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7728
2019

July 2019

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CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
Editor: Clemens Fuest
www.cesifo-group.org/wp

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CESifo *Working Paper No. 7728*
Category 8: Trade Policy

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Abstract

Using a new, global data base covering the years 1950 to 2015, we study the impact of sanctions on international trade and welfare. We make use of the rich dimensionality of our data and of the latest developments in the structural gravity literature. Starting with a broad evaluation by sanction type, we carefully investigate the case of Iran. Effects are significant but also widely heterogeneous across sanctioning countries. Moreover, they depend on the direction of trade. We also perform a counterfactual analysis which translates our partial equilibrium sanction estimates into heterogeneous but intuitive general equilibrium effects within the same framework.

JEL-Codes: F100, F130, F140, F500, F510, H500, N400.

Keywords: sanctions, effectiveness of sanctions, structural gravity.

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June 17, 2019

We are grateful to Rod Ludema for his insightful discussion of our paper during the inaugural Scientific Workshop on Sanctions at Drexel University. We also appreciate the useful comments and suggestions by Hana Attia, Richard Barnett, Tibor Besedes, Albrecht Bohne, Edward Cartwright, Andrea Charron, Anne-Celia Disdier, Jonathan Eaton, Lionel Fontagne, Annika Havlik, Friedrich Heinemann, James Harrigan, Gary Hufbauer, Krisztina Kis-Katos, Udo Kreickemeier, Mario Larch, Tuan Luong, Ahmed Mahmud, Thierry Mayer, Alejandro Molnar, Inmaculada Martinez-Zarzoso, Anna Miromanova, Daniel Mirza, Juan Mora-Sanguinetti, Cliff Morgan, Volker Nitsch, Clara Portela, Gerald Schneider, Holger Strulik, Farid Toubal, Alessia Lo Turco, Hylke Vandenbussche, Joschka Wanner, Zheng Wang and seminar participants at De Montfort University, Drexel University, the European Trade Study Group 2018, Katholieke Universiteit Leuven, Leibniz University Hannover, the Midwest Meetings in International Trade in Vanderbilt, Paris School of Economics, the Organisation for Economic Co-operation and Development, Technische Universitat Darmstadt, University of Göttingen, ZEW Mannheim, University of Hohenheim, and the 2018 Annual Conference of the German Economic Association.

"At the beginning of the 21st century, the same as a century earlier, economic sanctions remain an important yet controversial foreign policy tool."

(Hufbauer et al., 2007a)

1 Introduction

From the "Age of Pericles" in Athens of ancient Greece, to the times of Napoleon and Thomas Jefferson in the nineteenth century, to the inter-war years and the post-World War II period, economic sanctions have served as a prominent and "purposive tool" of coercive statecraft (Drezner, 1999).[1] They have been imposed unilaterally or coalitionally and, especially in the post-Cold War era, with increasing frequency.[2] What is more, it appears that economic sanctions are here to stay and their incidence will most likely continue to rise.[3] Therefore, it is eminently sensible for policy analysts and scholars to: (i) work to deepen our understanding of policymakers' motives, objectives and constraints in this context; (ii) develop models that link conceptually policy actions to observed and expected outcomes to improve assessment; and (iii) use quantitative methods to estimate the costs and benefits of economic sanctions to all sides for explanatory and predictive purposes. As will become clear shortly, this paper belongs to the last category.

[1]Notable examples of such sanctions include: the Megarian decree of Athenians in 435 B.C.; the US's sanctions at the time of Jefferson against France and Great Britain during their engagement in the Napoleonic Wars; the sanctions against Italy by the League of Nations in 1935; the Anti-Apartheid Act against South Africa in 1986; the US sanctions against Cuba; the United Nations financial and trade sanctions against Iraq prior to the overthrowing of Saddam Hussein in 2003; the recurrent sanctions on North Korea; the comprehensive and multi-round economic sanctions by EU, the US and other nations against Russia; the imposition of sanctions, under the US leadership, against Iran in 1987, their expansion in 1995 and 2006, and their controversial renewal by the US in 2018; the sanctions against Venezuela under President Hugo Chavez and, more recently, by the Trump administration against President Nicolás Maduro.

[2]Remarkably, and as we emphasize later on in connection with the content of the Global Sanctions Data Base (GSDB), the number of recorded sanctions during 1950-2016 is 729. Furthermore, over the last 25 years of this period, the number of sanctions more than doubled.

[3]For example, Drezner (1999, p. 7) remarked: "There is every reason to believe that the prominence of economic coercion will increase in the future. Over the course of the past century, major powers have been increasingly reluctant to use or threaten force, while at the same time demonstrating a growing eagerness to employ economic coercion." In similar spirit, (Kirshner, 2007, p. 32) predicted: "Economic diplomacy will play an increasingly large role in the post-cold war era." Blackwill and Harris (2016) provide a fascinating modern account of economic statecraft.

In their foreign policy pursuits, the sanctioning states (the "senders") have deployed sanctions to "punish, deter, and rehabilitate" (Hufbauer et al., 2007a, p. 7) or, more generally, to compel a sanctioned nation (the "target") to change its behavior on matters of political nature; to project their power, resolve or morality of cause; to reassure domestic businesses and constituencies of the policymakers' commitment to national interests and the quality of their leadership (Galtung, 1967; Renwick, 1981; Tsebelis, 1990; Whang, 2011); and, presumably, to achieve external policy goals peacefully rather than by means of force.[4]

Naturally, an understanding of the contending states' motives to impose and/or disregard sanctions (such as the ones described above) is important for policy assessments. But this is not enough for such tasks: one must also examine policymakers' objectives, their instruments, the constraints (political or institutional) on their actions, as well as the dependence of these constraints on domestic and international affairs.

Prior to WW II, economics sanctions were inextricably linked to military endeavors, mostly taking the form of trade sanctions and economic blockades, under the protective umbrella of the sanctioning states' naval forces.[5] In more recent times, though, the arsenal of weaponry in economic sanctions was enriched to include boycotts, restrictions on trade in arms, financial sanctions, travel bans, and the withholding of military assistance, among others.[6]

A broad range of these instruments has been deployed on numerous occasions for a num-

[4]In the words of (Hufbauer et al., 2007a, p. 7), "[T]he imposition of sanctions conveys a triple signal: To the target country it says the sender does not condone the target's actions; to allies it says that words will be supported with deeds; and to domestic audiences it says the sender government will act to safeguard the nation's vital interests."

[5]In some cases, they have served as precursors of armed conflict. As Findlay and O'Rourke (2009) amply document in their impressive discourse of international trade in the second millennium, trade and warfare were inseparable.

[6]Manifestly, the expanded diversity of instruments available to sanctioning states nowadays could be attributed to the deepening of integration in commodity, factor and financial markets, as well as the market for ideas, which have been promulgated by the liberal order of the GATT/WTO and the dramatic reductions in transaction costs due to technological advances. By increasing the target's vulnerability to external interventions, these conditions may have also improved the sanctioning states' ability to interfere in the target's national affairs more comprehensively and with enhanced precision. See Ahn and Ludema (2018) for an admirable analysis of targeted sanctions on Russia and Besedes et al. (2018) for an insightful analysis of financial sanctions on German economic activity.

ber of reasons: to destabilize autocratic and/or rogue regimes in target states; to support regional peace by discouraging local hostilities, curtailing arming and averting outbreaks of war; to limit "terrorist" activities and human rights abuses; and to promote democracy, among others. Yet, as noble as these objectives may sound, they are not immune to influence by domestic and international interest groups. Because the fortunes of these groups depend on the distributional consequences of sanctions, their activation often induces the groups to mobilize to influence the sender's policy preferences, actions and/or feasible sets of coercive tools (Kirshner, 2007; Kaempfer and Lowenberg, 2007). Surely these considerations play important roles in the determination of policy outcomes. But the world in which these outcomes unfold consists of multiple countries with shared and/or opposing interests. Because in this environment the costs of sanctions to the senders typically are spread unevenly among them, the effectiveness of sanctions hinges on whether they are unilateral or multilateral. Furthermore, because "sanctions busting" is a real possibility, it matters how multilateral sanctions are implemented and enforced.[7]

The brief overview of ideas on sanctions described above inevitably raises a fundamental question: Do economic sanctions work? In light of the growing popularity of sanctions among policymakers it would be comforting to have an affirmative answer. Unfortunately, there is no consensus on this issue among scholars. In fact, the conventional wisdom (e.g., Pape (1997)) is that "...Economic Sanctions Do Not Work." Hufbauer et al. (2007a), one of the most comprehensive contributions to the related empirical literature, report that 34% of the cases they examined could be viewed as successful. After subjecting this finding into

[7]In recent times, the US has engaged in the extraterritorial application of sanctions through litigation. For example, according to Reuters news (April 15, 2019), Italy's top bank UniCredit SpA agreed to "settle probes of violations of U.S. sanctions on Iran and other countries" by paying 1.3 billion dollars to U.S. authorities. Moreover, its German subsidiary, UniCredit Bank AG, "agreed to plead guilty to federal and New York state criminal charges for illegally moving [funds] through the U.S. financial system on behalf of sanctioned entities." In addition to national sovereignty, an important issue in this context is that powerful nations possess the capability to multilateralize sanctions regimes. In other words, the nature of the sanctions regime itself may be endogenous. What's more, and as evidenced by EU's "Blocking Regulation" (in support of the Iran Nuclear Deal (officially called "Joint Comprehensive Plan of Action" (JCPOA)), an important component of this problem is that it may trigger international policy responses that could significantly raise the worldwide resource costs of implementing sanctions.

scrutiny, Pape (1998) contends that the success rate was only 4%.[8] Why is it, then, that policymakers favor this policy tool?

The evocative title of Morgan and Schwebach (1997), "Fools Suffer Gladly..." may be in the vicinity of truth. Hufbauer et al. (2007a) and Drezner (1999) outline a number of reasons that could explain the limited success of sanctions. First, the types of sanctions used may be "inadequate" for the specific objective(s) considered. Second, the imposition of sanctions may prompt vociferous opposition in the target country by uniting citizens and domestic interests in "rallies behind the flag." Third, powerful allies of the sanctioned country may intervene (as "black knights") to counteract the damaging effects of sanctions. Fourth, uneven sharing of the costs of sanctions among the sender's allies and business interests may impair unity in multilateral relationships thereby "undermining" their effectiveness. Last, but not least, those policy leaders may choose to deploy sanctions because they perceive them as a less damaging substitute for military interventions.

