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ARTICLE

Economic sanctions and agricultural trade

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Abstract

Economic sanctions are more popular than ever. But do they affect agricultural trade? Combining two new datasets and capitalizing on the latest developments in the empirical structural gravity literature, we investigate the effects of sanctions on international trade of agricultural products. We find that trade sanctions impede agricultural trade, whereas other sanctions do not show any significant impact. Complete trade sanctions have led to about a 67% decrease in the agricultural trade between the sanctioned and sanctioning countries, or a corresponding tariff equivalent of 25%, and we also obtain significant estimates for partial sanctions. At the industry level, we find substantial heterogeneity depending on the sanctioning and sanctioned countries, the type of sanctions used, and the direction of trade flows. The 2014 sanctions on Russia substantially decreased Russia's agricultural trade, mainly due to reduced trade with the EU but also due to reduced trade with other countries. Although no definitive evidence exists that sanctions alter the actions of governments of receiving countries, this paper provides broad evidence that sanctions hamper agrifood trade and hurt producers, consumers, and real output.

KEYWORDS
agriculture, heterogeneity, Russia, sanctions, structural gravity, trade

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F14, F51, Q17

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1 | INTRODUCTION

Governments have utilized sanctions against foreign countries since the Peloponnesian War (431–404 BC), but, until recently, their infrequent use was typically an added dimension of a war effort (Hufbauer et al., 1990). Beginning with the Cold War ending in 1991, policymakers frequently deployed comprehensive economic sanctions as a foreign policy tool to punish or coerce foreign governments into altering their behavior as an alternative to military action when international conflicts arose (Weiss, 1999; Winkler, 1999).[1] The comprehensive economic sanctions of this 1990s era typically involved deliberate suspension of normal relations with foreign countries across the majority of trade and financial industries (Boomen, 2014; Coates, 2020; Elliott, 2010; Heine-Ellison, 2001; Morgan et al., 2022).[2] Ethical concerns about these comprehensive policies arose because humanitarian provisions were largely impromptu in the event of a crisis and the agrifood restrictions only expanded the frequency of humanitarian emergencies in the sanctioned country and created undue hardship for citizens.[3] Furthermore, many questioned the success of comprehensive sanctions in impacting the behavior of the offending foreign governments (Boomen, 2014; Gordon, 2011; Weiss, 1999).[4] At the same time, the expansion of restrictions on food and agricultural exports alarmed farm groups and agribusiness, who responded by lobbying the US government to exclude agrifood products from economic sanctions to protect their financial interest (HCA, 1998; Peterson & Haugen, 2016).

The confluence of ethics, lack of political success, and lobbying of farm groups, agribusiness, and pharmaceutical companies resulted in many governments shifting from comprehensive sanctions to targeted sanctions that excluded food and medical products circa 2000 (Drezner, 2011). For example, the Trade Sanctions Reform and Export Enhancement Act passed in the United States in 2000 terminated unilateral agricultural and medical sanctions and banned future sanctions from including these products (US Department of the Treasury, 2021). Although targeted sanctions are designed to lessen the ethical and humanitarian harm, they may still impact food and medicine trade because financial, insurance, and transportation restrictions create difficulties for the exporters of such products to conduct business in sanctioned countries and cause disruptions to trade patterns and countries' comparative advantage.[5] Although scholars agree that comprehensive sanctions are both unethical and unsuccessful in their political goals, no consensus exists on the ethics or political success of targeted sanctions (Peterson & Haugen, 2016). However, the connection between agricultural commodities and humanitarian concerns has been integral in shaping how governments implement economic sanctions.

Given the role food products have played in the evolution of sanctions, the main purpose of this study is to quantify the impact of economic sanctions on agricultural trade. We further investigate the heterogeneous impact of sanctions on agricultural trade based on type, direction, both type and directions of sanctions, and at the industry level. We hypothesize that sanctions will impede agricultural trade but not completely prevent it because many sanctions are imposed only from one or a few countries, allowing for trade diversion from nonsanctioning countries. We further hypothesize

[1]Tho sudden upsurge resulted in the 1990s being deemed the "Sanctions Decade."

[2]For example, in 1990 and 1995, the UN and US, respectively, imposed comprehensive sanctions on Iraq and Iran, which included embargoed trade in all commodities (Gordon, 2020: Katzman, 2020). Although the UN sanction on Iraq included provisions for food and medicine aid when a humanitarian crisis arose, the US sanction on Iran did not include humanitarian aid until 1999.

[3]Comprehensive economic sanctions are permitted under international law. As a result, scholars have argued the ethics and legality of these sanctions under human rights law, international humanitarian law, or the World Trade Organization (WTO) agreements (Peterson & Haugen, 2016). Within WTO. the Security Exception allows member countries to implement sanctions that violate the most-favored-nation treatment for reasons of national security (WTO., 2021). Also. WTO rules do not apply to members' trade with nonmember states, and targeted sanctions against nonstate terrorist groups do not violate WTO agreements.

[4]See Peterson and Haugen (2016) for a review of the extensive literature on the ethical, legal, and political success of sanctions.

[5]In addition to minimizing the negative impact on ordinary citizens, literature exists that suggests targeted sanctions are more successful at achieving their goals (Cortright & Lopez, 2002: Heine-Ellison, 2001; Elliott, 2010). For example, the Joint Comprehensive Plan of Action (commonly known as the Iran nuclear deal) is recent evidence that targeted sanctions influenced foreign governments to alter their behavior (Katzman, 2010; Laub, 2015). However, Early (2015) provides evidence that some targeted sanctions fail when states ignore them (Early, 2015).

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that complete sanctions will have blocked trade more than partial sanctions because partial sanctions only cause indirect impacts on agricultural trade. In doing so, we capitalize on the latest developments in the structural gravity literature. In addition to examining the overall impact of a complete set of sanctions on global agricultural trade, we provide a detailed analysis of the economic sanctions by Europe, North America, Japan, and allied countries on Russia in 2014 over the Crimea conflict.

Our empirical analysis implements two novel data sets: the 2022 edition of the International Trade and Production Database for Estimation (ITPD-E) (Borchert et al., 2021, 2022) and the 2021 edition of the Global Sanctions Database (GSDB) (Felbermayr, Kirilakha, et al., 2020; Felbermayr, Syropoulos, et al., 2020; Kirilakha et al., 2021), which are described in detail in the section Data: Description and Sources. Furthermore, the main results are based on structural gravity models with cutting-edge estimation techniques as, for example, described in Yotov et al. (2016). As such, our specifications implement the Poisson pseudo maximum likelihood (PPML) estimator for consistent estimates with heteroskedasticity in the trade data and the inclusion of zero trade flows;[6] data for both international trade flows and domestic sales; and three sets of fixed effects: (i) exporter-industry-time and importer-industry-time fixed effects to control for the inward and outward multilateral resistance terms and all unobservable exporter-industry-time and importer-industry-time effects; (ii) country-pair-industry fixed effects to control for all time-invariant bilateral trade costs and to mitigate endogeneity in policy variables by capturing all unobservable country-pair-industry effects; and (iii) time-industry-varying bilateral border fixed effects to account for the impact of globalization on trade.

We find that, on average, trade sanctions have impeded agricultural trade between the sanctioned and sanctioning countries by reducing trade volumes by around 10%, whereas other sanctions do not systematically affect trade. Focusing on trade sanctions, although complete sanctions reduce trade by about 67% on average, partial sanctions also show negative effects as trade declines by about 18%. This later result has important policy implications as partial sanctions typically do not include agricultural products over humanitarian concerns.

Furthermore, sanctions in both directions hinder agricultural trade substantially more compared to sanctions on only imports or only exports. Substantial heterogeneity transpires at the industry level depending on the sanctioning and sanctioned countries, the type of sanctions used, and the direction of trade flows. Concerning the sanctions involving Russia, the results reveal substantial negative effects as agricultural trade with Russia falls, particularly for EU–Russian trade, which declines by about 62%.

We translate the point estimates of the 2014 sanctions on Russia into effects on consumer prices, producer prices, total exports, and real output using a multicountry, single-sector endowment economy model. We find substantial heterogeneity among the countries in terms of producer prices, consumer prices, total exports, and real output. As expected, the largest losses for producers and consumers occur in countries with substantial trade volumes of agricultural products with Russia, among them many European countries. Moreover, we also find that countries that did not participate in the sanctions (e.g., Korea and Taiwan) experienced an increase in real output. Interestingly, we obtain positive effects for some countries that did participate in the sanctions (e.g., Malta, Canada, Norway, and Croatia), which we attribute to trade diversion. Trade diversion also explains why our estimates of the effects of total exports for some countries (e.g., Switzerland, Russia, and Luxembourg) are substantially smaller than the corresponding point estimates.

The agricultural gravity literature has primarily examined the impact of global and regional trade agreements (Grant & Lambert, 2008; Koo et al., 2006; Lambert & McKoy, 2009; Luckstead, 2022; Sarker & Jayasinghe, 2007; Zahniser et al., 2002) and tariff and nontariff measures (Anders & Caswell, 2009; Chevassus-Lozza et al., 2008; Disdier et al., 2008; Disdier & Marette, 2010; Otsuki

[6]See Santos Silva and Tenreyro (2006) for a detailed discussion and Monte Carlo analysis of the PPLM estimator. Also, see Head and Mayer (2014) and Martin (2020) for alternatives to PPLM for estimating gravity models.

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et al., 2001; Swann et al., 1996).[7] Thus, from a policy perspective, our first contribution to this literature is the focus on the impact of economic sanctions.

Our paper relates to the trade literature on trade remedies, wars, and retaliation, which governments utilize in response to dumping, political conflict, or national security concerns. Trade remedy laws, such as antidumping duties (AD) and countervailing duties (CVD), involve a country imposing tariffs specifically to offset predatory pricing resulting from dumping, but countries have also abused these policies to protect domestic producers (Carter & Steinbach, 2018). AD and CVD have been extensively studied in manufacturing (Bown & Crowley, 2007; Prusa, 2005; Vandenbussche & Zanardi, 2010) and agricultural (Blonigen, 2004; Carter & Gunning-Trant, 2010; Carter & Mohapatra, 2013; Kerr, 2006; Kinnucan & Myrland, 2006; Meilke & Sarker, 1997; Moschini & Meilke, 1992) settings. Furthermore, trade wars and retaliatory trade actions arise when one country imposes tariffs on one or more commodities of targeted trade partners for political or national security reasons and the trade partners respond by imposing retaliatory tariffs (see Felbermayr et al., 2012; Ossa, 2014 for theoretical treatments, Caceres et al., 2019 for empirical analysis, and Alston et al., 1994; Carter & MacLaren, 1997; Baryshpolets et al., 2022; Adjemian et al., 2021; Grant et al., 2021 for applications in agricultural trade). Although trade remedies, trade wars, and retaliatory trade actions are typically in response to undesirable actions by another country, a common thread of these policies entails tariffs on imports, which allows the targeted commodities to continue to enter the importing country but at a higher price due to the tax. By contrast, sanctions are a trade prohibition of specified commodities with the target country without using tariffs. Also, governments implement sanctions for various political and social reasons and can be imposed on imports, exports, or both imports and exports.

To the best of our knowledge, the agricultural gravity literature xamining the impact of sanctions on food and agrifood trade focuses on the case of sanctions imposed on Russia and Russia's retaliatory embargos on food-product imports resulting from the 2014 Ukraine conflict.[8] For example, Crozet and Hinz (2016) exploit both country-level and French firm-level bilateral trade data to analyze this sanction event on the sending countries. For the country-level analysis, Crozet and Hinz (2016) utilize monthly (January 2012 to June 2015) UN Comtrade bilateral trade flow data with products aggregated at two levels: embargoed[9] and not embargoed. Their results show that exports of both embargoed and nonembargoed agricultural products at both the industry and firm levels fell, which provides evidence of collateral damage from this sanction event. Cheptea and Gaigné (2020) also utilize the monthly UN Comtrade trade data for all agrifood commodities (HS chapters 1–23) to implement a log-linear gravity model without domestic sales to analyze the impacts of the Russian food sanctions on EU food exports and Russian food imports. Their triple-difference approach shows that the Russian sanctions caused EU food exports of banned commodities to Russia to decline by an average of 80%. Our paper complements this literature by moving past a case-study approach by considering the overall impacts of a complete set of sanctions on agricultural trade. We then focus on the impacts of sanctions on and by Russia as a particular case. In doing so, we examine the Russian sanctions using annual data and the latest structural gravity literature developments, allowing us to examine heterogeneity across several dimensions.

Finally, our study builds on Felbermayr, Kirilakha, et al. (2020), Felbermayr, Syropoulos, et al. (2020) and Larch et al. (2022) who implement theoretically consistent gravity models to quantify the

[7]See Santeramo and Lamonaca (2019) for a review of literature and meta-analysis on the impact of nontariff measures on agrifood trade. Several papers also examine the impact of SPS measures (Grant et al., 2015; Peterson et al., 2013), tariffs (Cipollina & Salvatici, 2020), and standard friction variables (Jayasinghe et al., 2010) on agricultural commodity trade with only one importer or one exporter. Tong et al. (2019) examine the impact of US subsidies on US state-level exports to the 100 largest destination countries. Finally, Raimondi and Olper (2011) quantify trade elasticities for 18 food industries using tariff data and a gravity model.

[8]A related literature examines the impact of sanctions on food security. Based on evidence linking food security and trade (Dorosh, 2001: Koc et al., 2007: Dithmer & Abdulai, 2017), Afesorgbor (2021) use panel data from 1950 to 2014 to show that sanctions increased the global hunger index by between 1.25 and 2.22 points. The previous research on the Russian food embargo primarily relied on *ex-post* computable general equilibrium analysis (see for example. Boulanger et al., 2016).

[9]See footnote 13 in the subsequent section for a list of embargoed agricultural commodities.

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impact of sanctions on aggregate trade and trade in the energy and mining industries, respectively.[10] Specifically, Felbermayr, Kirilakha, et al. (2020) and Felbermayr, Syropoulos, et al. (2020) highlight the new GSDB by examining the impact of sanctions against Iran—one of the most sanctioned countries in terms of country coverage, targets of commodities, industries, individuals, and time—on aggregate trade. Their results show that sanctions with Iran impact bilateral trade differently depending on the sanctioning country and the direction of trade. Larch et al. (2022) show that sanctions reduce energy and mining trade by an average of 44%, although significant heterogeneity exists across several dimensions, including mining industries, specific episodes or cases, sanction type, and direction of trade.[11] The current paper differs from these two papers by examining the impact of sanctions on agrifood commodities, which are typically excluded from comprehensive sanctions.

