** | −0.03 | −0.02 | −0.69 | −0.50 |
| LVA** | −0.08 | −0.08 | −1.78 | −1.27 |
| MEX | 0.00 | 0.00 | 0.02 | 0.01 |
| MLT** | −0.01 | −0.01 | −0.20 | −0.14 |
| NLD** | 0.01 | 0.01 | −0.14 | −0.10 |
| NOR* | −0.04 | −0.01 | 0.22 | 0.15 |

TABLE B6 (Continued)

| | S2: Coordinated shallow | | S4: Coordinated deep | |
|---|---|---|---|---|
| **Trade cost elasticity** | **−4** | **−6** | **−4** | **−6** |
| POL** | −0.09 | −0.08 | −1.02 | −0.72 |
| PRT** | −0.00 | −0.00 | −0.06 | −0.05 |
| ROU** | −0.05 | −0.05 | −0.48 | −0.34 |
| ROW | 0.01 | 0.01 | 0.13 | 0.10 |
| RUS | −0.31 | −0.30 | −5.20 | −3.57 |
| SVK** | −0.08 | −0.08 | −0.88 | −0.63 |
| SVN** | −0.01 | −0.01 | −0.31 | −0.22 |
| SWE** | −0.02 | −0.02 | −0.33 | −0.23 |
| TUR | 0.01 | 0.01 | 0.12 | 0.10 |
| TWN* | 0.00 | 0.00 | −0.06 | −0.04 |
| USA* | 0.00 | 0.00 | −0.02 | −0.02 |

*Note*: This table shows the aggregated sectoral value added effects, thus similar to GDP changes for all countries available in the data. The table shows the real income effects for the coordinated scenario with shallow sanctions (2014) and deep sanction for different values of the trade cost elasticity (corresponding to the parameter $-\frac{1}{\theta}$ in the model). The main simulations are based on $-\frac{1}{\theta} = -5$.

$**$ denotes EU countries, $*$ denotes the EU's allies.