Morgan and Schwebach (1997) propose a theoretical framework and an empirical test that suggests this: the higher the cost of economic sanctions to the target the higher the probability that sanctions will succeed. In addition to emphasizing the above costs, careful theoretical contributions to this problem, (e.g., Eaton and Engers (1992; 1999); Drezner (1999)), also suggest that the lower the cost of sanctions to the sender(s), the more likely that sanctions will succeed.

Motivated by the above insights, our objective in this paper is twofold. The first objective is related to the Global Sanctions Data Base (GSDB), which is a newly created database and has the following valuable characteristics: it provides a detailed description of the various types of sanctions observed during 1950-2016 and the policy objectives associated with each type of sanction; it contains a record of whether each sanction type is viewed in policy circles as a "success" or a "failure"; it also contains a descriptive analysis of the evolution of sanctions over time and regions in the world, and a preliminary analysis of the trade volumes that

[8] Also see Pape (1997), Baldwin (1985; 1999), Drezner (1999) and Kaempfer and Lowenberg (2007) for insightful reviews of various contrasting views in this literature.

may be potentially affected by the types of sanctions considered. Our second objective is to study quantitatively, with the help of the GSDB, the relationship between sanctions and trade. In particular, focusing on trade as the primary channel of economic pain to the target, we pursue this objective by assessing the related costs to it and the effects of these costs on real GDP and sectoral value added.

We view the quantitative exercise as limited in scope and are keenly aware that it alone cannot fully address the question of the "effectiveness" of sanctions.[9] Our motivation in pursuing this task is twofold. First, we believe that any attempts to bridge the gap between scholarship and policy making are doomed to remain unsatisfactory (or fail) if the costs that senders impose on targets through trade-related channels and the burden of their actions to themselves are not appraised. We think we can rectify this problem with the help of the GSDB. Second, while we recognize the importance of earlier efforts to quantity these effects, we believe our methodology, which relies on structural gravity, has solid theoretical and general equilibrium foundations. As such, we think it is well suited to capture both the significance of the heterogeneous effects of the various types of sanctions considered and the distributional effects on the burden of costs among senders.

More precisely, we demonstrate the usefulness of the newly created database with an application to international trade. Specifically, capitalizing on the latest developments in the literature on structural gravity, we implement novel methods, first, to quantify the direct effect of sanctions on international trade and then to translate our partial equilibrium estimates into general equilibrium effects on real GDP.[10] Taking advantage of the rich dimensionality

[9]This is so because the problem we are dealing with is multi-dimensional in nature and has component parts that are notoriously difficult to quantify and assess. As noted earlier, these difficulties are at least in part related to the potentially conflicting objectives of politicians and policymakers as well as the nuanced strategic policy interactions in the global economy.

[10]Our empirical analysis complements and extends a series of studies that quantify the impact of sanctions. For example, several papers have already used the gravity model to obtain partial equilibrium estimates of the effects of sanctions, (e.g., Hufbauer and Oegg (2003), Caruso (2003), Yang et al. (2004), and Afesorgbor (2018)). We offer three contributions in relation to these studies. First, we implement the latest developments in the estimation structural gravity literature. We use the PPML estimator and we obtain country-pair and directional estimates of the impact of trade sanctions in a setting with asymmetric pair fixed effects and importer-time and exporter-time fixed effects. Second, we capitalize on the rich dimensionality of GSDB to obtain novel estimates of the impact of trade sanctions. Third, we employ the full gravity system to

of GSDB, we analyze the direct impact of sanctions on trade flows in three steps. First, we obtain estimates of the average impact of sanctions on trade flows across all sanctions and by sanction type. The average and collective impact of economic sanctions on trade is insignificant. But the estimates of specific types of sanctions are significant. What's more, these estimates are very heterogeneous across the different types of sanctions we consider. And, as expected, they are negative and statistically significant. However, our estimates of the impact of arms sanctions are positive and significant. Interestingly, the effects of travel, financial and other types of sanctions are insignificant. Combined with mounting anecdotal evidence pointing to a significant relationship between non-trade sanctions and international trade, our findings underline the need for explicit modeling of the structural impact of such sanctions.

Second, we zoom in on the effects of trade sanctions by distinguishing (i) between the impact of export sanctions vs. import sanctions, and (ii) between the effects of complete trade sanctions vs. partial trade sanctions. Overall, our analysis confirms that, on average, trade sanctions are effective in impeding international trade. In addition, we show that their impact is heterogeneous across the two dimensions of interest to us. Depending on whether sanctions are bilateral or directional, we find that, on average, sanctions that apply simultaneously on exports and imports and sanctions that only apply on exports are more effective. In contrast, we do not obtain significant effects for import sanctions. To deepen our understanding of the effects of trade sanctions, we distinguish between complete vs. partial trade sanctions. Our estimates reveal that complete bilateral trade sanctions are effective, while partial bilateral trade sanctions are not. Furthermore, we find that all export sanctions (complete and partial) are effective. We do not offer evidence for the effectiveness of import sanctions.

quantify the general equilibrium effects of sanctions on trade, welfare and sectoral value added in the world. By focusing on the sanctions on Iran we also complement several papers that study the effects of specific sanctions (e.g., Crozet and Hinz (2017), who focus on Russia, and Haidar (2017), who uses disaggregated customs data to study export deflection in Iran, and Draca et al. (2017), who study the incidence of sanctions on Iranian firms). Our country-specific partial estimates of the sanctions on Iran and their impact on Iranian trade, real GDP, and sectoral value added are novel in relation to these studies.

Third, we quantify the effects of specific sanctions with a focus on Iran. In addition to obtaining a single estimate for the effect of the sanctions on this country, we decompose their impact into directional pair-specific estimates (e.g., Iran-Germany vs. Germany-Iran). We also identify the effects of deeper provisions within the Iran sanctions (e.g., the increase in EU sanctions on Iran post 2011). Our results demonstrate that the impact of sanctions is quite heterogeneous across sanctions (e.g., the sanction on Iran vs. all other trade sanctions). In addition, we find that the effects of sanctions vary across country pairs within the same sanction (e.g., USA-Iran vs. China-Iran) and also within pairs depending on the direction of trade flows (e.g., Turkey-Iran vs. Iran-Turkey). The estimates of the country-specific sanctions on Iran are mostly negative and significant. However, we also obtain some estimates that are not statistically significant (e.g., Turkey-Iran and China-Iran), reflecting sanction waivers, and even some positive estimates (e.g., United Arab Emirates-Iran), reflecting possible sanction evasion. Our methods and the wide heterogeneity in our estimates across sanctions, across pairs within sanctions, and within pairs open promising opportunities for an analysis of the effectiveness of sanctions.

We conclude by quantifying the general equilibrium effects of the sanctions on Iran on trade, real GDP, and sectoral value added using the same structural gravity framework that served as the foundation for our estimation analysis. Specifically, we rely on the gravity framework of Aichele and Heiland (2016) who calibrate the multi-sector model with intermediate goods of Caliendo and Parro (2015) for 130 countries and 57 sectors using the GTAP data. The counterfactual experiment employs our pair-and-direction-specific estimates from the previous section to simulate a hypothetical world without the Iran sanction in place. With respect to trade, we find that the removal of the sanctions on Iran would make the country substantially more open to international trade. However, despite the large percentage changes in trade with many developed nations, the new levels of trade between Iran and these countries would still be very low. Turning to the effects on welfare, unsurprisingly, we find that the biggest winner of terminating the sanctions regime would be Iran: it's real

per capita income is predicted to rise by about 4.2 percent. The effects on other countries are small but also intuitive. For example, we find that the next biggest winner from the removal of the Iran sanctions is Armenia, Iran's neighboring country. The Western initiators of the sanctions against Iran and UN Security Council members, (e.g., USA, France, or Great Britain), are barely affected by the removal of the sanction while Korea, Panama, the Ukraine and some oil producing countries are likely to lose. Finally, and expectedly, the model predicts that an end of the sanctions would benefit Iran's oil and gas sectors most strongly, with the value added in the gas sector reaching almost a 40 percent increase. Other sectors that would enjoy sizable gains in terms of value added include leather, textile, and transportation. In contrast, losses are concentrated in comparative disadvantage sectors, e.g., many agricultural products including vegetables, sugar and rice.

The rest of the paper is organized as follows. Section 2 offers some descriptive motivational evidence on the relationship between sanctions and international trade based on GSDB. Section 3 reviews the structural gravity theory and specifies our econometric model. Section 4 presents and discusses our partial equilibrium estimates of the impact of sanctions as well as the general equilibrium effects of the sanctions on Iran. Section 5 concludes with a summary of our results and a brief discussion of possible directions for future research.

2 Trade and Sanctions: Descriptive Evidence

2.1 A New Dataset

To quantify the impact of sanctions on international trade, we have put together a new data base that we dub the Global Sanctions Data Base (GSDB). It covers all publicly traceable multilateral, plurilateral, as well as purely bilateral sanctions over the period 1950-2016. The GSDB includes 729 sanction cases, which are classified on the basis of three main dimensions. First, the GSDB classifies sanctions by type in six categories that cover: trade, financial activity, arms, military assistance, travel, and other sanctions. Trade sanctions

represent national or international legal actions preventing the transfer of items, material or goods over a defined period. In comparison to existing prominent sanction datasets such as (Hufbauer et al., 2007a; Morgan et al., 2014) the GSDB not only identifies the existence of trade sanctions between two nations but also specifies the direction of affected trade flows (exports and/or imports), and the type of trade restriction (partial or complete sanctions).[11] Structurally, the GSDB is closer to Hufbauer et al. (2007a) because classical trade policy interventions such as tariffs or anti-dumping measures are not defined as sanctions. In fact all sanctions listed by Hufbauer et al. (2007a) are also part of the GSDB.

The second classification is based on the political objective(s) of the sanction(s) considered, and the GSDB groups sanction objectives into the following nine categories: change policy, destabilize a regime, resolve territorial conflict, prevent war, end war, prevent the rise of terrorist groups, end human rights violations, restore democracy, and other objectives. The third dimension is based on the degree to which each sanction is perceived as successful in achieving its objective. On that front, the GSDB offers eight categories, ranging from failed sanctions to full acceptance of the sender(s) demands.