The rest of the paper is organized as follows. In section Trade Sanctions and Agriculture, we discuss several sanction cases and highlight potential channels through which they can influence food and agricultural trade. In section Data: Description and Sources, we describe the two new datasets employed. This section lays out the econometric specification. Section *Impact of Sanctions on Agricultural Trade for Pooled Industries* presents our estimation results, where we first present the estimations at the pooled level and study the heterogeneity of the effects of sanctions along several dimensions, and then we obtain estimates of the sanction effects at the industry and sectoral level. In section On the Price, Output and Total Trade Effects of the Sanctions on Russia, we translate our estimates of the impact of the 1,702,014 sanctions on Russia into effects, taking into account changes in income and prices. The last section offers concluding remarks.

2 | TRADE SANCTIONS AND AGRICULTURE

We consider several cases during the sample period, 1986 to 2019, to detail various channels through which sanctions detailed in the GSDB can influence food and agricultural trade. The GSDB distinguishes between six broad types of sanctions: trade, financial, arms, military assistance, travel, and other sanctions. For this study, we focus on trade sanctions, which are most likely to impact agricultural trade but control all other sanction types in the analysis. Table A1 in Appendix A lists all trade sanctions that were active from 1986 to 2019 and includes information about the target/sanctioned country or region, the sender/sanctioning country or region, the start and end of the sanction, and also about the type of trade sanction. Despite many countries shifting from complete sanctions to partial sanctions in the late 1990s and early 2000s (Gordon, 2011; Peterson & Haugen, 2016), of the 299 sanctions included in Table A1, 174 started after 1999, of which 6.9% (or 12) were complete sanctions. For the 125 sanctions that started in or before 1999, 28.8% (or 36) were complete sanctions. Thus, although a dramatic drop in complete sanctions occurred after 1999, governments still utilized complete sanctions.[12]

Governments impose sanctions for a variety of reasons. Trade sanctions have been directed at specific products, often agricultural in nature, over pest and disease concerns. For example, bovine spongiform encephalopathy, commonly known as mad cow disease, has led to several cases of trade bans. Following an outbreak of mad cow disease in Europe in the mid-1990s, Canada banned all beef imports from the EU in 1996 (Case ID 106; Staff, 2015). Subsequently, Canada spearheaded a NAFTA-wide sanction on Brazilian beef in 2001 due to a mad cow disease outbreak (Case ID 137; Global and Mail, 2001; Rich, 2001). Also, outbreaks in the United States and Canada in the early-2000s resulted in Canada banning US beef and cattle imports (Case ID 145; Al Jazeera, 2003); the

[10]See Jing et al. (2003) and Sobel (1998) for a detailed analysis of the choice of sanctions and their impacts on exchange rates.

[11]Other papers, such as Caruso (2003) and Slavov (2007). have implemented gravity models to examine the impact of sanctions on trade. However, their results are likely biased and unreliable because they estimate log-linear models, exclude zeros in trade flows and domestic sales, and do not properly account for multilateral resistances.

[12]For example. Canada levied complete import and export sanctions against Myanmar (case ID 183) between 2007 and 2012. and the United States levied complete import sanctions on North Korea (case ID 210) between 2011 and 2019.

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United States banning Canadian beef and cattle imports (Case ID 151; Krauss & Blakeslee, 2003; USDA Press, 2019); Brazil and Japan banning US beef imports (Case ID 146 and 147; Tomson, 2017); and China, Japan, and Mexico banning Canadian beef imports (Case ID 150, 153, and 156; Vanderklippe, 2016; CBC, 2005; Rousseau, 2016) in 2003. Therefore, the GSDB considers a broad definition of sanctions that includes suspension of trade over pest and disease outbreaks. The common link between sanctions imposed for political pressure and those imposed for pests and diseases is that normal trade relations are suspended without the use of tariffs.

Countries or a set of countries can also impose trade sanctions to create political pressure on other countries for acts (often related to military actions or human rights violations) with which the sanctioning government does not agree. For example, the United States imposed economic sanctions against India (Case ID 118) in 1998 due to nuclear testing (CNN, 1998, 2001; USDS, 2001). Also, in 2013, the European Union implemented export restrictions on Egypt (Case ID 242) following the political violence to quell the Arab Spring protests (Grin, 2012; Sipri, 2017).

One of the more prominent sanction cases relates to the annexation of Crimea in Ukraine by Russia in 2014. The 2014 sanctions by Australia, Canada, EU(+), Japan, Switzerland, and the United States (Case IDs 256, 258, 261, 269, 271, 274, and 276) against Russia mainly related to foreign credit and investment; however, these sanctions triggered a severe depreciation of the ruble, causing inflation as the import price of food and other goods increased (Liefert & Liefert, 2015). Furthermore, this inflationary event coincided with a drop in the world oil price, straining the value of Russia's principal export. Russia responded by placing food embargoes on agricultural trade with the sanctioning countries (Case IDs 259, 263, 266, 272).[13] Furthermore, with Russia's invasion of Ukraine at the end of February 2022, sanctions against Russia have escalated significantly, including embargoes on key agricultural commodities such as wheat, but these new extensive sanctions are outside of our study period (BBC, 2022).

Although a detailed discussion of every sanction case in Table A1 is outside the scope of this paper, the above examples show that food and agricultural products are often used as leverage in or at the center of sanction cases, and with modern-day sanctions on agricultural products often being retaliatory in nature and geared toward compensation, they are rarely prohibitive. Even in complete sanction cases that contain food and medical aid exceptions (e.g., the UN lead Oil-for-Food program with Iraq, Case ID 54), normal agricultural trade relationships do not exist. Finally, a few trade embargoes exist on all commodities, including food and humanitarian aid, between countries with deep historical tensions (e.g., Turkey and Armenia, Case ID 86; The United States and Sudan, Case ID 109; Armenia and Azerbaijan, Case ID 46).

In broader terms, trade sanctions increase transport costs and disrupt trade patterns and comparative advantage, leading to indirect impacts of partial or smart sanctions on nonsanctioned commodities. In the targeted country, the price of the sanctioned good will likely rise, which can lead to rent seeking by third-party countries—known as sanction busting—that attempt to fill the supply void (Early, 2015; Peksen & Peterson, 2016). Therefore, the sending countries pay the cost of lost export revenue and disrupted exchange, sanctioned states are worse off due to higher prices, whereas third-party sanction busters benefit through higher export revenues. Other indirect channels in which economic and trade sanctions can disrupt trade patterns include a deterioration of financial stability and foreign capital flight of the sanctioned states (Lektzian & Biglaiser, 2013; Peksen & Son, 2015).

[13]The embargo on agricultural products was at the HS-4 level and covered the following products: 0103 "Swine, live"; 0203 "Meat of swine, fresh, chilled or frozen"; 0201 "Meat of bovine animals, fresh or chilled."; 0202 "Meat of bovine animals, frozen"; 0207 "Meat and edible offal of poultry"; 0210 "Meat, salted, in brine, dried or smoked"; 0301 0308 "Fish and crustaceans, mollusks and other aquatic invertebrates"; 0401 0406 "Milk and dairy products"; 0701 0714 "Vegetables and edible roots and tubers"; 0801 0811, 0813 "Fruit and nuts"; 1601 "Sausages and similar products, of meat, meat offal or blood"; 1901 "Food preparations, including cheeses and curd, based on vegetable fats"; and 2106 "Food preparations, based on vegetable fats and containing milk".

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3 | DATA: DESCRIPTION AND SOURCES

The two main datasets that we use to perform the empirical analysis are the International Trade and Production Database for Estimation (ITPD-E), developed by Borchert et al. (2021) and recently updated by Borchert et al. (2022), and the Global Sanctions Database (GSDB), developed by Felbermayr, Kirilakha, et al. (2020), Felbermayr, Syropoulos, et al. (2020) and updated by Kirilakha et al. (2021). The ITPD-E dataset includes international and domestic trade data for more than 250 countries over the years 1986–2019.[14] The trade data is consistently constructed for 170 industries, including 26 agricultural and food commodities, which are the focus of our analysis. For clarity and expositional simplicity, while preserving a sufficient number of degrees of freedom, for some of the analyses of heterogeneity we classify and aggregate the 26 agricultural industries in the original data into five broad agricultural sectors, including bulk commodities (BULK); live animals, meat, and animal products (ANIMAL); labor intensive (LABOR); processed foods (PRCSSD); and sugars (SUGARS). Table 1 lists the disaggregated industries in our sample and offers a concordance between them and the five aggregated categories.

The original data for the 26 agricultural industries in ITPD-E come from the Food and Agriculture Organization of the United Nations Statistics Division (FAOSTAT). Reported import flows are used as the main source and mirror exports reported by partner countries are used to fill missing import values. Domestic trade is calculated as the difference between the values of total (gross value) production and total exports. It turns out that only 0.22%of the resulting observations for domestic trade were negative and these are dropped from the analysis. ITPD-E is balanced across the exporter, importer, and industry dimensions by filling missing observations with zeros. The period covered is 34 years from 1986 to 2019. To drop irrelevant zeros, the final dataset keeps only observations that are retained when estimating a gravity model using the PPML estimator with exporter–time, importer–time, and directional bilateral fixed effects.

Overall, there are 5,930,263 observations in the 26 agricultural industries, with 3,925,557 observations where trade flows are zero. The largest industry is industry 26 "other agricultural products, nec" with 554,853 observations, followed by industries 12 "fresh fruit," 22 "beverages, nec," and 25 "spices," which all have around 400,000 observations. The industries with the fewest observations are 9 "raw and refined sugar and sugar crops," 18 "live swine," and 15 "prepared vegetables" with less than 40,000 observations. For industries, 5 "cereal products," 8 "animal feed ingredients and pet foods," 14 "prepared fruits and fruit juices," 15 "prepared vegetables," 17 "live cattle," 18 "live swine," and 23 "cotton" ITPD-E does not include intranational trade flows. The number of distinct exporters varies substantially over industries: Although there are about 200 distinct exporters in industries 7 "other oilseeds (excluding peanuts)," 12 "fresh fruit," 13 "fresh vegetables," 20 "other meats, livestock products, and live animals," 22 "beverages, nec," 25 "spices," and 26 "other agricultural products, nec," there are only about 100 distinct exporters in industries 9 "raw and refined sugar and sugar crops" and 18 "live swine." These differences have to be kept in mind when we discuss results based on the most disaggregate level.

The second major database that we use is the 2021 edition of the Global Sanctions Database (GSDB) (Felbermayr, Kirilakha, et al., 2020; Felbermayr, Syropoulos, et al., 2020; Kirilakha et al., 2021).[15] The GSDB covers all publicly traceable sanctions between 1950 and 2019 and classifies them according to their objectives, type, and success. As discussed in Section Trade Sanctions and Agriculture, the GSDB distinguishes among six types of sanctions (trade, travel, finance, arms, military assistance, and other). Of particular importance for our analysis, the GSDB includes several categories of trade sanctions based on their coverage, that is, partial versus complete sanctions, and depending on the direction of trade, that is, on exports, on imports, and in both directions of trade, as seen in Table A1. We capitalize on this feature of the GSDB in the empirical analysis to obtain estimates of the effects of each type of trade sanction.

[14]Thc countries in the ITPD-E follow the labeling of the Dynamic Gravity Database of the USITC, cf. Gurevich and Herman (2018). For further information and free downloading of the ITPD-E data please visit https://www.usitc.gov/data/gravity/itpde.htm.

[15]More details about the GSDB can be found at https://www.globalsarictiorisdatabase.com, and the data can be requested by e-mail from GSDBSdrexel.edu.

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TABLE 1 Agricultural industries ITPD-E: classification and concordance.

ID	Disaggregated industry description	Aggregated industry description
1	Wheat	Bulk commodities
2	Rice (raw)	Bulk commodities
3	Corn	Bulk commodities
4	Other cereals	Bulk commodities
5	Cereal products	Bulk commodities
6	Soybeans	Bulk commodities
7	Other oilseeds (excluding peanuts)	Bulk commodities
8	Animal feed ingredients and pet foods	Bulk commodities
9	Raw and refined sugar and sugar crops	Sugars
10	Other sweeteners	Sugars
11	Pulses and legumes, dried, preserved	Bulk commodities
12	Fresh fruit	Labor-intensive crops
13	Fresh vegetables	Labor-intensive crops
14	Prepared fruits and fruit juices	Processed foods
15	Prepared vegetables	Processed foods
16	Nuts	Labor-intensive crops
17	Live cattle	Live animals, meat, and animal products
18	Live swine	Live animals, meat, and animal products
19	Eggs	Live animals, meat, and animal products
20	Other meats, livestock products, and live animals	Live animals, meat, and animal products
21	Cocoa and cocoa products	Labor-intensive crops
22	Beverages, nec	Processed foods
23	Cotton	Bulk commodities
24	Tobacco leaves and cigarettes	Processed foods
25	Spices	Processed foods
26	Other agricultural products, nec	Processed foods

Note: This table lists the disaggregated industries in our sample, as well as the five broad sectoral categories that correspond to them.

Due to the shorter period covered by the ITPD-E, we only utilize a subsample of the GSDB dataset, that is, the years between 1986 and 2019. As will become clear shortly, although we will not be able to identify the impact of the trade sanctions that entered before the period of investigation, we will fully control for them in our preferred econometric model, which will include pair fixed effects. Finally, a drawback of the GSDB is that it does not include information about the sectors that were targeted by partial sanctions. Thus, in our empirical analysis, we cannot identify partial sanctions that target agriculture. To overcome this challenge, we obtain average estimates of the impact of all partial sanctions as well as estimates of the effects of some specific partial sanctions, that is, the sanctions involving Russia due to the Crimean crisis.

Finally, in addition to the two main datasets on trade and sanctions, we rely on the Dynamic Gravity Dataset (DGD) of the US International Trade Commission, compare to Gurevich and Herman (2018), for data on membership in the World Trade Organization, and on the Regional Trade Agreements Database of Egger and Larch (2008) for data on regional trade agreements (RTAs).[16] For the counterfactual analysis, we use the year 2014 of the World Input–Output Database (WIOD)

[16]The DGD and the RTA datasets are downloadable for free at https://catalog.data.gov/dataset/dynamic-gravity-dataset-1948-2016 and https://www.ewf.uni-bayreuth.de/en/research/RTA-data/index.html, respectively.

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November 2016 Release (available for download at https://www.rug.nl/ggdc/valuechain/wiod/wiod-2016-release), which provides data for 43 countries and is a fully balanced dataset (https://www.ewf.uni-bayreuth.de/en/research/RTA-data/index.html). Consistent with the focus on agricultural trade, we only use industry A01 "crop and animal production, hunting, and related service activities."

4 | IMPACTS OF SANCTIONS ON AGRICULTURAL TRADE

This section specifies our econometric model and presents the results for the impact of sanctions on agricultural trade across various specifications.

4.1 | Econometric specification

We estimate the impact of sanctions on agricultural trade by exploring various dimensions of the data (e.g., sanction types, industry variation, the direction of trade, etc.). To this end, we rely on the following econometric model, which capitalizes on the latest developments in the empirical gravity literature[17]:

$$X_{ij,t}^{k} = \exp\left[\pi_{i,t}^{k} + \chi_{j,t}^{k} + \mu_{ij}^{k} + \sum_{t} \alpha_{t}^{k} \mathrm{BRDR}_{ij,t} + \alpha_1 \mathrm{RTA}_{ij,t} + \alpha_2 \mathrm{WTO}_{ij,t}\right] \times \exp\left[\alpha_3 \mathrm{SANCT\_TRADE}_{ij,t} + \alpha_4 \mathrm{SANCT\_OTHER}_{ij,t}\right] \times \varepsilon_{ij,t}^{k}. \quad (1)$$

The here, $X_{ij,t}^{k}$ is bilateral agricultural trade in levels from exporter i to importer j in industry k at time t. Due to the separability property of the structural gravity model, Equation (1) can be estimated at any desired level of aggregation (e.g., at the product, sector, industry, and/or aggregate levels).[18] Along these lines, the main results in this section are obtained with all available data by stacking the 26 agricultural industries together. In addition, we examine heterogeneity across industries by presenting estimates of the effects of sanctions for each of the individual agricultural industries in our sample. Consistent with gravity theory, $X_{ij,t}^{k}$ includes domestic trade flows, compare with Yotov (2022). Domestic trade flows are important to include because they allow for trade diversion or import substitution with the domestic market, depending on the policy or trade shock being analyzed. Finally, following the recommendations of Egger et al. (2022), $X_{ij,t}^{k}$ includes data for all years in the sample.[19]

Turning to the covariates in (1), $\pi_{i,t}^{k}$ and $\chi_{j,t}^{k}$ are exporter-industry-time and importer-industry-time fixed effects. The theoretical motivation for including these fixed effects in gravity regressions is that they fully control for the unobservable multilateral resistance terms of Anderson and van Wincoop (2003) or, alternatively, for consumer and producer prices. In addition to controlling for the structural MRs, the exporter-industry-time and the importer-industry-time fixed effects will also absorb size variables (e.g., per capita income) and control for any other country-

[17]Specification (1) is representative of a large set of theoretical trade models, compare with Arkolakis et al. (2012). In Section On the Price, Output and Total Trade Effects of the Sanctions on Russia below, we use the structural gravity system to obtain the price, output, and total trade effects of the 2014 sanctions on Russia.

[18]See Anderson and van Wincoop (2004) for a derivation of an industry-level gravity model from a demand-side perspective. Costinot et al. (2012) for a derivation of an industry-level gravity model from a supply-side perspective, and Yotov et al. (2016) for a demonstration that the demand-side and supply-side industry-level gravity models are identical from an estimation point of view and for a discussion on the challenges and best practices for estimating industry-level/disaggregated gravity models.

[19]Cheng and Wall (2005) criticize gravity specifications with consecutive-year data "on the grounds that dependent and independent variables cannot fully adjust in a single year's time" (Footnote 8. p. 52. Cheng & Wall, 2005). However, more recently, Egger et al. (2022) offer econometric and economic arguments for the use of pooled/consecutive-year data, and we follow their recommendation to obtain our main results. In the robustness analysis, we experiment by using interval data and we obtain similar results.

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industry-specific characteristics on the exporter and on the importer side that may affect bilateral trade flows.

The variable μ_{ij}^{k} denotes the set of country-pair-industry fixed effects. The motivation for μ_{ij}^{k} is twofold. First, the country-pair-industry fixed effects will control for and absorb all possible time-invariant bilateral determinants of trade flows. This is potentially important in light of the findings from Egger and Nigai (2015) and Agnosteva et al. (2019) who show that the standard gravity variables (e.g., distance, colonial relationships, etc.) are poor proxies for bilateral trade costs. Second, on a related note, as famously demonstrated by Baier and Bergstrand (2007), the use of country-pair fixed effects mitigates potential endogeneity concerns in relation to bilateral trade policies by absorbing much of the unobserved/unmodeled correlation between the endogenous policy variables and the error term.

The variables $\sum_t \alpha_t^k \text{BRDR}_{ij,t}$ are the set of time-varying industry-specific border indicators. Anderson and Yotov (2020) provide a theoretical motivation for the inclusion of these covariates and Bergstrand et al. (2015) demonstrate that the estimates of trade agreements in gravity regressions may be biased upward because they potentially capture common globalization trends. In addition to the time-varying globalization effects, which are common across countries within each sector, we also control for time-varying policy variables. Specifically, we use indicator variables for the presence of regional trade agreements (RTAs) between i and j at time t, $\text{RTA}_{ij,t}$, and whether the two trading partners are members of the World Trade Organization (WTO), $\text{WTO}_{ij,t}$.[20] Finally, and most important for our purposes, we include two vectors of sanction variables. The variable $\text{TRADE\_SANCT}_{ij,t}$ is a vector that includes various types of trade sanctions, and $\text{OTHER\_SANCT}_{ij,t}$ captures sanctions of any other type.

All estimates are obtained with the Poisson pseudo maximum likelihood (PPML) estimator, which, owing to Santos Silva and Tenreyro (2006, 2011), has two main advantages for gravity estimations. First, PPML addresses the problem that, due to heteroskedasticity, the OLS gravity estimates are inconsistent. Second, due to its multiplicative form, the PPML estimator takes into account the information contained in the zero trade flows, which are omitted in OLS gravity regressions. Finally, the standard errors in all of our specifications are clustered by industry–country pair. Following the recommendations of Egger and Tarlea (2015), we also extend the standard errors to accommodate gravity regressions that use pooled industry data, and we obtain similar results with four-way clustered standard errors, that is, by exporter, importer, industry, and time.

4.2 | Impact of sanctions on agricultural trade for pooled industries

Table 2 presents our main results. Before we turn to the estimates of the effects of sanctions, we discuss two interesting findings that are related to the other policy variables in our model. First, we obtain a sizable, positive, and statistically significant estimate of the impact of WTO. This result is consistent with the estimates of Grant and Boys (2012), and it is encouraging because agriculture has traditionally been viewed as a key obstacle to multilateral negotiations at various WTO rounds. Our estimates reveal that the WTO has successfully expanded agricultural trade among its members by 44.5% ($(\exp(0.368)-1)\times 100$).

Another interesting result is the relatively small estimate of the effects of regional trade agreements on agricultural trade. The results indicate that RTAs boost agricultural trade by about 7%, on average. Although we are not surprised by this result because agriculture usually has many exceptions and exclusions in RTA negotiations (e.g., ASEAN), our estimate is smaller than those found in

[20]In robustness experiments, we follow Baier et al. (2019) to allow for country-specific and even pair-specific effects of RTAs and WTO membership. Our main findings remain robust. We also recognize that it is possible that, despite the rich set of fixed effects, our specification omits some bilateral, time-varying policy variables (o.g., antidumping duties or NTMs). However, we do not have access to comprehensive data that would enable us to control for such policies. Moreover, because many such policies are implemented at a very-disaggregated level, we expect that they may have relatively little impact on our more aggregate estimates.

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TABLE 2 On the heterogeneous effects of sanctions on agricultural trade.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Explanatory Variables	**Main**	**Complt**	**Dirctn**	**Both**	**Russia**	**Rus_Eu**	**Rus_all**
WTO	0.368	0.362	0.377	0.373	0.397	0.396	0.396
	(0.044)**	(0.044)**	(0.044)**	(0.044)**	(0.044)**	(0.044)**	(0.044)**
RTA	0.069	0.068	0.074	0.072	0.067	0.068	0.068
	(0.025)**	(0.025)**	(0.025)**	(0.026)**	(0.026)**	(0.026)**	(0.026)**
Trade sanctions	−0.210						
	(0.034)**						
Other sanctions	0.029	0.028	0.010	0.010	0.024	0.024	0.024
	(0.020)	(0.020)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Complete sanctions		−1.107					
		(0.235)**					
Partial sanctions		−0.203					
		(0.035)**					
Export & import sanctions			−0.400				
			(0.048)**				
Export sanctions			−0.088				
			(0.065)				
Import sanctions			0.040				
			(0.049)				
Complete export & import sanctions				−1.157	−1.116	−1.116	−1.116
				(0.247)**	(0.245)**	(0.245)**	(0.245)**
Partial export & import sanctions				−0.383	−0.300	−0.299	−0.299
				(0.049)**	(0.054)**	(0.054)**	(0.054)**
Complete import sanctions				−0.515	−0.507	−0.506	−0.506
				(0.419)	(0.417)	(0.418)	(0.418)
Partial import sanctions				0.039	0.039	0.038	0.038
				(0.049)	(0.049)	(0.049)	(0.049)
Complete export sanctions				0.266	0.273	0.273	0.273
				(0.343)	(0.341)	(0.341)	(0.341)
Partial export sanctions				−0.115	−0.107	−0.107	−0.107
				(0.067)+	(0.067)	(0.067)	(0.067)
Russian sanctions on all/nonEU/rest					−0.891	−0.501	−0.113
					(0.108)**	(0.184)**	(0.448)
Russian sanctions on EU						−0.966	−0.966
						(0.113)**	(0.113)**
Russian sanctions on Canada							−0.986
							(0.313)**
Russian sanctions on USA							−0.684
							(0.281)*
Russian sanctions on Switzerland							−0.023
							(0.378)

(Continues)

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TABLE 2 (Continued)

Explanatory Variables	(1) Main	(2) Complt	(3) Dirctn	(4) Both	(5) Russia	(6) Rus_Eu	(7) Rus_all
Russian sanctions on Norway							0.114
							(0.242)
Russian sanctions on Australia							−0.064
							(0.344)
Russian sanctions on Japan							0.456
							(0.342)
Russian sanctions on Ukraine							−0.206
							(0.529)
N	5,925,746	5,925,746	5,925,746	5,925,746	5,925,746	5,925,746	5,925,746

Note: This table reports estimates for the heterogeneous effects of sanctions. Column (1) provides the benchmark estimates. Column (2) distinguishes between the effects of complete and partial trade sanctions. Column (3) obtains results for sanctions that are imposed in both directions, export sanctions, and import sanctions. Column (4) simultaneously allows for the effects of sanctions to differ depending on whether they are complete or partial and depending on the direction of trade flows. Column (5) obtains a separate estimate of the impact of the sanctions on Russia, whereas Column (6) distinguishes between the effects of the sanctions on Russia between EU and non-EU members. Finally, Column (7) obtains country-specific estimates of the effects of the sanctions on Russia. Standard errors are clustered by industry-country-pair and are reported in parentheses. See text for further details.

$^{+}p < 0.10$;

$^{*}p < 0.05$; $^{**}p < 0.01$.

the existing literature, for example, Grant and Boys (2012) who obtain a large and significant RTA effect of over 50%. In addition to differences in the sample period, the number of countries, and the level of aggregation, a potential reason behind our relatively small RTA effect from a methodological perspective includes controlling for the border effect.[21] Another possibility is that the effects of RTAs are quite heterogeneous across agreements and across pairs within agreements, compare with Eicher and Henn (2011), Sun and Reed (2010), Grant (2013), and Baier et al. (2019).[22]

Turning to the effects of sanctions, our estimates imply that, ceteris paribus, the trade sanctions that were in existence during the period of investigation have resulted in about a 19% decrease in the volume of agricultural trade between the sanctioned and sanctioning countries. Using a representative value for the trade elasticity for agriculture, hunting, forestry, and fishing of −2.91 (see tab. 8 in Fontagné et al., 2022), the corresponding tariff equivalent of the average impact of sanctions in our sample is about 5% ($((\exp(-0.210/(1+2.91))-1)\times 100$).[23] This result confirms our first hypothesis that sanctions hamper agricultural trade but do not eliminate trade because many sanctions are imposed only from one or a few countries, allowing for trade diversion.

In Column (2) of Table 2, we allow for differential effects of complete versus partial trade sanctions. Similar to Felbermayr, Kirilakha, et al. (2020), Felbermayr, Syropoulos, et al. (2020), who analyzes the impact of sanctions on aggregate trade, we find that complete trade sanctions have a significantly stronger negative impact on agricultural trade as compared to partial trade sanctions, confirming our second hypothesis. We find this result intuitive because, by definition, complete

[21]Luckstead (2024) also finds a large reduction in coefficient estimates for friction variables and FTAs when border effects are included in a structural gravity setting.

[22]Following Baier et al. (2019), in sensitivity analysis we allow for the effects of WTO and RTAs to be heterogeneous across pairs and even within pairs, depending on the direction of trade flows. Our main conclusions regarding the impact of sanctions are not affected. In an additional specification, we exclude WTO from the gravity model. The estimated coefficients on RTA are similar (though slightly larger) in magnitude without WTO compared to the specification with WTO. Thus, although there is substantial overlap between RTA and WTO, RTA is not a subset of WTO and identifies the impacts of regional trade agreements controlling for WTO on agricultural trade.

[23]See Yotov et al. (2016) for further discussion and details on the calculation of tariff equivalents and interpretation of gravity estimates.

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trade sanctions apply to all industries and partial sanctions only cause second-order disruptions to agricultural trade.[24] Specifically, our estimates imply that, ceteris paribus, the complete trade sanctions in our sample have led to about a 67% decrease in the volume of bilateral trade between the sanctioned and sanctioning countries, or a corresponding tariff equivalent of about 25%.