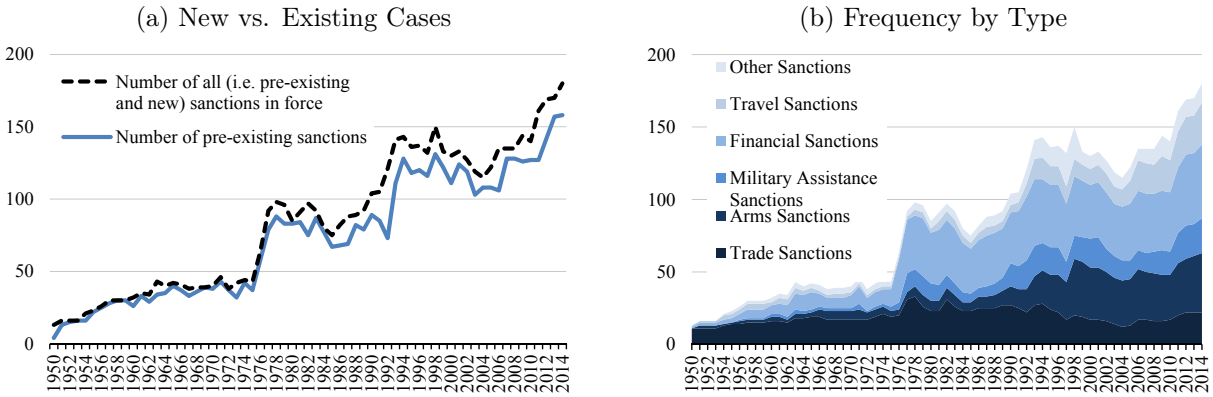
2.2 Sanctions: Incidence over Time

In light of our objectives, in this section we provide a brief description of the dimensions of the GSDB that is used in our structural analysis. Specifically, first we focus on the evolution of all sanctions by type during the period of investigation. We then take a close look at trade sanctions because they play a leading role in our quantitative analysis.

Figure 1 depicts the evolution of all identified sanctions between 1950 and 2015. For each year, Panel (a) of Figure 1 reports the number of newly imposed sanctions and the

[11] The most widely used database released in 1983 and updated several times over the past years is offered by Hufbauer et al. (2007a). It focuses on around 200 identified cases of trade and financial sanctions. First published in 2006, Morgan et al. (2014) offer the Threat and Imposition of Economic Sanctions database (TIES), covering not only imposed sanctions but also threats of sanctions. The TIES database has also an economic and financial focus. However, it differs from Hufbauer et al. (2007a) and from the GSDB by defining additionally measures of trade defence like anti-dumping as economic sanctions. Sanctions in the TIES database include tariffs, export controls, embargoes, import bans, travel bans, freezing assets, cutting foreign aid, and blockades. As a result the number of identified sanctions amount to over 1400 cases.

Figure 1: Number of Sanctions over Time



Panel (a): number of sanctions in force inherited from last year, and number of total (inherited plus new) sanctions in force per year. Panel (b): number of sanctions by type (trade sanctions, arms sanctions, military assistance sanctions, financial sanctions, travel sanctions, and other sanctions), stacked.

cases that were initiated in previous years. Three distinct time intervals can be identified. During the 1950-1990 period, we observe a gradual and steady rise in the use of sanctions. A strong increase in new sanctions is observed in the early 90s. In the succeeding decade, until 2004, both the total number of sanctions in force and the newly initiated cases fall. However, a strong and steady increase of initiated sanctions policies is taking place in the following years until the end of the sample period (which also continues today). Overall, the number of sanctions has been steadily rising over the last 65 years. We view this as evidence that the popularity of sanctions as a tool of coercive diplomacy has been on the rise. As a consequence, one may also suspect that the economic impact of sanctions will have been increasing as well.

Panel (b) of Figure 1 presents the evolution of the number of sanctions by type.[12] Several findings stand out: First, trade sanctions are the main type of sanctions implemented between 1950 and the late 70s. During this period, all other types of sanctions played a minor role. Second, over the years two specific policy measures have been applied with increasing frequency: financial and arms sanctions. Travel bans, restrictions on military assistance and other sanctions have also been imposed at an increasing rate. In contrast, the number of

[12]The exact number of countries that have been sanctioned with a specific type of sanctions is listed in the Appendix.

trade sanctions remained constant over the years, which, in combination with the increasing number of other sanctions, suggests that the number of trade sanctions is relatively smaller. This raises the question of whether trade sanctions are still an important and effective policy tool.

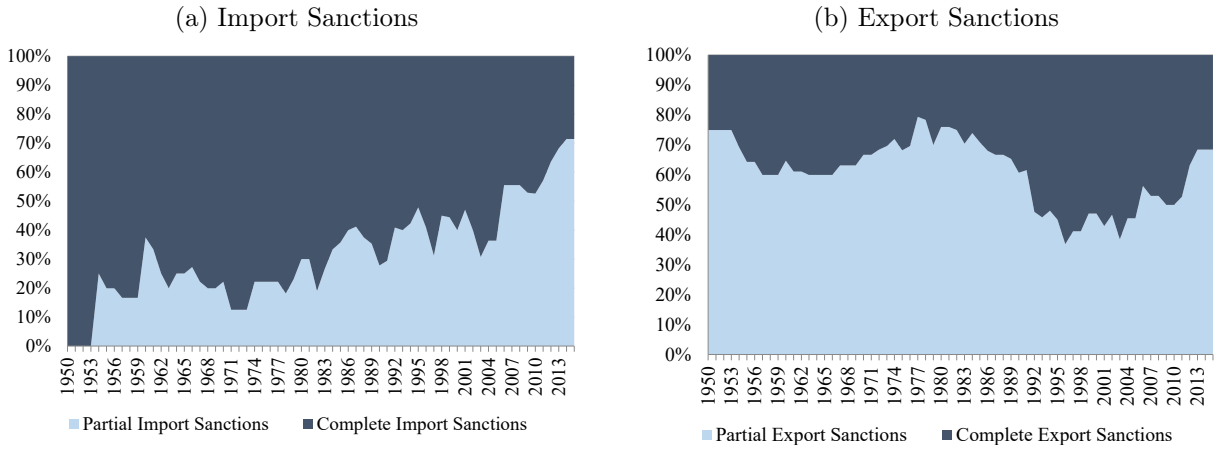
In the GSDB, trade sanctions are broadly defined as limitations of trade flows. The GSDB distinguishes between several types of trade sanctions depending on coverage, direction and participating countries. First, it is possible that only exports to or imports from a specific country are temporarily banned, or that both exports and imports are not permitted during the sanctions period. Accordingly, depending on the direction of banned trade flows, the GSDB distinguishes between sanctions on exports from the sender to the target, sanctions on imports from the target to the sender, and sanctions that simultaneously apply to both the exports and the imports between the two sides. Second, trade sanctions may apply only to specific goods (partial trade sanctions) or to exports and/or imports as a whole (complete trade sanctions). Thus, the GSDB distinguishes between "partial" vs. "complete" sanctions within each of the three dimensions, depending on the direction of banned trade flows.[13] Finally, an important aspect of sanctions is the scope of participating countries that can vary from one country (a unilateral sanction) to, for example, a sanction imposed multilaterally by all members of the United Nations.[14] To perform the structural empirical analysis, we capitalize on the variation across each of the three dimensions of trade sanctions in the GSDB.

Figure 2 tracks partial and complete trade sanctions over time. Interestingly, in the early 1950s, all countries participating in import sanctions restricted imports to the full extent.

[13]For a range of cases the GSDB additionally includes detailed trade ban information (e.g., export controls of small aviation, helicopter, aviation parts and electronics, or export restrictions of high-tech products). The partial character of this type of trade sanctions is very heterogeneous as the product ranges differ substantially.

[14]A prominent example of a complete unilateral sanction is the full trade sanction policy imposed by the United states on Cuba, which was introduced by President John F. Kennedy in February 1962. The UN sanction on Iran based on resolution 1996 is an example for a (partial) sanction policy that is imposed by all UN member states. The different dimensions of trade sanctions in the GSDB are illustrated in Figure 9, in the Appendix.

Figure 2: Partial versus Complete Trade Sanctions



Partial and complete import (Panel (a)) and export (Panel (b)) sanctions over time (1950 to 2015).

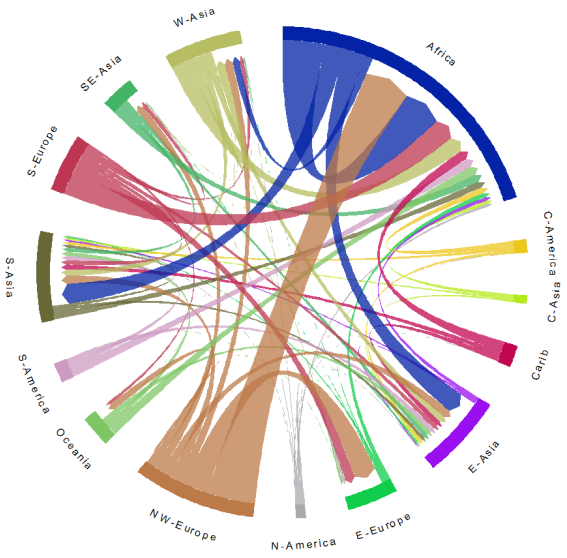
However, in the succeeding years, an increasing number of countries restricted imports only partly. In 2015, their share stood at around 70% of all countries applying import sanctions. In contrast, as illustrated in Panel (b) of Figure 2, over the past 65 years, countries have been less eager to impose restrictions on all exports. Between 1950 and 1990, around 70% of countries sanctioning exports imposed partial restrictions. In the following period of 20 years, almost half of all export restricting countries applied complete export sanctions, whereas in recent years two thirds of countries participating in export sanctions applied partial sanctions only. These patterns illustrate the importance of identifying the differing extent of trade sanctions in terms of partial and complete export and import restrictions.