Before turning to the results in Column (3), we dig deeper into the evolution of the effects of sanctions across time. Given their relative importance, we focus on complete trade sanctions and perform two experiments. First, following Egger et al. (2022), who perform a similar analysis for RTAs, and Dai et al. (2021) and Felbermayr et al. (2022), who study the effects of sanctions on aggregate trade, we allow for anticipation and phasing-in effects of complete trade sanctions on agricultural trade. The results, depicted in Panel (a) of Figure 1, are obtained after replacing the single variable for complete trade sanctions from Column (2) of Table 2 with 16 new variables, including five leads, a contemporaneous effect, and 10 sanction lags. These results are consistent with the findings of Felbermayr et al. (2022) and four main conclusions stand out. The effects of complete trade sanctions are (i) large, (ii) immediate, and (iii) relatively stable over time. In addition, (iv) we do not find any anticipation effects, which, from an event study perspective, can also be interpreted as no evidence of pretrends in our analysis.

Motivated by the observation that, although still implemented, complete trade sanctions have decreased in popularity over time, in our next experiment we obtain estimates of the effects of complete trade sanctions for three periods in our sample. Specifically, we rely on the classification from Morgan et al. (2022), who traces the evolution of sanctions in distinct "eras." Given the time coverage of our data, we distinguish among the effects of sanctions in three periods (1986–1989, 1990–2000, and 2001–2019) by replacing the single sanction variable from Column (2) of Table 2 with three new variables. Based on the estimates from Panel (b) of Figure 1, we conclude that, together with the less frequent use of complete trade sanctions, their impact on agricultural trade has fallen over time. Two possible, and related, explanations for this result are (i) the increase in the use of "smart" sanctions, which aim at specific areas of the target's economy; and (ii) the use of partial trade sanctions. Thus, although the impacts of complete sanctions decreased over the eras, the ideological shift away from complete sanctions had only a small reduction in their ability to hinder agricultural trade.[25]

The specification that we use to obtain the results in Column (3) of Table 2 distinguishes between the impact of sanctions depending on the direction of trade flows, that is, sanctions on exports, sanctions on imports, or sanctions on trade in both directions. Based on these results, we conclude that sanctions that are imposed on trade in both directions have significant negative effects on agricultural trade, whereas, on average, export sanctions and import sanctions alone do not impact agricultural trade. Thus, although sanctions in only one direction hinder trade in general, these sanctions on exports only or on imports only do not hinder agricultural exports or imports because trade diversion by sanction-busting countries replaces imports and exports of agricultural products of sanctioned countries, leading to an insignificant net impact on agricultural trade. This result highlights the importance of examining the impact of policies on individual industries as well as studying the heterogeneous effects of sanctions for specific food industries, which we examine later.

In Column (4) of Table 2, we simultaneously allow for the effects of sanctions to differ depending on their coverage (i.e., partial versus complete) and depending on the direction of trade flows that they target (i.e., exports, imports, or trade in both directions). Several findings stand out. First, we see that complete sanctions that target trade in both directions have the strongest negative impact on agricultural trade, whereas the impact of partial trade sanctions is also negative and significant but much smaller. We find these results intuitive. Second, we see that the impact of complete import

[24]Unfortunately, the GSDB does not allow us to identify the specific industries to which partial trade sanctions are applied. Below we address this challenge by obtaining estimates of the effects of some specific partial sanctions, for example, the sanctions on Russia.
[25]Unfortunately, the GSDB does not allow us to identify the specific sectors that are targeted by partial trade sanctions.

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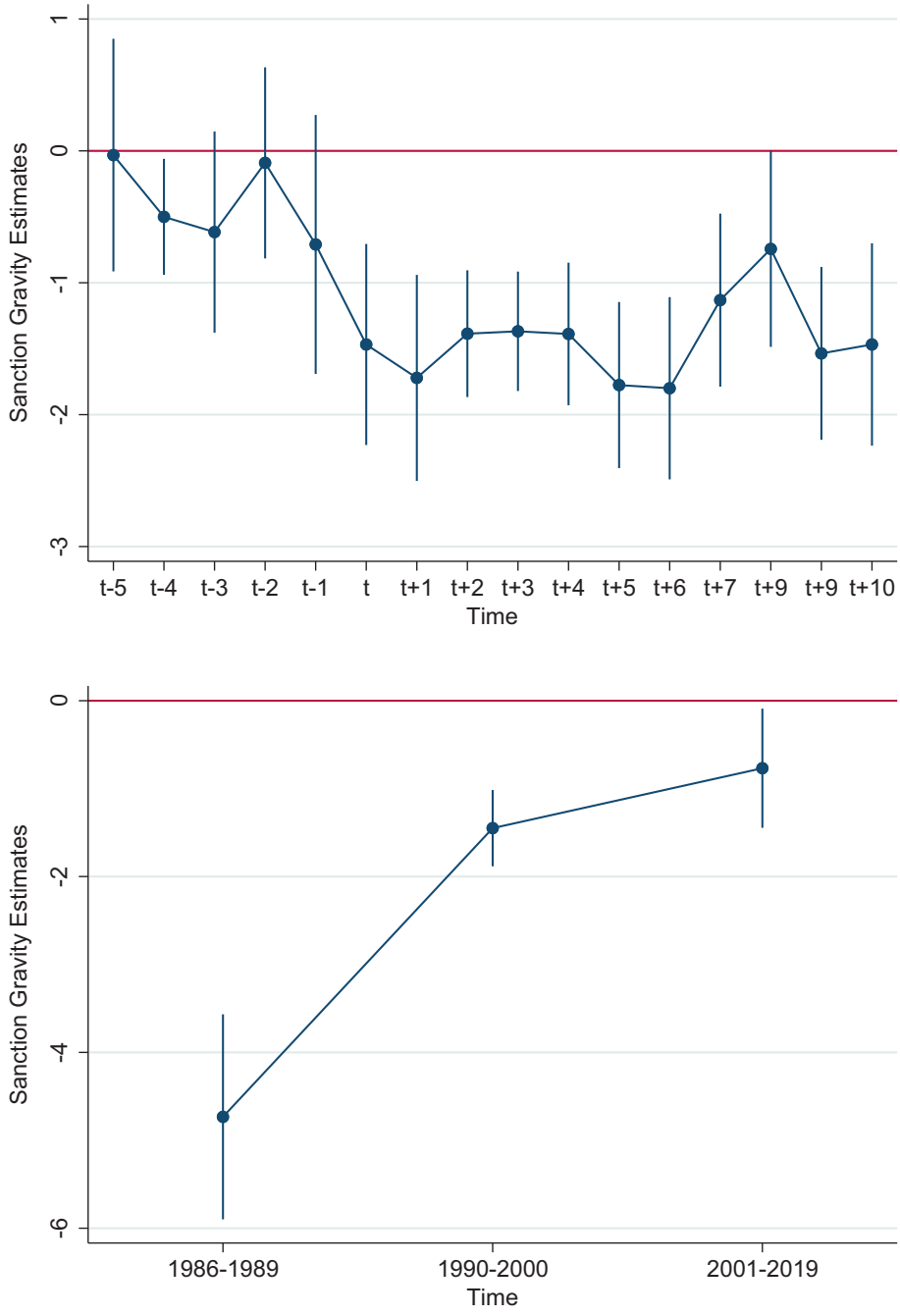

FIGURE 1 Sanctions and agricultural trade over time. The two panels of this figure visualize estimates of the heterogeneous effects of sanctions over time. All estimates are obtained from the specification in Column (2) of Table 2 after replacing the single variable for complete trade sanctions with alternative covariates. The results in the top panel allow for pretrend and phasing-in sanction effects. The estimates in the bottom panel allow for heterogeneous effects across three time periods. See text for further details.

sanctions, partial import sanctions, and complete export sanctions are not statistically significant, although the estimate of the effect of partial export sanctions is negative and (marginally) statistically significant. In sum, the results from Column (4) confirm (i) that complete trade sanctions hinder

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agricultural trade more than partial trade sanctions and (ii) that sanctions that are imposed in both directions have stronger negative effects than unidirectional sanctions.

One of the recent high-profile sanction cases that largely focused on food products is the conflict among Europe, North America, Japan, and allied countries with Russia that started in 2014 over the Ukraine conflict.[26] Therefore, our next specification delivers a separate estimate for the impact of the sanctions imposed on and imposed by Russia starting in 2014. Specifically, to obtain the estimates in Column (5) of Table 2, we generate a new indicator variable for the sanctions involving Russia in 2014, "RUSSIAN SANCTIONS ON ALL," and we set the rest of the trade sanction dummies in our specification to zero when "RUSSIAN SANCTIONS ON ALL" is equal to one.[27] Thus, we can interpret the estimate we obtain for the sanctions on Russia as a level rather than as a deviation from the effects of the other trade sanction variables in our specification. The estimates in Column (5) suggest that the sanctions among Russia and the United States, European Union, and allied countries decreased Russia's international trade of agricultural products by about 59% (with a corresponding tariff equivalent of about 20%).

In Columns (6) and (7) of Table 2, we zoom in on the impact of the sanctions involving Russia by distinguishing between the impact of the sanctions that were with EU versus non-EU countries, in Column (6), and by obtaining country-specific estimates in Column (7). The estimates in Column (6) reveal that the negative impact of the "RUSSIAN SANCTIONS ON EU" on agricultural trade has been strong as trade declined by about 62%, whereas the "RUSSIAN SANCTIONS ON NONEU" had a smaller but still strong impact of 39% decline in agricultural trade with Russia. In comparison, Crozet and Hinz (2016) find that, after August 2014, the targeted sanctions reduced Western countries' exports to Russia of all commodities by 27.7%, on average. When distinguishing EU versus non-EU countries, their results show exports fell on average by 24.9% and 35.1%, respectively.

The results in Column (7) show that the common estimate on "RUSSIAN SANCTIONS ON NONEU" masks significant heterogeneity. Specifically, based on these results, we conclude that the negative and significant estimate of the effects of the sanctions from non-EU countries in Column (6) was mainly driven by the sanctions with the United States and Canada. Interestingly, we do not obtain significant estimates for the sanctions of Switzerland and Norway, which traditionally align their policies closely with those of the EU. We also do not obtain significant estimates for the sanctions of Australia, Japan, and even Ukraine.

4.3 | Industry specific impacts of sanctions

We conclude the empirical analysis by obtaining industry-specific estimates of the impact of sanctions on agricultural trade. Tables 3 and 4 produce estimates that correspond to specifications (1)–(4) from Table 2 at the most disaggregated level in the ITPD-E, that is, for all of the 26 agricultural industries. Specifically, the estimates in Panel A of Table 3 are obtained with the same specification that is used to obtain the results in Column (1) of Table 2, whereas the estimates in panels B and C correspond to the results in Columns (2) and (3) of Table 2. Due to the large number of estimates, we report the results that correspond to Column (4) of Table 2 in a separate Table 4. For brevity and clarity of exposition, in Tables 3 and 4, we only report the results related to our research question, that is, the estimates of sanctions. All other estimates are available by request.

[26]Since writing the first version of this paper, the sanctions on Russia due to the invasion of Ukraine have attracted even more attention. However, we cannot study the effects of the new sanctions due to a lack of trade data.

[27]Please see details about these sanctions in the data section. Also, although the ITPD-E database has the advantage of including domestic sales, the industry classifications do not allow us to correctly identify sanctioned agricultural industries versus nonsanctioned industries. Therefore, we focus on the average impact of the Russian food embargo across all agricultural industries. Note that for this row, in the description "RUSSIAN SANCTIONS ON ALL/NONEU/REST," "ALL," "NONEU," and "REST" are the coefficient names for Columns (5), (6), and (7), respectively.

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TABLE 3 Industry estimates of the effects of sanctions on agricultural trade.

	A. Trade	B. Complete vs. Partial		C. Export vs. Import		
		Cmplt	Partl	Exp_Imp	Exprt	Imprt
Sector	(1)	(2)	(3)	(4)	(5)	(6)
Wheat	−0.130	−1.082	−0.123	−0.430*	0.066	0.012
Rice	0.084	−0.702	0.083	0.026	0.285	0.077
Corn	0.019	−0.101	0.019	−0.199	−0.297	0.445*
Other cereals	−0.037	−0.967*	−0.034	0.107	−0.435*	−0.067
Cereal products	−1.310*	−4.095*	−1.304*	−1.708*	−1.163*	−0.357
Soybeans	−0.772*	−2.156*	−0.793*	−1.281*	−0.435	−0.053
Other oilseeds	0.109	−1.074*	0.123	−0.110	−0.951*	0.379*
Animal feed	0.121	−1.563*	0.127	0.174	−0.506*	0.182*
Sugars	−0.322	1.244	−1.289*	0.175	−2.121	−0.137
Other sweeteners	−0.349	−0.905	−0.335	−0.770*	−0.152	0.390
Pulses & legumes	−0.103	−0.771*	−0.098	−0.131	−0.248	0.054
Fresh fruit	−0.401*	−1.460*	−0.385*	−0.838*	0.392*	0.101
Fresh vege.	−0.201*	−0.292	−0.199*	−0.839*	−0.348*	0.217*
Prepared fruits	0.051	−0.521	0.056	−0.206*	0.194	0.337
Prepared vege.	0.953	−6.166*	2.472	1.473	−1.619	−1.048
Nuts	−0.064	−1.411*	−0.047	−0.108	−0.021	0.053
Live Cattle	−0.328	−1.200*	−0.318	−0.448	−0.133	−0.918
Live Swine	−0.639*	−7.127*	−0.612*	−2.207*	0.277	−0.451
Eggs	0.245*	0.407	0.239*	0.135	0.071	0.438*
Other meats	−0.366*	−1.491*	−0.362*	−0.403*	−0.038	−0.475*
Cocoa	−0.640*	−3.018*	−0.635*	−0.772*	1.161	−0.860
Beverages	0.155*	−2.370*	0.217*	0.219*	−0.092	−0.128
Cotton	−0.070	−1.465*	−0.067	−0.198	0.005	0.277
Tobacco	−0.189*	−0.683*	−0.180*	−0.247*	−0.193	−0.072
Spices	−0.044	−1.124*	−0.022	−0.027	−0.346	−0.006
Other agri.	−0.325*	−0.994*	−0.323*	−0.378*	−0.483*	−0.147*

Note: This table reproduces some of the specifications from Table (2) for each disaggregated agricultural industry in our sample. Specifically, the estimates in Panel A correspond to the results in Column (1) of Table (2), but for brevity we only report the estimates on trade sanctions. The results in Panel B correspond to the results from Column (2) of Table (2). Finally, the estimates in Panel C are obtained with the same specification as Column (3) of Table (2). For brevity, we do not report standard errors; however, those are clustered by industry-country-pair and are available upon request. See text for further details.

$^{+}p < 0.10$;

$^{*}p < 0.05$; $^{**}p < 0.01$.

Overall, the estimates at the industry level from Tables 3 and 4 largely reinforce our conclusions thus far. However, the main message from the analysis with disaggregated data is that the effects of sanctions vary widely across the agricultural commodities in our sample and depending on the different types of sanctions. Accordingly, a potentially important policy implication of the industry analysis is that aggregate estimates of the effects of sanctions on agricultural trade may mask significant heterogeneity at the industry level.

Turning to specific results, we see from Panel A of Table 3 that the estimates of trade sanctions are negative in most agricultural industries (18 out of 26) and statistically significant in 9 of them. The strongest significant negative impact of sanctions is for industries 5 "cereal products," followed

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TABLE 4 Industry estimates of the effects of sanctions on agricultural trade.

	(1)	(2)	(3)	(4)	(5)	(6)
Sector	**Exp_Imp_Cmpl**	**Exp_Imp_Prtl**	**Exp_Cmpl**	**Exp_Prtl**	**Imp_Cmpl**	**Imp_Prtl**
Wheat	−1.196*	−0.391*	−1.213	0.036	−5.489*	0.007
Rice	−0.658	0.047	−0.353	0.209	0.659	0.077
Corn	−0.313	−0.197	1.398*	−0.306	−8.075	0.445*
Other cereals	−0.944*	0.124	9.895*	−0.445*	−8.868	−0.071
Cereal products	−4.219*	−1.687*		−1.214*	0.293	−0.359
Soybeans	−2.552*	−1.274*	5.456*	−1.010*		−0.057
Other oilseeds	−1.549*	−0.083	1.996*	−0.974*	2.727*	0.380*
Animal feed	−1.556*	0.190	−1.461	−0.507*	−13.441*	0.183*
Sugars	1.241	−1.527*		−2.200		−0.116
Other sweeteners	−1.455	−0.754*	1.907*	−0.152	0.169	0.393
Pulses & legumes	−0.773*	−0.119	1.135*	−0.262	−1.209*	0.065
Fresh fruit	−1.55*	−0.822*	0.510	0.391*	−0.362	0.100
Fresh vege.	−0.282	−0.879*	1.048*	−0.349*	−2.194*	0.217*
Prepared fruits	−0.646*	−0.200*	0.450	0.193	−0.873*	0.339
Prepared vege.	−7.375*	4.726	10.344*	−0.532		−1.076
Nuts	−1.396*	−0.082	1.239*	−0.027	−3.211*	0.054
Live cattle	−1.195*	−0.403		−0.136		−0.922
Live swine	−7.049*	−2.135*		0.323		−0.448
Eggs	0.405	0.111	2.083*	0.067	−12.970	0.438*
Other meats	−1.487*	−0.392*	−0.414	−0.038	−0.831	−0.475*
Cocoa	−3.021*	−0.767*	11.170*	1.160		−0.860
Beverages	−2.391*	0.299*	−0.709*	−0.085	−1.905*	−0.122
Cotton	−1.446*	−0.191	0.591	0.001	−7.191*	0.278
Tobacco	−0.691*	−0.231*	−4.823*	−0.196	5.606*	−0.072
Spices	−1.204*	0.001	0.882	−0.360*	0.198	−0.021
Other agri.	−1.077*	−0.372*	0.061	−0.495*	0.191	−0.148*

Note: This table reproduces the estimates from Column (4) of Table (2) for each disaggregated agricultural industry in our sample. For brevity, we do not report standard errors; however, those are clustered by industry–country pair and are available upon request. See text for further details.

$^{+}p < 0.10$;

$^{*}p < 0.05$; $^{**}p < 0.01$.

by 6 "soybeans," 21 "cocoa and cocoa products," and 18 "live swine." Interestingly, we also obtain two positive and statistically significant estimates for industries 19 "eggs" and 22 "beverages, nec." The estimates from Panels B and C of the same table suggest that these positive estimates could be due to the trade diversion effects of partial sanctions. We turn to the analysis of the differences between the effects of complete versus partial sanctions at the sectoral level next.

The estimates from Panel B of Table 3 confirm our previous finding that complete trade sanctions impede agricultural trade more than partial trade sanctions. Only two of the estimates on complete trade sanctions are positive, but they are not statistically significant. Moreover, 18 of the 24 negative estimates for complete sanctions are statistically significant. Most of the estimates (18) on the partial trade sanctions are also negative, of which 10 are statistically significant. The result that partial trade sanctions are also found to have significant negative effects on agricultural trade has important policy implications because, given partial sanctions are typically designed to

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exclude food products, our findings provide evidence that the rising transport and insurance costs for sending products to a sanctioned country, disruptions to countries' comparative advantage, deterioration of financial stability, and foreign capital flight of the sanctioned states are in line with our second hypothesis that partial sanctions indirectly impede agricultural trade. Furthermore, we note that complete sanctions generally impede trade in bulk commodities (industries 1–11 and 23), but partial sanctions generally do not influence trade in these commodities. This may occur because bulk commodities are easy to transport and store. Furthermore, bulk commodities consist of staple foods that are central to humanitarian relief efforts and central to the ethical concerns of complete sanctions. Similar observations are made with industries 15, 16, 17, and 25.

Panel C reveals that most of the estimates on the effects of sanctions that apply simultaneously to both imports and exports are negative and many of them are statistically significant. The disaggregated results show substantial heterogeneity in the impact of export and import sanctions by industry, with export sanctions having mostly negative estimates and mixed findings for the effects of import sanctions. A possible explanation for these results is that once we move to the disaggregated industry level, the estimates of the effects of import and export sanctions are obtained with a relatively small number of degrees of freedom, and, therefore, they are subject to the impact of outliers (we address this issue in the subsequent subsection).

Several findings stand out from the results reported in Table 4, where we allow for the effects of sanctions to vary simultaneously depending on the direction of sanctioned trade flows and depending on whether the sanctions are complete or partial. Complete trade sanctions that apply in both directions of trade have the strongest negative impact on agricultural trade, followed by partial sanctions that apply simultaneously to exports and to imports. Once we move beyond the effects of sanctions imposed in both directions, the results are mixed and unstable. A possible explanation is the relatively small number of observations that are used to identify the impact of import and export sanctions. Consistent with this explanation, we note that once we introduce all the interactions in Table 4, we can no longer identify the impact of some import and export complete sanctions.

4.4 | Aggregated industry specific impacts of sanctions

Given the substantial heterogeneity with the disaggregated data, we proceed with the remainder of the analyses by grouping the 26 industries into five more aggregated categories, which we label bulk commodities (BULK); Live animals, meat, and animal products (ANIMAL); labor intensive (LABOR); processed foods (PRCSSD); and sugars (SUGARS). Table 1 offers a concordance between the five aggregated categories and the underlying disaggregated industries.

Table 5 presents the estimated coefficients for the five aggregated groups (Columns 1–5) for the impact of all trade sanctions (Panel A), complete versus partial trade sanctions (Panel B), sanctions based on the direction of trade (Panel C), and both coverage and direction (Panel D). The results in Panel A reveal that the estimate of trade sanctions is negative for all five groups, and only one of them (for "sugars") is not statistically significant. The results in Panel B reinforce this result by demonstrating that, except for "sugars," the estimates on complete and partial sanctions are all negative and statistically significant, and the impacts of complete sanctions are again significantly larger in terms of economic magnitude. Furthermore, the magnitudes of the statistically significant coefficients in Panels A and B show some heterogeneity across industries, but are generally in line with the main results in Table 2 Columns (1) and (2), respectively.

Panel C further confirms our results on the impact of sanctions based on the direction of trade in Table 2, Column (3) and Table 3, Columns (4)–(6). Namely, sanctions concurrently on imports and exports hinder trade for all five groups, as seen by the negative and statistically significant coefficient estimates for all five groups. By contrast, sanctions in only one direction (exports or imports) generally do not systematically impact trade for these groups. Only one of

TABLE 5 On the effects of sanctions on agricultural trade by industry.

Explanatory Variables	(1) Bulk	(2) Animal	(3) Labor	(4) Prcssd	(5) Sugars
A. Trade sanctions					
Trade sanctions	−0.167	−0.320	−0.300	−0.189	−0.348
	(0.055)**	(0.089)**	(0.061)**	(0.067)**	(0.283)
B. Coverage: complete vs. partial sanctions					
Complete sanctions	−1.041	−1.078	−1.108	−1.239	−0.709
	(0.355)**	(0.353)**	(0.200)**	(0.213)**	(0.556)
Partial sanctions	−0.165	−0.316	−0.287	−0.176	−0.337
	(0.055)**	(0.090)**	(0.061)**	(0.068)**	(0.290)
C. Direction: export vs. import sanctions					
Export & import sanctions	−0.400	−0.360	−0.679	−0.195	−0.764
	(0.079)**	(0.129)**	(0.074)**	(0.092)*	(0.367)*
Export sanctions	−0.107	−0.028	0.102	−0.333	−0.168
	(0.104)	(0.096)	(0.122)	(0.082)**	(0.378)
Import sanctions	0.097	−0.423	0.132	−0.121	0.389
	(0.078)	(0.144)**	(0.061)*	(0.057)*	(0.277)
D. Sanctions by coverage and direction					
Complete export & import sanctions	−1.148	−1.069	−1.169	−1.280	−1.011
	(0.369)**	(0.363)**	(0.206)**	(0.213)**	(0.795)
Partial export & import sanctions	−0.384	−0.348	−0.666	−0.176	−0.755
	(0.080)**	(0.130)**	(0.076)**	(0.094)+	(0.376)*
Complete import sanctions	−0.340	−0.816	−1.830	−0.156	0.175
	(0.748)	(1.035)	(0.637)**	(0.472)	(0.267)
Partial import sanctions	0.094	−0.423	0.133	−0.121	0.393
	(0.078)	(0.144)**	(0.061)*	(0.058)*	(0.281)
Complete export sanctions	−0.235	1.340	0.955	0.018	1.910
	(0.335)	(1.008)	(0.355)**	(0.357)	(0.930)*
Partial export sanctions	−0.153	−0.028	0.099	−0.346	−0.169
	(0.108)	(0.097)	(0.122)	(0.082)**	(0.378)

Note: Panels A through D of this table reproduce the estimates from Columns (1) through (4) from Table (2), respectively, for each of the five broad agricultural sectors in our sample. Standard errors are clustered by industry--country pair and are reported in parentheses. See text for further details.

$^{+}p < 0.10$;

$^{*}p < 0.05$; $^{**}p < 0.01$.

the estimates on export sanctions is statistically significant and negative, and for import sanctions, we obtain two negative and statistically significant estimates and one positive and statistically significant estimate.

The coefficient estimates presented in Panel D for both coverage and direction largely confirm our results from the pooled analysis in Table 2 Column (4) and individual industry results in Table 4 that both complete and partial sanctions on both imports and exports contract trade. Specifically, all estimates on complete trade sanctions that apply in both directions of trade flows are negative and large, and only one of them (for "sugars") is not statistically significant. Moreover, although smaller in magnitude, the estimates on partial trade sanctions that apply in both directions of trade are all negative and statistically significant. The results for partial sanctions are surprising considering the

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importance of bulk goods as staple foods in many developing countries and partial sanctions typically pertain to nonfood items, financial, insurance, and transportation restrictions.

Next, we consider the impact of the 2014 sanctions between Russia and the European Union, the United States, and allied countries for the five aggregate groups. Table 6 reports our estimates. The results in Panels A and B of Table 5 correspond to Columns (5) and (6) of Table 2, respectively. Consistent with our pooled results from Table 2, the estimates in panel A of Table 6 are negative and large for all five groups, and they are statistically significant for all categories except for "sugars." Our estimates imply a decrease in trade between 29% for bulk products and 83% for labor-intensive products. For comparison, Crozet and Hinz (2016) find that exports of embargoed agricultural products fell between 89% for EU countries and 92% for non-EU countries subject to the embargo. Collateral damage exists as trade in commodities not subject to the Russian embargo fell for EU countries by about 15%. Thus, although the group-specific results do generally agree with the pooled results, heterogeneity exists in the estimates. We also note, consistent with our expectations, that the magnitude of the coefficient estimate on animal and meat products in Column (2), the primary target of Russia's sanctions against the EU, US, and allied countries, is the second largest in our sample when considering pooled and aggregated industry groups.

The estimates in Panel B of Table 6 allow for differential impacts of sanctions between Russia and the European Union versus sanctions between Russia and the non-EU countries involved. The Russia-EU results are largely consistent with those from Panel A, but we also see a distinct pattern—the negative effects of the EU sanctions on Russia are stronger in three of the five broad sectors, especially for bulk and labor-intensive products, whereas the effects of non-EU sanctions for sugar are much larger. Animal products is another category where the effects of non-EU sanctions have been particularly strong.

5 | ON THE PRICE, OUTPUT, AND TOTAL TRADE EFFECTS OF THE SANCTIONS ON RUSSIA

The estimates we have presented so far are based on the gravity equation for bilateral trade flows and provide the effects of sanctions on bilateral trade. The specified estimating Equation (1) can be derived from various trade models, which allow for the translation of the point estimates into effects on producer and consumer prices as well as on trade and changes in real output. We use a simple one-sector framework focusing on agricultural trade only to quantify the effects of the 2014 Russian sanctions on producers, consumers, trade, and real output as, for example, described in Costinot and Rodríguez-Clare (2014) and Yotov et al. (2016). The baseline is the situation without the 2014 sanctions on Russia, whereas the counterfactual assumes the sanctions are imposed.

We assume N countries, each endowed with a fixed stock Q_i of a unique variety of an agricultural product (Armington, 1969), which countries trade with each other. In each country i, the value of total output is therefore given by $Y_i = p_i Q_i$, where p_i is the farm-gate product price for the variety produced in country i. Consumers have CES preferences with σ denoting the elasticity of substitution and γ_i the CES preference parameter, that is,

$$\left\{ \sum_i \gamma_i^{\frac{1-\sigma}{\sigma}} c_{ij}^{\frac{\sigma-1}{\sigma}} \right\}^{\frac{\sigma}{\sigma-1}}, \tag{2}$$

where c_{ij} denotes consumption of varieties from country i in country j. Consumer prices for variety i in country j are given by $p_{ij} = p_i t_{ij}$, with $t_{ij} \geq 1$ capturing iceberg trade costs. Maximizing utility subject to the budget constraint $E_j = \sum_i p_{ij} c_{ij}$ leads to the following equation for bilateral trade flows of agricultural products from country i to country j:

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TABLE 6 On the effects of sanctions on Russia's agricultural trade.