2.3 Sanctions: Country Patterns

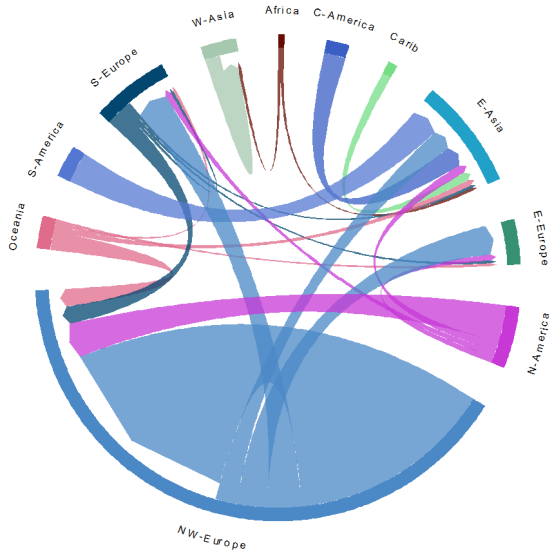
Who imposes sanctions on whom? Figure 3 offers two radial dendrograms by major regions. Arrows starting in a specific region and pointing on a particular region indicate the number of imposed trade sanctions. Panel (a) of Figure 3 illustrates the sanction activities between regions for the year 2015. Countries from North-Western Europe (NW Europe) imposed the largest number of trade sanctions in Africa (brown arrow). At the same time, however, not a single state from Africa imposed a trade ban against a North-Western European state. Interestingly, some regions are barely sanctioned by other regions while at the same time

Figure 3: Bilateral Structure of Sanctions

(a) 2015



(b) 1950



Note: These two radial dendrograms visualize sanctions between different regions in the world for the years 2050 and 2015. Regions are classified according to the UN Geoscheme. For details see the Appendix.

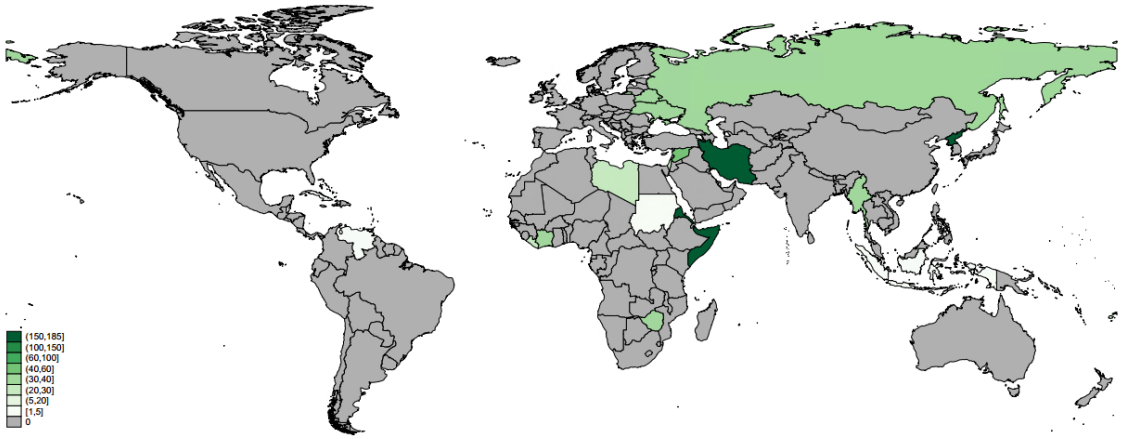
others have been confronted with sanctions of almost every listed region. For example, East and South Asia have been sanctioned by almost all regions, at least in 2015. Panel (b) of Figure 3 offers a radial dendrogram that illustrates the sanction activities between regions for the year 1950. For the sake of comparability, we hold the regional classification of countries constant to that in 2015. The figure illustrates a much smaller variety and number of sanctions policies among different regions. The biggest share of arrows indicate that trade sanctions took place between members of the Eastern and Western blocks at that time.

Next, we zoom in to illustrate which specific countries have acted as senders of sanctions and which nations have been the targets of those sanctions. For brevity and clarity of exposition, we focus on a cross section presentation for a single year, 2015, which is the latest year in our sample. The top panel of Figure 4 highlights all countries that were involved in trade sanctions. Targets are represented in green with a darker scale indicating a larger number of sanctioning countries. Accordingly, in 2015 Iran, Somalia and Eritrea were the nations that were hit with trade sanctions by the largest number of countries in the world. The bottom panel of Figure 4 offers a corresponding map of countries that imposed

trade sanctions in 2015. A darker blue scale indicates the increasing number of imposed sanction by respective countries. The map illustrates very clearly that the USA and the EU countries have been the most active nations in imposing trade sanctions against other states, followed by North-African nations and Canada. This serves to motivate our focus on these regions in the next set of descriptive analysis.

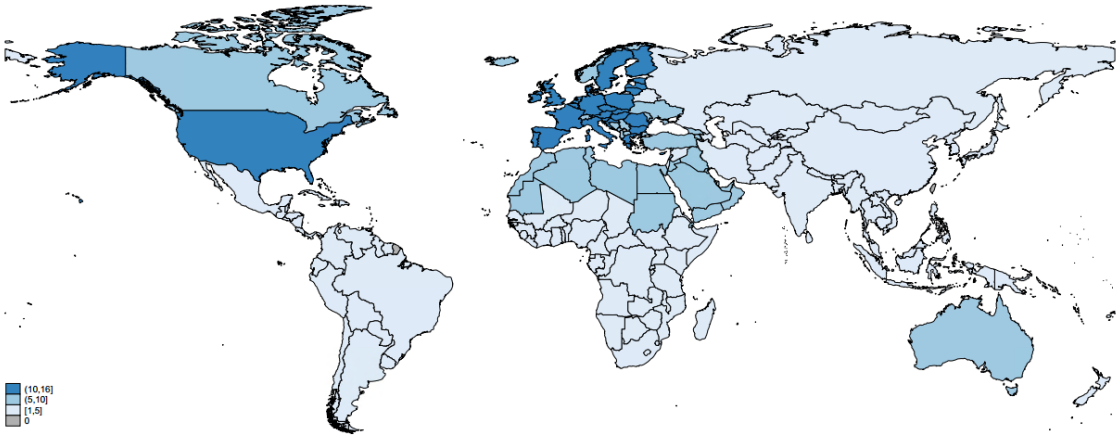
Figure 4: Sanctioned and Sanctioning Countries in 2015

(a). Sanctioned Countries in 2015



Note: This map illustrates all countries that were involved in trade sanctions in 2015. Targeted countries with sanctions are represented in green with a darker scale indicating a larger number of sanctioning countries.

(b) Sanctioning Countries in 2015



Note: This map illustrates all countries that imposed trade sanctions on other countries in 2015. A darker blue scale indicates the increasing number of imposed sanction by respective countries.

The descriptive analysis of trade sanctions thus far reveals that they are used by many countries in an intricate network. We also saw (from Panel (b) of Figure 4) that the United States and the European Union are two of the major sanctioning actors. This evidence already suggests that trade sanctions are relevant. However, an important question in the context of measuring the cost and efficiency of trade sanctions, which we have not answered thus far, is related to the extent of international economic integration of sanctioned countries. If a nation is barely trading with the rest of the world, the probability that it would achieve a foreign policy aim by trade sanctions is small due to the expected small economic costs. In other words, while the number of trade sanctions and the composition of the regions and countries involved is important, what is also important is the potential economic impact of those sanctions, which in our case is the potential trade volume that could be affected by sanctions. We shed light on this aspect in Figures 5 and 6.

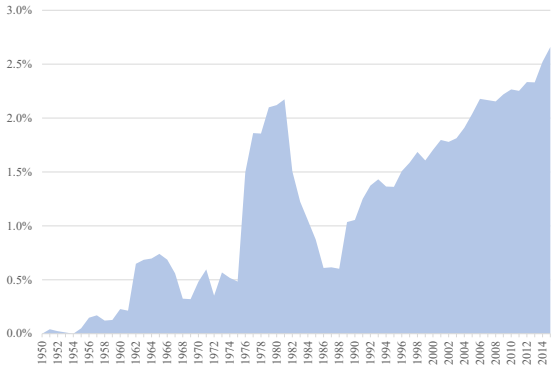
2.4 The US and the EU: Major Players

Motivated by our earlier finding from Panel (b) of Figure 4 that the United States and the European Union countries have been the most active nations in imposing trade sanctions against other states, Figure 5 depicts the exposure share of world trade to U.S. sanctions (in Panel (a)), and to EU sanctions (in Panel (b)). Panel (a) reveals that the US sanctions had the potential to negatively impact 2.5 percent of global trade in 2015. Interestingly, the share of global trade potentially affected by EU sanctions turns out to be substantially less volatile (but similarly sized). Moreover, in recent years EU sanctions have been threatening an increasingly larger share of global trade than US sanctions. The EU and US are jointly responsible for around two third of global trade that can be affected negatively by sanctions policies.[15] The main message from Figure 5 is that, individually and in combination, the U.S. and EU sanctions have the potential to affect a significant fraction of trade flows, and

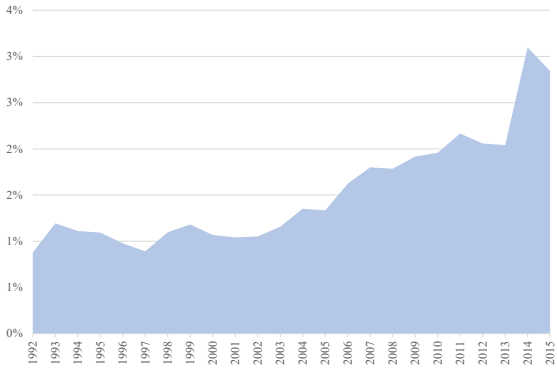
[15]In the Appendix we also offer figures that depict the share of world trade exposed to Chinese, Russian and Japanese sanctions. The volume of trade potentially affected by those countries' sanction policies has been very small, at least compared to the EU and the US.

Figure 5: Share of World Trade Exposed to...