Explanatory Variables	(1) Bulk	(2) Animal	(3) Labor	(4) Prcssd	(5) Sugars
A. Overall impact of the sanctions on Russia					
Russian sanctions on all	−0.340	−1.303	−1.776	−0.503	−1.929
	(0.153)*	(0.417)**	(0.137)**	(0.194)**	(1.324)
N	1,580,646	494,132	901,526	1,460,706	142,731
B. Impact of EU vs. non-EU sanctions on Russia					
Russian sanctions on EU	−0.426	−1.313	−1.861	−0.500	0.632
	(0.182)*	(0.408)**	(0.138)**	(0.213)*	(1.958)
Russian sanctions on non EU	−0.006	−1.272	−0.969	−0.517	−3.288
	(0.154)	(0.558)*	(0.548)+	(0.337)	(0.489)**
N	1,580,646	494,132	901,526	1,460,706	142,731

Note: Panels A and B of this table reproduce the estimates from Columns (5) and (6) from Table (2), respectively, for each of the five broad agricultural sectors in our sample. For brevity, we only report the estimates of the effects of the sanctions on Russia. All other estimates are available upon request. Standard errors are clustered by industry–country pair and are reported in parentheses. See text for further details.
$^{+}p < 0.10$;
$^{*}p < 0.05$; $^{**}p < 0.01$.

$$X_{ij} = \left(\frac{\gamma_i p_i t_{ij}}{P_j}\right)^{1-\sigma} E_j, \tag{3}$$

where P_j denotes the price index given by:

$$P_j^{1-\sigma} = \sum_i \left(\gamma_i p_i t_{ij}\right)^{1-\sigma}. \tag{4}$$

Replacing this expression for $P_j^{1-\sigma}$ in Equation (3), we can rewrite the expression for trade flows as follows:

$$X_{ij} = \frac{\left(\gamma_i p_i t_{ij}\right)^{1-\sigma}}{\sum_l \left(\gamma_l p_l t_{lj}\right)^{1-\sigma}} E_j. \tag{5}$$

Expressing the spending of country j on goods from country i as a share of total spending from country j yields:

$$\pi_{ij} = \frac{X_{ij}}{E_j} = \frac{\left(\gamma_i p_i t_{ij}\right)^{1-\sigma}}{\sum_l \left(\gamma_l p_l t_{lj}\right)^{1-\sigma}}. \tag{6}$$

To avoid specifying trade costs in levels, we follow Dekle et al. (2007, 2008) and formulate the structural gravity framework in changes. Assuming that the CES preference parameters γ's stay constant, the change, denoted by a hat, of π_{ij} between the baseline (denoted with superscript b) and the counterfactual (denoted with superscript c) is given by:

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TABLE 7 On the price, output, and total trade effects of the sanctions on Russia.

(1)	(2)	(3)	(4)	(5)	(6)
Country	**Producers**	**Consumers**	**Total Exports (%)**	**Total Exports (M US$)**	**Real Output**
Australia	−0.12	−0.13	0.06	4.85	0.00
Austria	−0.51	−0.43	−2.13	−32.04	−0.09
Belgium	−0.94	−0.76	−1.98	−87.87	−0.18
Bulgaria	−0.91	−0.89	−0.59	−9.55	−0.03
Brazil	−0.28	−0.28	−0.02	−5.44	−0.00
Canada	0.00	−0.01	0.12	20.05	0.02
Switzerland	−0.85	−0.74	−37.01	−55.69	−0.11
China	−0.13	−0.13	0.48	32.93	0.00
Cyprus	−3.27	−2.66	−17.29	−21.40	−0.63
Czechia	−1.01	−0.98	−1.48	−26.25	−0.04
Germany	−0.73	−0.71	−1.58	−169.00	−0.01
Denmark	−0.75	−0.72	−0.61	−26.66	−0.03
Spain	−0.78	−0.74	−0.92	−116.73	−0.04
Estonia	−3.74	−3.23	−11.57	−21.17	−0.53
Finland	0.73	1.33	−8.85	−82.42	−0.59
France	−0.83	−0.82	−0.77	−111.63	−0.01
United Kingdom	−0.84	−0.81	−4.41	−111.28	−0.03
Greece	−0.81	−0.74	−2.13	−34.86	−0.07
Croatia	−0.74	−0.74	−0.64	−2.69	0.01
Hungary	−1.08	−1.04	−1.12	−29.09	−0.05
Indonesia	−0.11	−0.11	0.44	8.67	0.00
India	−0.33	−0.33	−0.19	−12.11	−0.00
Ireland	−0.77	−0.71	−0.61	−47.02	−0.06
Italy	−0.62	−0.61	−1.36	−88.72	−0.01
Japan	1.38	1.46	−4.61	−13.92	−0.07
South Korea	−0.22	−0.24	2.82	9.24	0.02
Lithuania	−2.08	−1.59	−4.85	−45.05	−0.50
Luxembourg	−7.99	−3.64	−24.92	−70.90	−4.51
Latvia	−2.30	−1.98	−4.38	−20.96	−0.33
Mexico	−0.02	−0.03	0.04	4.15	0.00
Malta	−0.55	−0.61	−0.50	−0.04	0.06
Netherlands	−0.84	−0.74	−1.09	−167.96	−0.10
Norway	−0.29	−0.31	−0.38	−0.62	0.02
Poland	−1.17	−1.11	−2.66	−97.21	−0.06
Portugal	−0.59	−0.59	−1.33	−12.90	−0.00
Romania	−0.90	−0.89	−1.19	−17.77	−0.01
Russia	−2.14	−1.69	−27.18	−1446.62	−0.45
Slovakia	−0.96	−0.93	−1.23	−14.57	−0.03
Slovenia	−0.64	−0.64	−1.14	−2.94	0.00
Sweden	−0.19	−0.14	−1.42	−13.35	−0.05
Turkey	−0.77	−0.77	−0.75	−48.76	−0.00

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TABLE 7 (Continued)

(1)	(2)	(3)	(4)	(5)	(6)
Country	**Producers**	**Consumers**	**Total Exports (%)**	**Total Exports (M US$)**	**Real Output**
Taiwan	−0.02	−0.03	1.99	5.44	0.01
United States	0.00	0.00	−0.09	−38.06	−0.00

Note: This table reports estimates of the general equilibrium effects due to the sanctions on Russia from 2014. The change in the vector of bilateral trade costs is based on the estimate of RUS_ALL = −0.8908708 from Table 2, Column (5). Column (1) lists the ISO codes for the selected countries. Column (2) reports estimates of the effects on producers due to changes in producer prices (in %). Column (3) reports estimates of the effects on consumers due to changes in consumer prices (in %). Column (4) reports changes in total exports in %, whereas Column (5) reports changes in total exports in millions of US$. Finally, Column (6) shows real output changes in %. See the text for further details.

$$\widehat{\pi}_{ij} = \frac{\pi_{ij}^c}{\pi_{ij}^b} = \frac{\left(\widehat{p}_i \widehat{t}_{ij}\right)^{1-\sigma}}{\sum_l \pi_{lj}^b \left(\widehat{p}_l \widehat{t}_{lj}\right)^{1-\sigma}}. \tag{7}$$

Market clearance implies that the total output of each country is equal to sales to all destination countries including sales at home: $Y_i = \sum_j X_{ij}$. Using Equations (5) and (6), we can express Y_i as:

$$Y_i = \sum_j \frac{\left(\gamma_i p_i t_{ij}\right)^{1-\sigma}}{\sum_l \left(\gamma_l p_l t_{lj}\right)^{1-\sigma}} E_j = \sum_j \pi_{ij} E_j. \tag{8}$$

The counterfactual value of Y_i, Y_i^c, can be stated as:

$$Y_i^c = \sum_j \pi_{ij}^c E_j^c. \tag{9}$$

As we assume an endowment economy, expenditures are related to output as follows:

$$E_i = Y_i + TI_i = p_i Q_i + TI_i, \tag{10}$$

where TI_i allows for exogenous trade imbalances observed in the data, which we hold constant between baseline and counterfactual.

Using the expressions given in Equations (7), (9), and (10), and $\widehat{Y}_i = \widehat{p}_i$ as well as $\widehat{E}_i = \left(Y_i^b \widehat{Y}_i + TI_i\right)/E_i^b$, the change in Y_i, $\widehat{Y}_i$, can be written as:

$$Y_i^b \widehat{Y}_i = \sum_j \frac{\pi_{ij}^b \left(\widehat{Y}_i \widehat{t}_{ij}\right)^{1-\sigma}}{\sum_l \pi_{lj}^b \left(\widehat{Y}_l \widehat{t}_{lj}\right)^{1-\sigma}} \left(Y_j^b \widehat{Y}_j + TI_j\right). \tag{11}$$

This system needs only data on trade shares in the baseline (π_{ij}^b) and knowledge about σ. To calculate output and trade imbalances, we utilize the relationships $Y_i^b = \sum_j X_{ij}^b$ and $TI_j = E_j^b - Y_j^b = \sum_i X_{ij}^b - Y_j^b$. Knowledge about the CES preference parameter γ_j is not necessary. For σ, we rely on the trade elasticity estimates for agriculture, hunting, forestry, and fishing from Fontagné et al. (2022) that we also utilized in the calculation of the tariff equivalents, which imply

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$\sigma = 3.91$. The change in t_{ij}, $\widehat{t}_{ij}$, is given by our counterfactual experiment. Specifically, we use the point estimate for the overall effect of the Russian sanctions from Table 1 Column (5), RUSSIAN SANCTIONS ON ALL, given by −0.891, to calculate $\widehat{t}_{ij}$ as follows: $\widehat{t}_{ij} = [\exp(-.891 \times \text{RUSSIAN SANCTIONS ON ALL})]^{1/(1-\sigma)}$. Hence, Equation (11) can be used to solve for the unknown $\widehat{Y}_i$'s. As the system is homogeneous of degree zero in prices, we have to choose a numéraire. We chose producer prices in the United States as our numéraire, as the underlying data are in dollars, and we also report dollar values for total exports.

Having solved for $\widehat{Y}_i$, we can calculate the changes for expenditures ($\widehat{E}_j$), producer prices ($\widehat{p}_j$), consumer prices ($\widehat{P}_j$), trade shares ($\widehat{\pi}_{ij}$), and nominal trade flows ($\widehat{X}_{ij}$) as follows:

$$\widehat{E}_j = \frac{Y_j^b \widehat{Y}_j + TI_j}{E_j^b}, \tag{12}$$

$$\widehat{p}_j = \widehat{Y}_j, \tag{13}$$

$$\widehat{P}_j = \left(\sum_l \pi_{lj}^b \left(\widehat{p}_l \widehat{t}_{lj} \right)^{1-\sigma} \right)^{\frac{1}{1-\sigma}}, \tag{14}$$

$$\widehat{\pi}_{ij} = \frac{\left(\widehat{p}_i \widehat{t}_{ij} \right)^{1-\sigma}}{\sum_l \pi_{lj}^b \left(\widehat{p}_l \widehat{t}_{lj} \right)^{1-\sigma}}, \tag{15}$$

$$\widehat{X}_{ij} = \widehat{\pi}_{ij} \widehat{E}_j. \tag{16}$$

Real output changes, $\widehat{\mathcal{Y}}_j$, are given by:

$$\widehat{\mathcal{Y}}_j = \frac{\widehat{Y}_j}{\widehat{P}_j} = \left(\widehat{\pi}_{jj} \right)^{\frac{1}{1-\sigma}}, \tag{17}$$

where the last expression holds assuming $\widehat{t}_{jj} = 1$ for all j. As we are focusing on the agricultural sector only and due to trade imbalances, the real output changes are not a direct measure of welfare, as is typically the case in such frameworks.

Although we use ITPD-E for our estimations, ITPD-E is highly unbalanced and thus not suitable for the quantification of the price and output effects. Therefore, we rely on the fully balanced WIOD database for our quantification of the price and output effects, which covers trade and production for 43 countries between 2000 and 2014. We select 2014 as the baseline year because it corresponds to the year that countries imposed sanctions on Russia and the year we used for our estimates. We use only the data from industry A01 "crop and animal production, hunting, and related service activities."

Table 7 presents the results of the quantification of the price, output, and total trade effects of the sanctions on Russia from 2014. Column (1) lists the ISO codes for the available countries in WIOD. Column (2) reports estimates of the effects on producers due to changes in producer prices, p_i, expressed in percentage changes. Importantly, these changes are all relative to the numéraire country, the United States, where the change in the producer price is zero, and our findings should be interpreted accordingly. Three results stand out from Column (2). First, producer prices fall the most in Luxembourg, Estonia, Cyprus, Latvia, and Russia. These large losses are explained by their comparably large export share of agricultural products to Russia (31% of the agricultural production

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from Luxembourg is exported to Russia, for example). Producers in Russia are not hit harder because over 95% of the agricultural production in Russia is sold locally. Second, for a few countries (i.e., Japan and Finland), producer prices increase, which can occur for several reasons. Japan did not participate in the sanctions, which lowers their relative trade costs and makes Japan's producers relatively more competitive on world markets. Finland exports a comparably large amount of their agricultural production and has considerable exports to China and many European countries. Hence, Finland profits from increased export demand for agricultural products from these countries due to the heightened trade barriers with Russia. Third, many other countries that did not participate in the sanctions (i.e., Australia, China, Indonesia, Korea, Mexico, and Taiwan) also see only a slight decrease in their producer prices (relative to the United States).

In Column (3) of Table 7, we present the effects on consumers via changes in the consumer price index, P_i. Once again, these are nominal effects that depend on our numéraire choice (i.e., producer prices in the United States) and should be interpreted accordingly. We make two main observations. First, and most notably, the signs of the effects on consumers coincide with the signs of the effects on producers. This is consistent with the standard economic logic that lower producer prices imply lower consumer prices. Trade-induced changes in producer prices, therefore, have direct implications for local consumers. Second, not only the sign of the effects of producer and consumer prices but also their magnitudes are similar. This is reflected by a high correlation of 0.922 between producer and consumer prices.

Next, in Column (4) of Table 7, we present the changes in total exports for each country. As before, these are nominal effects that depend on our numéraire choice. We find large negative effects for Switzerland, Russia, and Luxembourg. Switzerland has very low agricultural trade flows, and thus, relatively small absolute changes turn into relatively large percentage changes. The large negative effects of total exports of Russia and Luxembourg are a direct reflection of the increased trade costs, remembering that Luxembourg exports a large share of its agricultural products to Russia. Overall, we see large losses for some European countries based on the common point estimate for the overall effect of the Russian sanctions from Table 2. Some countries that did not participate in the sanctions, like South Korea, Taiwan, China, and Indonesia, see increases in their total exports. The reason is that they started exporting more to countries that trade fewer agricultural products with Russia after the imposition of sanctions on Russia. This is a reflection of trade diversion from Russia to third-party countries. Compared to the point estimates, which amount to a drop of 59% of trade between the sanctioning countries and Russia, the trade effects reported in Table 7 are smaller. There are two reasons for this. First, we report changes in total exports in Table 7 and not the change in bilateral trade flows between sanctioning countries and Russia reflected in the coefficient estimate. Second, trade between all countries other than Russia may increase due to the sanctions, mitigating the reduction of total exports of the sanctioning countries due to decreased trade with Russia.

In Column (5), we translate the percentage changes into dollar values by multiplying the percent changes with the baseline total exports of industry A01 "crop and animal production, hunting, and related service activities" of each country. The values are in million US$. Here, we clearly see that, in absolute values, the biggest loss occurs for Russia with a decline of about 1450 million US$. In absolute terms, many European countries follow, ranging from a 169.0 million US$ decline for Germany to an 87.9 million US$ decline for Belgium, an order of magnitude lower than the impact on Russia. The largest gains are for China with 32 million US$, followed by Canada with 20 million US$, South Korea with 9.2 million US$, and Indonesia with 8.6 million US$.

Finally, in Column (6) of Table 7, we present real output changes. These indexes do not depend on our numéraire choice. Consistent with the list of countries where we saw large producer price drops, we find that these countries (e.g., Luxembourg, Cyprus, Estonia, and Lithuania) experienced the largest drop in real output. Finland also is among the countries with the largest drop in real output, but in this case, the decline occurs due to a larger increase in consumer price. This increase in consumer price is driven by the rise in producer price and the elevated prices for the imports of agricultural products (5% of Finish agricultural expenditures are on imported agricultural products from

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Russia, for example). Many European countries experience decreases in real output, which reflects the significant negative point estimates for the European Union (see Table 2, Column (7)). Some countries that did not participate in the 2014 sanctions with Russia see slight increases in real output, such as South Korea and Taiwan. The intuition is that these countries know the adverse effects and thus do not participate in these sanctions. We also find some countries (e.g., Malta, Canada, Norway, and Croatia) that participated in the sanctions experienced a slight increase in real output. For all these countries, consumer prices fall more than producer prices, leading to an increase in real output. The stronger fall in consumer prices is driven by cheaper imports from abroad. For example, Malta imports large amounts of agricultural products from Italy and the Netherlands, where producer prices fall.

To sum up, we find substantial heterogeneity in the effects of the uniform imposition of sanctions on Russia in 2014. Overall, most producers and consumers lose, with the largest losses for countries with substantial trade volumes of agricultural products with Russia. But we also observe trade diversion, leading to increased exports and real output for some countries. Our analysis is based on a single-sector endowment economy. Therefore, the quantification only captures price changes. Overall quantities produced and consumed in the world stay constant. Furthermore, the single-sector setting does not take into account intersectoral linkages and spillover effects between sectors. Undertaking an analysis in a multiple-sector setting and allowing for investments and production would be an interesting avenue for future investigations but is beyond the scope of our analysis. Even with these caveats, we view our point estimates of the effects of sanctions on Russia as informative and reliable, and the accompanying quantification of the price and output changes capture the first-order effects of price and trade diversion.

6 | CONCLUSION

Trade sanctions are frequently used as a foreign policy tool to punish or coerce foreign governments into altering their behavior. We investigate empirically whether trade sanctions affect agricultural trade. Our main findings are that trade sanctions do impede agricultural trade. However, the degree varies by type, with complete sanctions having a larger impact than partial trade sanctions, by industry, by sanctioning and sanctioned countries, and by the direction of trade flows. Although partial sanctions reduce agricultural trade by a smaller degree than complete sanctions, this is an important finding because ethical concerns of heightened food insecurity following an embargo on food products were the primary impetus for governments to switch to partial sanctions that explicitly exclude agricultural products. These findings are consistent with our prior expectations that complete sanctions directly impede trade of all commodities, including agricultural products, by suspending normal trade relations. However, the impacts of partial sanctions are more nuanced because of indirect costs and uncertainty for exporters or products caught in the crossfire of the WTO trade dispute settlement system. We also show the effects of the bilateral trade sanctions involving Russia, which reduced trade substantially, particularly between the EU and Russia, and we translate the partial estimates into producer price, consumer price, and real output changes using a multicountry, single-sector general equilibrium model.

To quantify the effects of sanctions, we utilized two novel datasets—the 2022 edition of the International Trade and Production Database for Estimation (ITPD-E) and the 2021 edition of the Global Sanctions Database (GSDB) —and employed the latest developments in the structural gravity literature, for example, control for multilateral resistance terms, introduce country-(industry) fixed effects, introduce bilateral-(industry) fixed effects, use the PPML estimator, include intranational trade flows, and control for (industry-specific) globalization trends.

We believe that the usage of the databases and the described methods are useful for additional quantification of other sanctions. Moreover, such estimates could be combined with a more elaborate model that allows for multiple sectors, an input–output structure, multiple production factors,

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and dynamic effects to obtain a more nuanced picture of the effects of sanctions on prices for producers and consumers, as well as for welfare.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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APPENDIX A

TABLE A1 Active trade sanctions, GSDB, 1986–2019.

(1)	(2)	(3)	(4)	(5)	(6)
Case ID	Start	End	Target(s)	Sender(s)	Type
1	1950	1994	Palestine	League of Arab States	Exp.compl., Imp.compl.
2	1950	1994	Comecon	Austria, Finland, Sweden, Switzerland	Exp.partl.
3	1950	1994	Comecon	CoCom	Exp.partl.
4	1955	2008	Korea, North	United States	Imp.compl., Imp.partl.
5	1963	1994	South Africa	Switzerland	Exp.partl.
6	1964	1993	South Africa	India	Exp.compl., Imp.compl.
7	1974	2008	India	Canada	Exp.partl., Exp.partl.
8	1974	2008	India	United States	Exp.partl.
9	1975	1992	South Africa	Denmark	Exp.compl., Imp.compl.
10	1976	1994	South Vietnam	United States	Exp.compl., Imp.compl.
11	1977	1989	Argentina	United States	Exp.partl.
12	1978	1987	Soviet Union	United States	Exp.partl.
13	1978	1988	South Vietnam	China	Exp.compl., Imp.compl.
14	1978	2004	Libya	United States	Exp.partl.
15	1979	1989	Cambodia	United States	Exp.compl., Imp.compl.
16	1980	1990	Iraq	United States	Exp.partl.
17	1981	1987	Poland	United States	Exp.partl.
18	1981	2004	Libya	United States	Exp.partl.
19	1982	1989	United Kingdom	Argentina	Imp.compl.
20	1982	1987	Poland	United States	Imp.partl.
21	1982	2004	Libya	United States	Exp.partl., Imp.partl.
22	1984	2016	Iran	United States	Exp.partl.
23	1985	1994	South Africa	Australia	Exp.partl., Imp.partl.
24	1985	1992	South Africa	EEC	Imp.partl.
25	1985	1994	South Africa	Commonwealth	Exp.partl., Imp.partl.
26	1985	1994	South Africa	Denmark, Finland, Iceland, Norway, Sweden	Exp.partl., Imp.partl.
27	1985	1990	Nicaragua	United States	Exp.compl., Imp.compl.

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TABLE A1 (Continued)

(1) Case ID	(2) Start	(3) End	(4) Target(s)	(5) Sender(s)	(6) Type
28	1985	1994	South Africa	United States	Exp.partl., Imp.partl.
29	1986	1994	South Africa	Japan	Exp.partl., Imp.partl.
30	1986	2004	Libya	United States	Exp.partl., Imp.partl.
31	1986	1994	South Africa	UN	Exp.partl.
32	1986	1994	South Africa	Denmark	Exp.compl., Imp.compl.
33	1986	1992	Angola	United States	Imp.partl.
34	1986	1994	South Africa	EEC	Imp.partl.
35	1986	1987	Syria	United States	Exp.partl.
36	1987	1996	Romania	United States	Imp.partl.
37	1987	1987	Fiji	Australia	Exp.compl.
38	1987	1987	Fiji	New Zealand	Exp.compl.
39	1987	1993	South Africa	Norway, Sweden	Exp.compl., Imp.compl.
40	1987	1995	Iran	United States	Imp.compl.
41	1987	1989	Panama	United States	Imp.partl.
42	1987	1998	Fiji	India	Exp.compl., Imp.compl.
43	1988	1996	France	Australia	Exp.partl.
44	1988	1995	France	Australia	Exp.partl.
45	1989	1989	Chile	United States	Exp.partl.
46	1989	2019	Armenia	Azerbaijan	Exp.compl., Imp.compl.
47	1989	1992	Cambodia	United States	Exp.compl., Imp.compl.
48	1989	1990	Nepal	India	Exp.compl., Imp.compl.
49	1989	2016	Myanmar	United States	Imp.partl.
50	1990	1990	Lithuania	Soviet Union	Exp.partl.
51	1990	1990	Estonia, Latvia, Lithuania	Soviet Union	Exp.partl.
52	1990	2003	Iraq	EU	Exp.partl.
53	1990	1991	Kuwait	Japan	Exp.compl., Imp.partl.
54	1990	2003	Iraq	UN	Exp.compl., Imp.compl.
55	1990	1991	Transjordan	Saudi Arabia	Exp.partl.
56	1990	1990	Soviet Union	Lithuania	Exp.partl.
57	1990	2016	Myanmar	United States	Imp.compl.
58	1990	1991	Suriname	Venezuela	Exp.compl., Imp.compl.

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TABLE A1 (Continued)

(1) Case ID	(2) Start	(3) End	(4) Target(s)	(5) Sender(s)	(6) Type
59	1990	1991	Kuwait	UN	Exp.compl., Imp.compl.
60	1990	1991	Kuwait	United States	Exp.partl., Imp.partl.
61	1991	1994	Haiti	Organization of American States	Exp.compl., Imp.compl.
62	1991	1994	Haiti	Canada	Exp.compl., Imp.compl.
63	1991	1991	Turkmenistan	Soviet Union	Exp.partl.
64	1991	2003	Iraq	UN	Exp.compl., Imp.compl.
65	1991	1994	Haiti	Venezuela	Exp.partl.
66	1991	1994	Haiti	United States	Exp.compl., Imp.compl.
67	1992	1992	Turkmenistan	Russia	Exp.partl.
68	1992	1994	Algeria	EU	Exp.partl.
69	1992	1992	Cambodia	UN	Exp.partl., Imp.partl.
70	1992	1992	Lithuania	Russia	Exp.partl.
71	1992	1998	Cameroon	United States	Imp.partl.
72	1992	1997	Liberia	ECOWAS	Imp.partl.
73	1992	2003	Libya	UN	Exp.partl.
74	1992	1998	Latvia	Russia	Exp.partl., Imp.partl.
75	1992	1993	Estonia	Russia	Exp.partl.
76	1992	1998	Estonia	Russia	Exp.partl., Imp.partl.
77	1992	1996	Yugoslavia	UN	Exp.compl., Imp.compl.
78	1993	1993	Estonia	Russia	Exp.partl.
79	1993	1994	France	China	Imp.partl.
80	1993	1996	Russia	Ukraine	Imp.partl.
81	1993	1995	Turkmenistan	Russia	Imp.partl.
82	1993	2003	Libya	UN	Exp.partl.
83	1993	1994	China	United States	Exp.partl.
84	1993	1996	Ukraine	Russia	Exp.partl.
85	1993	1995	Pakistan	United States	Exp.partl.
86	1993	2019	Armenia	Turkey	Exp.compl., Imp.compl.
87	1993	2003	Angola	United States	Exp.partl., Imp.partl.
88	1993	2002	Angola	UN	Exp.partl.
89	1993	1994	Haiti	UN	Exp.partl.

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TABLE A1 (Continued)

(1) Case ID	(2) Start	(3) End	(4) Target(s)	(5) Sender(s)	(6) Type
90	1994	1995	Macedonia	Greece	Exp.compl., Imp.compl.
91	1994	1995	Taiwan	United States	Imp.partl.
92	1994	1995	Bosnia and Herzegovina	FRY	Exp.compl., Imp.compl.
93	1994	1995	Kazakhstan	Russia	Exp.partl., Imp.partl.
94	1995	1996	France	Australia	Imp.partl.
95	1995	1995	France	Japan	Imp.partl.
96	1995	1995	France	Denmark	Imp.partl.
97	1995	1996	France	United Kingdom	Imp.partl.
98	1995	1995	Lebanon	Israel	Exp.partl., Imp.partl.
99	1995	1995	France	Norway, Sweden	Imp.partl.
100	1995	1996	Ukraine	Russia	Imp.partl.
101	1995	1996	France	New Zealand	Imp.partl.
102	1995	2016	Iran	United States	Exp.compl., Imp.compl.
103	1995	1996	France	United States	Imp.partl.
104	1996	1999	Burundi	Congo, Eritrea, Ethiopia, Kenya	Exp.compl., Imp.compl.
				Rwanda, Tanzania, Uganda, Zambia	
105	1996	1999	Burundi	Organization of African Unity	Exp.compl., Imp.compl.
106	1996	2015	EU	Canada	Imp.partl.
107	1996	2019	Libya	United States	Exp.partl.
108	1996	2019	Iran	United States	Exp.partl.
109	1997	2019	Sudan	United States	Exp.compl., Imp.compl.
110	1997	2003	Sierra Leone	ECOWAS	Exp.compl., Imp.compl.
111	1997	2002	Angola	UN	Exp.partl.
112	1997	2004	Belize	United States	Imp.partl.
113	1997	1998	Sierra Leone	UN	Exp.partl.
114	1998	2002	Angola	UN	Imp.partl.
115	1998	2017	France	United States	Imp.partl.
116	1998	2001	Yugoslavia	EU	Exp.partl., Imp.partl.
117	1998	1999	Italy	Turkey	Imp.partl.
118	1998	2001	India	United States	Exp.partl.
119	1998	2014	Ireland	United States	Imp.partl.
120	1998	1998	Kyrgyzstan	Uzbekistan	Exp.partl.