(a) ...US Sanctions



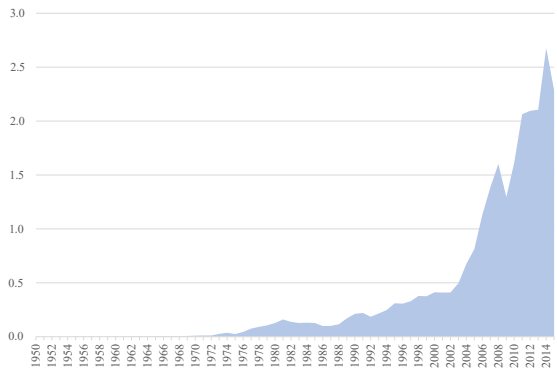
(b) ...EU Sanctions



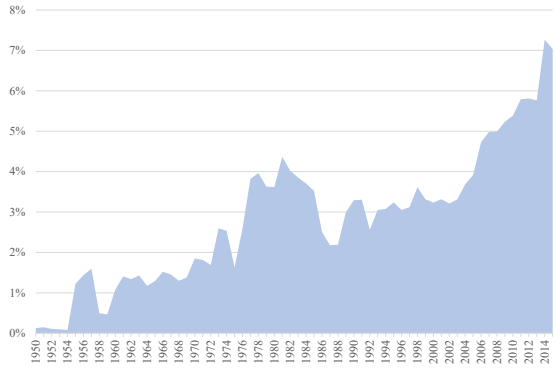
Note: The diagrams show the share of world exports exposed to US and EU sanctions. Trade data stem from the IMF Direction of Trade Statistics. EU statistics start in 1992 due to German unification.

Figure 6: Trade Potentially Affected by All Sanctions

(a) in trn. USD



(b) in % of world trade



Note: These diagrams quantify the exposed value and the share of exposed trade in world trade to all observed sanctions for each year between 1950 and 2015. The presented trade volume is the amount of observed yearly trade between countries that introduce a sanctions policy in the same year. Trade data stem from the IMF Direction of Trade Statistics.

therefore economic activity, in the world.

Figure 6 complements the analysis of the impact of U.S. and EU sanctions by illustrating the total potential impact on trade that could be caused by all trade sanctions that are imposed in the world during a given year.[16]

The left panel of Figure 6 reports the impact on trade volumes in levels, measured in trillions of current U.S. dollars. Three periods with a stepwise increase in potentially affected global trade volume can be identified. In the mid 1970s, sanctions started to have some bite,

[16]In case of unilateral sanctions the graph accounts for imports and exports of sanctioning countries while for cases with reciprocal sanctions only both import volumes have been accounted for.

but their extent remained very minor. After the fall of the iron wall in 1989, potentially affected trade volumes quickly rose to something like 200 bn. U.S. dollars. The most dramatic increase occurred after 2002; the trade volume potentiall affected by sanctions stood at more than 2 trillion U.S. dollars in recent years. Clearly, the increasing economic integration over the last decades is one reason for the exponential pattern depicted in Figure 6.

In order to gauge the relative importance of sanctions for international trade, Panel (b) of Figure 6 translated the levels from Panel (a) of the same figure into percentages. The share of world trade potentially impacted by sanction policies has risen steadily since 1950, reaching 7 percent of world trade in recent years. In contrast to the nominal trade volume development the potentially affected trade in relative terms turns out to be less exponential in its development. A major message of these statistics is, however, that the size of economic damage achievable by sanction policies through the trade channel has reached quite a significant volume. This motivates and validates our focus on measuring the impact of sanctions on international trade as an important component of the overall effectiveness of sanctions.

2.5 Sanctions against Iran

Later in this paper, we take a deeper look into sanctions against Iran. These sanctions are interesting for several reasons. Iran has been exposed to sanctions bilaterally, plurilaterally and multilaterally along several UN resolutions. Moreover, all presented dimensions of the GSDB are relevant in this case, so that we can demonstrate the usefulness of our data.

Over the past decades the United Nations security council passed several resolutions that imposed increasingly tighter sanctions on Iran. The triggering event of more recent UN sanctions against Iran has been the report by the International Atomic Energy Agency (IAEA) regarding Iran's nuclear activities in particular, the country's Uranium enrichment activities. The first UN resolution imposing economic sanctions on Iran came into force when the county rejected the security council's request to suspend uranium enrichment activities.

The first economic sanctions against Iran started in July 2006 based on the UN security council resolution 1696 and were extended and continuously tightened in the succeeding years. Starting with trade sanctions related to goods that could be used in Iran's nuclear and ballistic missile programm, sanctions were extend by increasing the range of goods that were not allowed to trade, financial sanctions and travel bans for individual people.

Table 1: UN security council resolutions imposing sanctions on Iran - since 2006

Resolution 1696	from July 2006.
Resolution 1737	from December 2006.
Resolution 1747	from March 2007.
Resolution 1803	from March 2008.
Resolution 1835	from September 2008.
Resolution 1929	from June 2010.
Resolution 1984	from June 2011.
Resolution 2049	from June 2012.
Resolution 2105	from June 2013.
Resolution 2159	from June 2014.

On top of the UN resolutions listed in Table 1, the USA and the EU additionally imposed their own sanctions on Iran. In 1979 the US imposed sanctions after Iranian students stormed the US embassy in Tehran (import sanctions). Moreover, in 1984 the USA imposed further sanctions on Iran because of the country's support for acts of international terrorism. In 1995 the US formulated an executive order to prohibit bilateral trade between Iran and the USA. European sanctions reached their peak in January 2012 when the EU introduced an oil embargo and freezed assets of Iran's central bank. Sanctions covered foreign trade, financial services, and in addition banned the provision of insurance by insurers in member states to Iran. Finally, all Iranian banks identified as institutions in breach of US or EU sanctions were disconnected from the SWIFT, the global payment system that connects banks.

3 On the Effects of Sanctions on Trade and Welfare

To quantify the impact of sanctions on trade and welfare we rely on the structural gravity model of international trade. Owing to its remarkable empirical performance, solid theo-

retical foundations, and flexibility to accommodate various extensions, the gravity model has established itself as the workhorse framework for trade policy analysis. We offer a brief review of the theoretical foundations of structural gravity in Section 3.1. Then, guided by theory and implementing the latest developments in the empirical gravity literature, in Section 3.2 we specify an econometric gravity model that enables us to obtain partial equilibrium estimates of the impact of sanctions on trade across various dimensions of the new sanctions database.

3.1 The Structural Gravity Model of Trade: A Brief Review

This section presents the Armington-CES version of the gravity model of international trade.[17] Anderson (1979) is the first to derive a structural gravity model of trade under the assumptions that goods are differentiated by place of origin (Armington, 1969) and that consumer preferences are homothetic, identical across countries, and approximated by a CES utility function. Anderson and van Wincoop (2003) refine and popularize the ideas of

[17]It is now well established that the same gravity system can be obtained from a series of alternative micro foundations (Arkolakis et al. (2012)). In addition to the original demand-side gravity model of Anderson (1979) and Anderson and van Wincoop (2003) that we review in this section, the same gravity system can be derived on the supply side (i.e., as in Eaton and Kortum (2002)), as a sectoral model on the demand side (as in (Larch and Wanner (2017) and Anderson and Yotov (2016)), and as a sectoral model from the supply side, following Costinot et al. (2012). Caliendo and Parro (2015) extend the gravity model of Eaton and Kortum (2002) to a sectoral model with intermediates. Finally, Dekle et al. (2007; 2008) derive a structural gravity system in changes, which is very convenient for computational purposes. We will capitalize on that, in combination with the sectoral gravity model with intermediates of Caliendo and Parro (2015), in the counterfactual analysis where we use the system in changes to obtain general equilibrium effects of sanctions. We refer the reader to Anderson (2011), Costinot and Rodríguez-Clare (2014), and Larch and Yotov (2016) for surveys of the theoretical gravity literature.

Anderson (1979) by delivering the following structural gravity system of international trade:

$$X_{ij,t} = \frac{Y_{i,t}E_{j,t}}{Y_t}\left(\frac{t_{ij,t}}{P_{j,t}\Pi_{i,t}}\right)^{1-\sigma}, \quad (1)$$

$$\Pi_{i,t}^{1-\sigma} = \sum_j \left(\frac{t_{ij,t}}{P_{j,t}}\right)^{1-\sigma}\frac{E_{j,t}}{Y_t}, \quad (2)$$

$$P_{j,t}^{1-\sigma} = \sum_i \left(\frac{t_{ij,t}}{\Pi_{i,t}}\right)^{1-\sigma}\frac{Y_{i,t}}{Y_t}, \quad (3)$$

$$p_{j,t} = \frac{(Y_{j,t}/Y_t)^{\frac{1}{1-\sigma}}}{\gamma_j\Pi_{j,t}}. \quad (4)$$

Here, at each point of time t, $X_{ij,t}$ denotes trade flows from exporter i to destination j; $E_{j,t}$ is the total expenditure in importer j; $Y_{i,t}$ is the value of total production in exporter i; Y_t is the value of world output; $t_{ij,t}$ denotes bilateral trade frictions between partners i and j; $\sigma > 1$ is the elasticity of substitution among goods from different countries. Equation (1) intuitively links bilateral exports to market size (the first term on the right-hand side) and trade frictions (the second term on the right-hand side). The numerator of the trade cost term includes bilateral trade frictions ($t_{ij,t}$), which we model explicitly below as a function of the possible impact of sanctions among other variables that have been recognized as significant determinants of trade flows in the existing literature. $P_{j,t}$ and $\Pi_{i,t}$ defined in equations (2)-(3) are the multilateral resistance terms (MRs, inward and outward, respectively), coined by Anderson and van Wincoop (2003).

The MRs are consistent aggregates of bilateral trade costs for each country and are interpreted as buyers' and sellers' incidence of the global system of trade costs respectively (Anderson and Yotov, 2010). The multilateral resistances are a key vehicle that enables us to translate the partial equilibrium estimates that we obtain of the impact of sanctions on bilateral trade among sanctioned and sanctioning countries into general equilibrium effects on trade and welfare on all countries in the world. This is so because the MRs represent the endogenous structural links between the changes in bilateral trade costs and their impact on

consumer prices, nominal income and real income at the country level.[18]

Finally, equation (4) captures the link between trade and national income (through the multilateral resistances). Equation (4), where γ_j is the CES share parameter, is a restatement of the market-clearing condition ($Y_{i,t} = \sum_j X_{ij,t}$), which unveils an inverse relationship between the outward multilateral resistance that captures the incidence of trade costs on the producers in j and the factory-gate price in j. The intuition for this result, with an application to sanctions, is that when a country is sanctioned, producers in this country will suffer higher outward MRs, i.e., higher incidence of trade costs, which according to equation (4), translates into lower factory-gate prices. Similarly, producers in the sanctioning countries will also suffer increases in their outward MRs that lead to lower factory-gate prices. The lower factory-gate prices translate into lower nominal income, which defines the value of production in country j and, therefore, via equation (1), affects negatively bilateral trade flows not only between the sanctioned and sanctioning countries, but also between them and any other country in the world. In Section 4.4, we will be able to quantify such general equilibrium effects within the structural gravity framework in case of the sanction on Iran.