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TABLE A1 (Continued)

(1)	(2)	(3)	(4)	(5)	(6)
Case ID	Start	End	Target(s)	Sender(s)	Type
121	1999	2002	Afghanistan	United States	Exp.partl., Imp.partl.
122	1999	2000	Kyrgyzstan	Uzbekistan	Exp.partl.
123	1999	2000	Yugoslavia	EU	Exp.partl.
124	1999	2000	Yugoslavia	United States	Exp.partl.
125	1999	2000	Indonesia	EU	Exp.partl.
126	2000	2006	Myanmar	Switzerland	Exp.partl.
127	2000	2003	Sierra Leone	UN	Exp.partl.
128	2000	2000	Fiji	New Zealand	Exp.compl.
129	2000	2000	Kyrgyzstan	Uzbekistan	Exp.partl.
130	2000	2000	Fiji	Australia	Exp.compl.
131	2000	2003	Myanmar	EU(+)	Exp.partl.
132	2000	2003	Fiji	United Kingdom	Exp.partl.
133	2000	2002	Afghanistan	UN	Exp.partl.
134	2001	2003	Sierra Leone	Liberia	Imp.partl.
135	2001	2016	Liberia	EU	Imp.partl.
136	2001	2002	Afghanistan	EU(+)	Exp.partl.
137	2001	2001	Brazil	NAFTA	Imp.partl.
138	2001	2004	Belize	EU	Imp.partl.
139	2001	2001	Kyrgyzstan	Uzbekistan	Exp.partl.
140	2001	2007	Liberia	UN	Imp.partl.
141	2002	2019	Zimbabwe	Switzerland	Exp.partl.
142	2002	2019	Zimbabwe	United Kingdom	Exp.partl.
143	2002	2006	Korea, North	United States	Exp.partl.
144	2002	2019	Zimbabwe	EU(+)	Exp.partl.
145	2003	2006	United States	Canada	Imp.partl.
146	2003	2016	United States	Brazil	Imp.partl.
147	2003	2013	United States	Japan	Imp.partl.
148	2003	2016	Myanmar	United States	Exp.partl.
149	2003	2003	France	United States	Imp.partl.
150	2003	2016	Canada	China	Imp.partl.
151	2003	2005	Canada	United States	Imp.partl.
152	2003	2006	Liberia	UN	Imp.partl.
153	2003	2006	Canada	Japan	Imp.partl.
154	2003	2010	Myanmar	EU(+)	Exp.partl.
155	2003	2007	Argentina	Iran	Exp.partl.
156	2003	2016	Canada	Mexico	Imp.partl.
157	2004	2019	Syria	United States	Exp.partl., Imp.partl.
158	2004	2007	Thailand, South Vietnam	Cambodia	Imp.partl.

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TABLE A1 (Continued)

(1)	(2)	(3)	(4)	(5)	(6)
Case ID	Start	End	Target(s)	Sender(s)	Type
159	2004	2015	Liberia	United States	Exp.partl., Imp.partl.
160	2005	2009	Uzbekistan	EU	Exp.partl.
161	2005	2016	Cote d'Ivoire	EU(+)	Exp.partl.
162	2005	2014	Cote d'Ivoire	UN	Exp.partl., Imp.partl.
163	2005	2006	Kyrgyzstan	Uzbekistan	Exp.partl.
164	2006	2011	Georgia	Russia	Exp.compl., Imp.compl.
165	2006	2019	Korea, North	EU	Exp.partl.
166	2006	2016	Iran	Japan	Imp.partl.
167	2006	2007	Moldova	Russia	Imp.partl.
168	2006	2012	Myanmar	Switzerland	Exp.partl.
169	2006	2013	Georgia	Russia	Imp.partl.
170	2006	2019	Korea, North	Japan	Imp.compl.
171	2006	2019	Korea, North	Australia	Exp.partl., Imp.partl.
172	2006	2019	Congo, Democratic Republic of the	United States	Exp.partl., Imp.partl.
173	2006	2006	Lebanon	Israel	Exp.partl., Imp.partl.
174	2006	2016	Belarus	Canada	Exp.partl.
175	2006	2019	Korea, North	UN	Exp.partl., Imp.partl.
176	2006	2019	Belarus	United States	Exp.partl., Imp.partl.
177	2006	2016	Iran	UN	Exp.partl., Imp.partl.
178	2006	2009	Uzbekistan	Switzerland	Exp.partl.
179	2006	2017	Sudan	United States	Exp.partl., Imp.partl.
180	2006	2006	Ukraine	Russia	Exp.partl.
181	2006	2019	Sudan	United States	Exp.partl.
182	2006	2013	Georgia	Russia	Imp.partl.
183	2007	2012	Myanmar	Canada	Exp.compl., Imp.compl.
184	2007	2016	Myanmar	United States	Exp.partl., Imp.partl.
185	2007	2015	Fiji	EU	Exp.partl.
186	2008	2016	Iran	Australia	Exp.partl., Imp.partl.
187	2008	2016	Myanmar	United States	Imp.partl.
188	2008	2019	Korea, North	United States	Exp.partl.

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TABLE A1 (Continued)

(1)	(2)	(3)	(4)	(5)	(6)
Case ID	Start	End	Target(s)	Sender(s)	Type
189	2009	2019	Korea, North	Japan	Exp.compl.
190	2009	2019	Somalia	Switzerland	Imp.partl.
191	2009	2009	Ukraine	Russia	Exp.partl.
192	2009	2011	Georgia	Russia	Exp.partl.
193	2009	2014	Guinea	EU(+)	Exp.partl.
194	2009	2009	Honduras	Venezuela	Exp.partl.
195	2009	2009	Tajikistan	Uzbekistan	Exp.partl.
196	2009	2018	Eritrea	Russia	Exp.partl.
197	2010	2010	Kyrgyzstan	Uzbekistan	Exp.partl.
198	2010	2012	Iran	Korea, South	Imp.partl.
199	2010	2016	Iran	UN	Exp.partl.
200	2010	2016	Iran	Canada	Exp.partl.
201	2010	2014	Guinea	Switzerland	Exp.partl.
202	2010	2011	Switzerland	Libya	Exp.compl., Imp.compl.
203	2010	2013	Myanmar	EU(+)	Exp.partl., Imp.partl.
204	2010	2018	Norway	China	Imp.partl.
205	2010	2010	Belarus	Russia	Exp.partl.
206	2010	2010	Tajikistan	Uzbekistan	Exp.partl.
207	2010	2019	Somalia	United States	Imp.partl.
208	2010	2019	Korea, North	Korea, South	Exp.compl., Imp.compl.
209	2011	2019	Syria	Australia	Exp.partl., Imp.partl.
210	2011	2019	Korea, North	United States	Imp.compl.
211	2011	2019	Jamaica	United States	Exp.partl., Imp.partl.
212	2011	2014	Colombia	United States	Exp.partl., Imp.partl.
213	2011	2016	Iran	Canada	Exp.partl.
214	2011	2019	Libya	EU(+)	Exp.partl.
215	2011	2016	Iran	Switzerland	Exp.partl., Imp.partl.
216	2011	2012	Syria	Switzerland	Exp.partl.
217	2011	2019	Libya	Switzerland	Exp.partl.
218	2011	2013	Syria	EU(+)	Exp.partl., Imp.partl.
219	2011	2019	Korea, North	Canada	Exp.compl., Imp.compl.
220	2011	2019	Libya	Canada	Exp.partl., Imp.partl.

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TABLE A1 (Continued)

(1) Case ID	(2) Start	(3) End	(4) Target(s)	(5) Sender(s)	(6) Type
221	2011	2019	Syria	United States	Exp.partl., Imp.partl.
222	2011	2019	Indonesia	United States	Exp.partl., Imp.partl.
223	2011	2018	Eritrea	UN	Imp.partl.
224	2011	2019	Dominican Republic	United States	Exp.partl., Imp.partl.
225	2011	2019	Syria	League of Arab States	Exp.partl., Imp.partl.
226	2011	2019	Syria	Canada	Exp.partl., Imp.partl.
227	2011	2011	Indonesia	Australia	Exp.partl.
228	2011	2016	Belarus	EU(+)	Exp.partl.
229	2012	2019	Somalia	UN	Imp.partl.
230	2012	2019	Syria	Switzerland	Exp.partl.
231	2012	2019	Somalia	United States	Imp.partl.
232	2012	2019	Belize	United States	Exp.partl., Imp.partl.
233	2012	2012	Tajikistan	Uzbekistan	Exp.partl.
234	2012	2016	Iran	Canada	Exp.partl., Imp.partl.
235	2012	2019	Syria	Canada	Exp.partl.
236	2012	2019	Moldova	United States	Exp.partl., Imp.partl.
237	2012	2019	Somalia	EU(+)	Imp.partl.
238	2012	2016	Palestine	United States	Exp.partl., Imp.partl.
239	2012	2016	Iran	EU(+)	Exp.partl., Imp.partl.
240	2012	2016	Iran	EU	Exp.partl.
241	2012	2019	Ceylon	United States	Exp.partl., Imp.partl.
242	2013	2019	Egypt, Arab Rep.	EU	Exp.partl.
243	2013	2019	Greece	United States	Exp.partl., Imp.partl.
244	2013	2019	Nigeria	United States	Exp.partl., Imp.partl.
245	2013	2019	Moldova	Russia	Imp.partl.
246	2013	2019	Somalia	Switzerland	Imp.partl.
247	2013	2016	Central African Republic	Kimberly Process Participants	Imp.partl.
248	2013	2019	Syria	EU(+)	Exp.partl., Imp.partl.
249	2013	2019	Taiwan	United States	Exp.partl., Imp.partl.

(Continues)

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TABLE A1 (Continued)

(1)	(2)	(3)	(4)	(5)	(6)
Case ID	Start	End	Target(s)	Sender(s)	Type
250	2013	2019	Myanmar	EU(+)	Exp.partl.
251	2013	2014	Kyrgyzstan	Uzbekistan	Exp.partl.
252	2013	2014	Lithuania	Russia	Imp.partl.
253	2013	2019	Syria	Canada	Exp.partl.
254	2013	2016	Iran	Canada	Exp.compl., Imp.compl.
255	2013	2013	Mali	United States	Exp.partl., Imp.partl.
256	2014	2019	Russia	EU	Exp.partl., Imp.partl.
257	2014	2019	Ukraine	Switzerland	Exp.partl., Imp.partl.
258	2014	2019	Russia	Canada	Exp.partl.
259	2014	2019	United States	Russia	Imp.partl.
260	2014	2019	Israel	Spain, United Kingdom	Exp.partl.
261	2014	2019	Russia	Australia	Exp.partl.
262	2014	2014	Kyrgyzstan	Uzbekistan	Exp.partl.
263	2014	2019	Australia	Russia	Imp.partl.
264	2014	2014	Belize	EU	Imp.partl.
265	2014	2014	Ukraine	EU(+)	Exp.partl.
266	2014	2019	Norway	Russia	Imp.partl.
267	2014	2018	Colombia	United States	Exp.partl., Imp.partl.
268	2014	2019	Ukraine	Canada	Exp.partl., Imp.partl.
269	2014	2019	Russia	Japan	Imp.partl.
270	2014	2019	Ukraine	United States	Exp.partl., Imp.partl.
271	2014	2019	Russia	EU(+)	Imp.partl.
272	2014	2019	EU	Russia	Imp.partl.
273	2014	2014	Ukraine	Russia	Exp.partl.
274	2014	2019	Russia	United States	Exp.partl., Imp.partl.
275	2014	2019	Ukraine	EU(+)	Exp.partl., Imp.partl.
276	2014	2019	Russia	Switzerland	Exp.partl., Imp.partl.
277	2014	2019	Ukraine	Japan	Imp.partl.
278	2015	2018	Ukraine	South Vietnam	Imp.partl.
279	2015	2019	Albania, Montenegro, Liechtenstein, Iceland	Russia	Imp.partl.
280	2015	2019	Venezuela	United States	Exp.partl., Imp.partl.
281	2015	2016	Canada	Korea, South	Imp.partl.

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TABLE A1 (Continued)

(1) Case ID	(2) Start	(3) End	(4) Target(s)	(5) Sender(s)	(6) Type
282	2015	2016	Canada	Taiwan	Imp.partl.
283	2015	2016	Nepal	India	Exp.partl.
284	2016	2019	Burundi	United States	Exp.partl., Imp.partl.
285	2016	2017	Egypt, Arab Rep.	Saudi Arabia	Exp.partl.
286	2016	2016	Iran	Switzerland	Exp.partl.
287	2016	2019	Iran	Canada	Exp.partl.
288	2017	2019	Venezuela	EU(+)	Exp.partl.
289	2017	2019	Korea, North	Burkina Faso	Imp.compl.
290	2017	2019	China	United States	Exp.partl., Imp.partl.
291	2018	2019	Saudi Arabia	United States, France, Germany, Canada	Exp.partl., Imp.partl.
292	2018	2019	Ghana	United States	Exp.partl., Imp.partl.
293	2018	2019	Sierra Leone	United States	Exp.partl., Imp.partl.
294	2018	2019	Iran	Korea, South	Imp.partl.
295	2018	2019	Lebanon	United States	Exp.partl., Imp.partl.
296	2018	2019	Venezuela	Switzerland	Exp.partl.
297	2018	2018	Turkey	United States	Exp.partl., Imp.partl.
298	2019	2019	China	United States	Exp.partl., Imp.partl.
299	2019	2019	Iraq	United States	Exp.partl., Imp.partl.

Note: This table lists the active trade sanction cases from the GSDB during the period 1986–2019. The cases are sorted by the year of the start of the sanction, which appears in Column (2). Columns (3) reports the end year of the sanction. Some sanctions do not actually end in 2019, however, this year is listed because it is the last year in the GSDB. Columns (4) and (5) list the sanctioned/target state and the sanctioning/sender states. EU (+) in this column denotes cases where the EU was joined by other countries. Often these countries include Cyprus, Malta, Turkey, Croatia, Macedonia, Montenegro, Iceland, Albania, Serbia, Bosnia and Herzegovina, Liechtenstein, Norway, Ukraine, Moldova, Armenia, Georgia, and Switzerland. However, not all of these countries join the EU sanctions at all times. For details, we refer the reader to the description of the original GSDB data at https://www.globalsanctionsdatabase.com. Finally, Column (6) describes the type of trade sanctions.

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