3.2 Structural Gravity and Sanctions: From Theory to Empirics

Guided by the theoretical foundations of the gravity model from the previous section and capitalizing on the rich dimensionality of the new database on sanctions, we set an econometric gravity model that corresponds to the structural gravity equation (1), and which will enable us to obtain partial equilibrium estimates of the effects of sanctions on international trade:[19]

$$X_{ij,t} = \exp[SANCT_{ij,t}\alpha + GRAV_{ij,t}\beta + \mu_{ij} + \pi_{i,t} + \chi_{j,t}] + \epsilon_{ij,t}. \quad (5)$$

[18]For further analysis of the MRs and their importance in the structural gravity system, we refer the reader to Larch and Yotov (2016), who offer a detailed discussion of the properties of the multilateral resistances and highlight their practical uses and their relevance in general equilibrium analysis.

[19]We refer the reader to Baldwin and Taglioni (2006), Head and Mayer (2014), and Piermartini and Yotov (2016) for surveys of the empirical gravity literature.

As defined before, $X_{ij,t}$ denotes nominal trade flows from exporter i to importer j at time t. Most important for our purposes, $SANCT_{ij,t}$ is a vector of sanction variables that take central stage in our analysis. Initially, $SANCT_{ij,t}$ is constructed as a single indicator variable that equals one if there is a sanction of any sort between countries i and j at time t, and equals zero otherwise. Then, gradually, we take advantage of the rich database, in combination with economic intuition, to study the impact of sanctions across different dimensions. First, we allow for different types of sanctions (e.g., trade sanctions vs. arms sanctions vs. travel sanctions, etc.). Then, we zoom in on the impact of trade sanctions by distinguishing between export vs. import sanctions and between complete vs. partial sanctions. Third, we focus on specific sanctions, i.e., the sanctions on Iran. In addition to obtaining a single estimate for the impact of the sanctions on Iran, we decompose these sanctions into pair-specific effects (e.g., Iran-Germany vs. Iran-Russia) and even into pair-specific directional effects (e.g., Iran-Germany vs. Germany-Iran). We also identify and evaluate the impact of deeper provisions within the Iran sanctions, e.g., the increase in EU sanctions on Iran post 2011.[20]

The rest of the variables in equation (5) are standard in the gravity literature. The vector $GRAV_{ij,t}$ includes standard time-invariant gravity covariates such as the logarithm of bilateral distance and indicator variables for colonial relationships, common language, and common borders. In addition, we control for the presence of regional trade agreements (RTAs) with a dummy variable ($RTA_{ij,t}$), which takes a value of one if there is an RTA between countries i and j at time t, and it is equal to zero otherwise. $\pi_{i,t}$ denotes the set of time-varying exporting-country dummies, which control for the outward multilateral resistances of Anderson and van Wincoop (2003) as well as for any other observable and unobservable exporter-specific factors that may influence bilateral trade. Similarly, $\chi_{j,t}$ encompasses the set of time-varying destination-country dummy variables that account for the inward multilateral resistances as well as for any other observable and unobservable

[20]To obtain estimates of the partial impact of sanctions on trade, we implement the latest developments in the empirical gravity literature. Nonetheless, there are certain aspects of sanctions (e.g., their potential multilateral and extraterritorial impact), which require special attention in the interpretation of our results. We discuss these features and their implications for our findings when we present our estimates.

importer-specific characteristics that may influence international trade.

Finally, μ_{ij} denotes the set of country-pair fixed effects, which serve two main purposes. First, the pair fixed effects are the most flexible and comprehensive measure of time-invariant bilateral trade costs because they absorb any observable and unobservable time-invariant bilateral determinants of trade costs. Second, as demonstrated by Baier and Bergstrand (2007), the pair fixed effects absorb most of the linkages between the potentially endogenous RTAs and the remainder error term $\epsilon_{ij,t}$ in order to control for potential endogeneity of RTAs. Similarly, and more important for our analysis, the pair fixed effects mitigate endogeneity concerns with respect to sanctions.[21] In the robustness analysis we also add linear bilateral time trends. Furthermore, to obtain our main results, we follow Baier et al. (2016) and employ *directional* bilateral fixed effects. The benefits are: (i) the directional fixed effects allow and control for the presence of asymmetric trade costs; and (ii) this treatment is consistent with the fact that many of the sanctions in our database are directional in nature themselves.

We employ panel data to obtain the estimates for all specifications of equation (5) that we present in this section. In addition to improving efficiency, the panel data allow for the use of country-pair fixed effects and enable us to study the impact of deeper sanction provisions within the same specification. Finally, following the recommendations of Santos-Silva and Tenreyro (2006), we rely on the Poisson Pseudo Maximum Likelihood (PPML) estimator to obtain our main results. The benefits of using PPML are: (i) this estimator handles successfully the heteroskedasticity in trade data which would otherwise lead to inconsistent OLS estimates; and (ii) due to its multiplicative form, the PPML estimator enables us to take advantage of the information contained in the zero trade flows. In sensitivity analysis,

[21] Another factor that mitigates potential endogeneity concerns with respect to sanctions is that, by definition, sanctions are usually imposed in response to actions/inactions that are specific to the target country. Therefore, the use of exporter-time and importer-time fixed effects in our econometric specification completely controls for any such target-specific linkages. The downside of the use of country-time fixed effects is, of course, that they will also absorb any multilateral effects of sanctions. Therefore, our estimates of the bilateral impact of sanctions should be interpreted as lower bounds. We will return to this discussion in the next section when we present our estimates.

we demonstrate that our main findings are robust to the use of the standard OLS estimator.

4 Sanctions and Trade: Estimation Results and Analysis

This section presents the results from a series of specifications, which gradually zoom-in on the impact of sanctions on international trade. Section 4.1 starts with an analysis of the impact of sanctions on trade by the type of sanction considered. Section 4.2 focuses on the effects of trade sanctions depending on (i) whether they are imposed on imports, on exports, or on both, and (ii) whether they are complete or partial. In Section 4.3 we isolate the impact of the sanctions on Iran and obtain pair-specific estimates of the impact of these sanctions. Then, in Section 4.4, we employ these partial equilibrium estimates in combination with structural gravity theory to obtain general equilibrium effects of the Iran sanctions.

4.1 International Trade and Sanctions by Type

This section presents and discusses estimates of the impact of sanctions on international trade depending on the type of the sanction considered. Our main results are presented in Table 2.[22] As described in the previous section, the estimates are obtained with the PPML estimator and directional exporter-time, importer-time, and pair fixed effects. Due to the rich structure of fixed effects, we can only identify the impact of time-varying bilateral covariates, which in our case includes various sanctions variables, as the main object of the analysis, as well as controls for regional trade agreements.

The estimates in column (1) are obtained across all sanctions in our sample. Interestingly, we obtain an economically small and statistically insignificant estimate of the coefficient on ALL_SANCT, which suggests that economic sanctions do not affect international trade. A possible explanation for this result is the heterogeneous nature of the sanctions

[22]Three sets of sensitivity experiments, including PPML estimates with standard gravity variables instead of pair fixed effects, OLS estimates with the full set of fixed effects, and PPML estimates with bilateral time trends, which are available upon request, confirm the robustness of our main findings.

Table 2: Estimates of the Effects of Sanctions by Type

	(1) ALL	(2) TRADE	(3) TYPE	(4) INTRCT
ALL_SANCT	-0.025			
	(0.052)			
RTA	0.043	0.042	0.043	0.043
	(0.049)	(0.049)	(0.048)	(0.048)
TRADE_SANCT		-0.151	-0.176	-0.170
		(0.056)**	(0.058)**	(0.056)**
ALL_OTHR_SANCT		0.024		
		(0.057)		
ARMS_SANCT			0.237	0.259
			(0.096)*	(0.112)*
MLTR_SANCT			-0.016	-0.024
			(0.117)	(0.147)
FINC_SANCT			-0.095	-0.097
			(0.092)	(0.116)
TRVL_SANCT			0.005	-0.008
			(0.112)	(0.165)
OTHR_SANCT			0.085	0.093
			(0.076)	(0.084)
TRADE_ARMS_SANCT				-0.150
				(0.201)
TRADE_MLTR_SANCT				0.069
				(0.204)
TRADE_FINC_SANCT				0.037
				(0.150)
TRADE_TRVL_SANCT				0.017
				(0.250)
TRADE_OTHR_SANCT				-0.021
				(0.149)
N	1268340	1268340	1268340	1268340

Notes: This table reports estimates of the effects of sanctions on trade by type of sanction. The dependent variable is trade in levels. All estimates are obtained with the PPML estimator and exporter-time, importer-time and directional country-pair fixed effects. Column (1) includes a single covariate for all sanctions. Column (2) distinguishes between trade vs. other sanctions. Column (3) includes separate covariates for the main types of sanctions in our database. Finally, column (4) introduces interactions between trade sanctions and sanctions of each other type. Standard errors are clustered by country pair. $^{+}$ $p < 0.10$, * $p < .05$, ** $p < .01$. See text for further details.

variable, which includes all possible types of sanctions in our database. We confirm this intuition in column (2) of Table 2, where we separately identify the impact of trade sanctions ($TRADE\_SANCT$) vs. all other sanctions. The estimate on ALL_OTHR_SANCT remains statistically insignificant. However, the estimate of the impact on trade sanctions is negative and highly significant statistically as expected. Somewhat surprisingly, the estimate of the coefficient on $TRADE\_SANCT$ is relatively small in terms of economic magnitude.[23] The interpretation is that, while trade sanctions do impede international trade flows, they are not very effective on average. These findings motivate the analysis in the next section, where we demonstrate that the small estimate of the average effect of trade sanctions is due to significant heterogeneity in the effectiveness of trade sanctions across different sanctions types and across countries within the same trade sanction.

Column (3) of Table 2 reports estimates of the effects of different sanctions by type. Three main findings stand out. First, our estimate of the impact of trade sanctions ($TRADE\_SANCT$) remains significant but it is not statistically significantly different from the corresponding estimate in column (2). Second, we obtain a large, positive and significant estimate of the impact of arms sanctions ($ARMS\_SANCT$) on trade. This result remains robust across various sensitivity specifications. Finally, despite anecdotal evidence that financial sanctions ($FINC\_SANCT$) and travel sanctions ($TRVL\_SANCT$) have a significant impact on trade flows, their significance is not borne out in our estimates. We confirm these results in column (4) of Table 2, where we interact trade sanctions with each other possible type of sanctions. From an economic/policy perspective, these interactions enable us to identify the potential differential impact of trade sanctions when they are imposed in combination with other types of sanctions. Furthermore, from an econometric perspective, the interactions we introduce reveal whether we should be concerned about possible collinearity issues related to the fact that different types of sanctions are often imposed

[23] Our estimates implies that, on average, trade sanctions reduce international trade flows by about 14 percent, $(e^{-0.151} - 1) \times 100$. Capitalizing on the structural properties of the gravity model and using a standard value of the elasticity of substitution $\hat{\sigma} = 6$, our estimate implies a 2.5 percent, $(e^{-0.151/\hat{\sigma}} - 1) \times 100$ ad-valorem tariff equivalent effect of the impact of sanctions.

simultaneously. The results in column (4) reveal that none of the estimates on the new interaction variables are statistically significant. Moreover, none of the other estimates in column (4) are statistically different from the corresponding indexes in column (3).

A possible explanation for the insignificant estimates on sanctions (other than trade sanctions) is that their effects are captured by the country-time fixed effects in the empirical gravity model, along with other general equilibrium forces. For example, some countries have used 'secondary sanctions' to go after a target's country global transactions. In addition, some financial sanctions aim to prevent financial institutions from processing payments or to provide trade finance regardless of the direction of trade. Similarly, in some cases insurers cannot offer freight insurance. Such multilateral effects are absorbed by the sanctioning country fixed effects and point to the need for more careful modeling of the structural impact of non-trade sanctions on international trade. The implication for our estimates is that, by capturing only the impact of bilateral trade sanctions on international trade, they represent a lower bound for the possible impact of sanctions on trade.

We draw the following conclusions based on the analysis in this subsection. (i) The average impact of economic sanctions on international trade is insignificant. (ii) However, the estimates of specific types of sanctions are significant and very heterogeneous across the different types of sanctions. (iii) Specifically, the effects of trade sanctions on international trade are negative and statistically significant. (iv) Nevertheless, we obtain positive estimates on the impact of arms sanctions and statistically insignificant estimates of the effects of financial and travel sanctions. (v) Our estimates are robust to PPML specifications with standard gravity variables and with linear trends as well as the OLS estimator.

4.2 Zooming-in on the Impact of Trade Sanctions

This section utilizes additional information from the newly created sanctions dataset to shed light on the heterogeneous impact of trade sanctions across two dimensions. One that studies the effects of directional trade sanctions, i.e., sanctions on exports vs. sanctions on imports.

And another that distinguishes between the impact of partial trade sanctions vs. complete trade sanctions within each directional category. Our findings are presented in Table 3 where, as before, we obtain all estimates with the PPML estimator and exporter-time, importer-time, and directional pair fixed effects. For comparison purposes, column (1) of Table 3 reproduces the estimates in column (3) of Table 2.

In column (2) of Table 3, we distinguish between export sanctions (EXP_SANCT) vs. import sanctions (IMP_SANCT) vs. sanctions that apply simultaneously to both exports and imports (EXP_IMP_SANCT). We christen the latter 'bilateral trade sanctions'.[24] Several findings stand out from the estimates in column (2) of Table 3. First, the estimates of the common variables between columns (1) and (2) are not statistically different from each other. Second, the estimate of the effect of bilateral sanctions is negative; it is also statistically significant and larger than the common estimate of all trade sanctions in column (1). Third, the effect of export sanctions is also negative, statistically significant, and much stronger than the effect of bilateral sanctions. The estimate on EXP_SANCT is twice larger than the estimate on EXP_IMP_SANCT. Lastly, our estimates reveal that the impact of import sanctions is statistically insignificant. These results point to significant differences in the efficacy of exports vs. imports sanctions.

In column (3) of Table 3, we go a step further to decompose the effects of sanctions and isolate the impact of *complete* sanctions (vs. partial sanctions). To this end, we introduce three new covariates: $EXP\_IMP\_SANCT\_COMPL$, which is an indicator variable that takes the value of one when there is a complete sanction in each direction of trade, and the value of zero otherwise; EXP_SANCT_COMPL, which is a dummy variable that equals one for a complete sanction on exports, and zero otherwise;

[24]Note that, even though EXP_IMP_SANCT takes a value of one only when a sanction is imposed in each direction of trade flows, EXP_IMP_SANCT is not really symmetric. For example, some sanctions shut down imports completely but affect exports only partially. In that sense these sanctions are indeed bilateral but not symmetric; that is, the dummy variable for EXP_IMP_SANCT is still equal to one and does not distinguish between complete sanctions in each direction and a partial sanction in one direction. In other words, if there is some sort of trade sanction in each direction, then EXP_IMP_SANCT is equal to one, and it is equal to zero otherwise. In subsequent analysis we further distinguish between complete vs. partial trade sanctions.

Table 3: Zooming-in on the Impact of Trade Sanctions

	(1) TYPE	(2) EXP_IMP	(3) COMPLETE
TRADE_SANCT	-0.176		
	(0.058)**		
ARMS_SANCT	0.237	0.272	0.264
	(0.096)*	(0.100)**	(0.098)**
MLTR_SANCT	-0.016	-0.030	-0.029
	(0.117)	(0.116)	(0.112)
FINC_SANCT	-0.095	-0.032	-0.039
	(0.092)	(0.103)	(0.103)
TRVL_SANCT	0.005	0.012	0.028
	(0.112)	(0.110)	(0.111)
OTHR_SANCT	0.085	0.075	0.123
	(0.076)	(0.076)	(0.075)
RTA	0.043	0.045	0.045
	(0.048)	(0.047)	(0.047)
EXP_IMP_SANCT		-0.275	-0.194
		(0.137)*	(0.138)
EXP_SANCT		-0.448	-0.449
		(0.122)**	(0.122)**
IMP_SANCT		0.168	0.175
		(0.123)	(0.130)
EXP_IMP_SANCT_COMPL			-2.108
			(0.450)**
EXP_SANCT_COMPL			-1.007
			(0.451)*
IMP_SANCT_COMPL			-0.570
			(0.451)
N	1268450	1268450	1268450

Notes: This table reports estimates of the heterogeneous effects of trade sanctions. The dependent variable is trade in levels. All estimates are obtained with the PPML estimator and exporter-time, importer-time and directional country-pair fixed effects. Column (1) reproduces the estimates in column (3) of Table 2 and includes separate covariates for the main types of sanctions in our database. Column (2) decomposes the impact of of the trade sanctions in column (1) to distinguish between the effects of export sanctions vs. import sanctions vs. bilateral sanctions. Column (3) further allows for differential effects of partial vs. complete sanctions. Standard errors are clustered by country pair. $^{+}$ $p < 0.10$, * $p < .05$, ** $p < .01$. See text for further details.

and IMP_SANCT_COMPL, which is a dummy that equals one for a complete sanction on imports, and zero otherwise. In order to ease interpretation, in column (3) we also redefine the bilateral and directional trade sanction covariates from column (2) by subtracting the corresponding 'complete' variable from each of them, e.g., $EXP\_IMP\_SANCT = EXP\_IMP\_SANCT - EXP\_IMP\_SANCT\_COMPL$. Thus, the estimates of the two sets of trade sanction covariates in column (3) can be interpreted independently from each other, while the estimates on EXP_SANCT, IMP_SANCT, and EXP_IMP_SANCT capture the impact of partial sanctions.[25]

The estimates from column (3) of Table 3 reveal the following. First, we find that the impact of the complete bilateral sanctions ($EXP\_IMP\_SANCT\_COMPL$) is the strongest: It is negative, very large, and statistically significant. In quantitative terms, our estimates suggest that complete sanctions are capable of reducing about 88% of international trade between the countries involved. Second, we find that the impact of the partial bilateral sanctions is no longer statistically significant. This suggests that the significant estimate on EXP_IMP_SANCT in column (2) is driven by the presence of complete sanctions. Third, the impact of both the partial and the complete export sanctions is negative, large in economic magnitude, and statistically significant. However, as expected, the impact of complete export sanctions is stronger. In particular, it is twice as strong as compared to the impact of partial export sanctions according to our estimates. Finally, and consistent with our findings from column (2), neither the estimate of the impact of partial import sanctions nor the estimate of the impact of complete import sanctions is statistically significant.

Overall, we can summarize the main findings from Table 3 as follows. First, on average, trade sanctions are effective in impeding trade. Second, the impact of trade sanctions is

[25] Alternatively, we would have used the original variables EXP_SANCT, IMP_SANCT, and EXP_IMP_SANCT without any transformation. In that case, the estimates should still be interpreted as the effects of partial sanctions. However, the estimates on $EXP\_IMP\_SANCT\_COMPL$, EXP_SANCT_COMPL and IMP_SANCT_COMPL, should be interpreted as deviations from the corresponding average sanctions regressor (for example, the estimate on the complete import sanctions, $SANCT\_EXP\_IMP\_COMPL$, should be interpreted as a deviation from the estimate on $SANCT\_EXP\_IMP$.)

heterogeneous depending on whether they are bilateral or directional. More specifically, we find that, on average, bilateral sanctions and export sanctions are most effective in terms of their impact on trade, while for import sanctions we don't find such effects. Third, our estimates suggest that complete bilateral sanctions are effective, but this result does not hold for all other bilateral sanctions. All export sanctions (complete or otherwise) are effective; however, we do not obtain the same result for import sanctions. Finally, our results are robust to PPML specifications with standard gravity variables and with linear trends, as well as from specifications that are estimated with OLS.

4.3 Estimating the Impact of Sanctions on Iran

Our estimates in the previous section suggest that the effects of sanctions on international trade are quite heterogenous. This section reinforces this argument by analyzing the effects of sanctions against one specific country: Iran. Our motivation for this focus is twofold. First, the case of Iran is one of the most prominent and most widely discussed sanction cases in recent history, both from economic and political perspectives. Second, the sanctions on Iran are multi-dimensional because they vary in terms of country coverage (e.g., UN vs. US vs. EU sanctions), in terms of targets (e.g., on goods for military purposes vs. all goods vs. travel vs finance vs. individuals) as well as over time (e.g., first EU sanctions were imposed in 2006 and they reached a peak in terms of stringency in 2012). We exploit this multi-dimensionality to identify heterogeneous effects within the sanctions on Iran. Our results are presented in Table 4 where, as before, we use the PPML estimator, exporter-time fixed effects, importer-time fixed effects, and directional pair fixed effects. All specifications control for the presence of RTAs, trade sanctions on exports and imports, complete trade sanctions, and all other sanctions. However, for brevity, in Table 4 we only present the estimates on the sanctions on Iran and omit the estimates on all other variables (including the fixed effects).

In column (1) of Table 4 we introduce an indicator variable $SANCT\_IRAN$, which

takes a value of one for trade between Iran and any country that imposed a sanction on Iran after 2006. In order to facilitate the interpretation of our estimates, we subtracted $SANCT\_IRAN$ from all other sanction variables that we control for in column (1). Thus, the estimate on $SANCT\_IRAN$ should be interpreted independently and not as a deviation from any of the other sanctions variables. The estimates from column (1) of Table 4 reveal that, on average, the sanctions on Iran had a very strong negative impact on Iranian trade. The estimate on $SANCT\_IRAN$ is negative, large, and statistically significant at any conventional level. In terms of the volume effect, our estimate implies that, all else equal, the sanctions decreased Iranian trade with the sanctioning countries by about 55 percent $(exp(-.896) - 1) \times 100)$.

Motivated by the heterogeneous effects on the impact of export vs. import trade sanctions obtained in the previous section, in column (2) of Table 4 we separate the indicator variable for the Iran sanction into two dummies, one for Iranian exports to the sanctioning countries ($SANCT\_IRAN\_EXP$) and another for Iranian imports from the sanctioning countries ($SANCT\_IRAN\_IMP$). Two main findings stand out from the estimates in column (2) of Table 4. First, the estimates on $SANCT\_IRAN\_EXP$ and $SANCT\_IRAN\_IMP$ are both negative and statistically significant. The implication is that, on average, the sanctions on Iran have been effective in reducing its exports as well as its imports. Second, the estimates on $SANCT\_IRAN\_EXP$ and $SANCT\_IRAN\_IMP$ are not statistically different from each other. The implication is that, all else equal, the impact of the sanctions on Iran is symmetric in each direction of trade flows.

In column (3) of Table 4 we allow for directional pair-specific sanctions effects. Specifically, we isolate the effects on Iranian exports and imports with a series of individual countries and regions (e.g., the United Sates vs. the European Union). Our choice of sanctioning countries is based on the three criteria: (i) Identifying the major exporters to Iran (e.g., United Arab Emirates, Germany, China) and the main destinations for Iranian exports (e.g., Japan, China, Turkey) at the beginning of the sanctioning period; (ii) selecting countries that im-

Table 4: Estimates of the Effects of Sanctions on Iran

	(1) ALL	(2) COMPL	(3) IRAN	(4) EXPIMP
SANCT_IRAN	-0.808			
	(0.243)**			
SANCT_IRAN_EXP		-0.895	-0.602	-0.609
		(0.367)*	(0.372)	(0.368)+
SANCT_IRAN_IMP		-0.773	-0.635	-0.638
		(0.295)**	(0.256)*	(0.257)*
SANCT_IRN_USA			-4.853	-4.855
			(0.358)**	(0.353)**
SANCT_USA_IRN			-2.258	-2.262
			(0.198)**	(0.200)**
SANCT_IRN_CAN			-3.775	-3.778
			(0.352)**	(0.347)**
SANCT_CAN_IRN			-2.043	-2.045
			(0.209)**	(0.210)**
SANCT_IRN_AUS			-2.008	-2.015
			(0.355)**	(0.350)**
SANCT_AUS_IRN			-2.126	-2.128
			(0.231)**	(0.233)**
SANCT_IRN_CHE			-2.786	-2.804
			(0.352)**	(0.348)**
SANCT_CHE_IRN			-0.958	-0.968
			(0.208)**	(0.210)**
SANCT_IRN_CHN			-0.057	-0.074
			(0.349)	(0.344)
SANCT_CHN_IRN			0.203	0.192
			(0.223)	(0.225)
SANCT_IRN_TUR			-0.163	-0.170
			(0.347)	(0.342)
SANCT_TUR_IRN			-0.522	-0.532
			(0.215)*	(0.217)*
SANCT_IRN_BRA			-4.624	-4.635
			(0.348)**	(0.343)**
SANCT_BRA_IRN			-0.933	-0.933
			(0.213)**	(0.214)**
SANCT_IRN_ARE			-1.437	-1.449
			(0.354)**	(0.349)**
SANCT_ARE_IRN			0.643	0.632
			(0.222)**	(0.223)**
SANCT_IRN_RUS			-0.830	-0.840
			(0.358)*	(0.353)*
SANCT_RUS_IRN			-1.433	-1.438
			(0.225)**	(0.227)**
SANCT_IRN_IND			-0.305	-0.320
			(0.353)	(0.348)
SANCT_IND_IRN			-0.502	-0.510
			(0.207)*	(0.209)*
SANCT_IRN_ZAF			-1.484	-1.488
			(0.361)**	(0.356)**
SANCT_ZAF_IRN			-1.395	-1.399
			(0.234)**	(0.237)**
SANCT_IRN_JPN			-0.627	-0.629
			(0.352)+	(0.347)+
SANCT_JPN_IRN			-1.724	-1.717
			(0.202)**	(0.204)**
SANCT_IRN_SGP			-1.748	-1.753
			(0.350)**	(0.345)**
SANCT_SGP_IRN			-0.718	-0.717
			(0.226)**	(0.228)**
SANCT_IRN_EU			-1.366	-1.073
			(0.390)**	(0.382)**
SANCT_EU_IRN			-1.386	-0.983
			(0.211)**	(0.221)**
SANCT_IRN_EU_2011				-1.579
				(0.264)**
SANCT_EU_IRN_2011				-1.020
				(0.156)**
N	1268450	1268450	1268450	1268450

Notes: This table reports estimates of the heterogeneous effects of trade sanctions on Iran. The dependent variable is trade in levels. All estimates are obtained with the PPML estimator and exporter-time, importer-time and directional country-pair fixed effects. In addition, we control for the presence of RTAs, trade sanctions on exports and imports, complete trade sanctions, and all other sanctions. Column (1) obtains a single average estimate of the effects of the sanctions on Iran. Column (2) decomposes the impact of of the Iranian sanctions on the exports vs. imports of Iran. Column (3) further allows for differential effects across country pairs and in each direction of trade flows. Finally, column (4) captures the impact of the stricter EU sanctions on Iran post 2011. Standard errors are clustered by country pair. $^{+}$ $p < 0.10$, * $p < .05$, ** $p < .01$. See text for further details.

posed individual sanctions on Iran (e.g. USA, Canada, and Australia); (iii) isolating the impact of sanctions whose stringency changed over time (e.g., the stringency of the EU sanctions on Iran reached a peak in 2012).[26] In order to ease interpretation, we subtracted the directional pair-specific sanctions dummies from the corresponding indicators for Iranian exports to sanctioning countries and for Iranian imports from sanctioning countries. Thus, the estimates on the new sanction dummies should be interpreted independently and not as deviations from $SANCT\_IRAN\_EXP$) and ($SANCT\_IRAN\_IMP$.

Several findings stand out from the results in column (3) of Table 4. First, most of the estimates on the country-specific sanction effects are negative, statistically significant, and large in terms of magnitude. Twenty six of the twenty eight individual sanction estimates are negative and twenty three of them are statistically significant. Second, the negative effects of the sanctions on Iran are heterogeneous across countries. The estimates on the trade sanctions of US and Canada are among the largest. A possible explanation for this finding is that these countries imposed individual sanctions on Iran. Third, some of the estimates we have obtained are insignificant and/or positive. Our results suggest that, on average, the sanction on Iran was not implemented effectively by China, Turkey, and India. The estimates on the directional effects on the sanctions on trade between China and Iran are not statistically significant, while only the impact of the sanction on Turkey's and India's exports to Iran is significant, and marginally so. The explanation for the insignificant estimates of the impact of the sanction on Iran for trade with China and Turkey is that these countries were given a sanction waiver. The single positive and significant estimate we obtain here is on exports from the United Arab Emirates to Iran. This result suggests the presence of 'trade creation' effects and reinforces the claims that the United Arab Emirates could have

[26]The countries that are included individually in our estimations based on the three criteria noted above account for more than 83% of Iranian trade with sanctioning countries at the beginning of the sanctioning period. In principle, our methods allow us to identify the impact of the sanctions on Iran separately for each possible sanctioning country in our sample. It is also possible to identify the extraterritorial impact of the sanctions on Iran on third countries. We experimented with such specifications and found that they do not affect our main partial estimates and general equilibrium results significantly. A possible explanation is that, due to the imposition of the UN sanctions on Iran, almost all countries in our sample are technically involved in the sanction. Therefore, for brevity, we only focus on the selected countries for our main analysis.

indeed played a role in evading Iran's sanctions. Fourth, we observe significant asymmetries between the impact of the sanctions on exports vs. imports within country pairs. In most cases, our estimates of the sanction effect on Iranian exports are larger (e.g., for exports to US, to Switzerland, and to Canada), but in some cases the impact of the sanction on Iranian imports is larger (e.g., for imports from Russia and from Japan).

The estimates from column (4) of Table 4 allow for additional (presumably stronger) effects of the sanctions on the European Union on Iran. The motivation for this specification is that the EU sanctions reached a peak in 2012 with the imposition of a series of new provisions and additional sanctions on Iran. To capture these effects we introduce two new indicator variables for the EU sanctions on Iranian exports to EU post 2011 ($SANCT\_IRN\_EU\_2012$) and for the EU sanctions on Iranian imports from EU post 2011 ($SANCT\_EU\_IRN\_2012$). Since the new variables are not subtracted from the original dummies for the EU sanctions, the estimates on $SANCT\_IRN\_EU\_2012$ and $SANCT\_EU\_IRN\_2012$ should be interpreted as deviations from $SANCT\_EU\_IRN$ and $SANCT\_IRN\_EU$. Consistent with our expectations, the estimates from column (4) of Table 4 indicate that the impact of the EU sanctions on Iran more than doubled during the period post-2011.

We draw four main conclusions on the basis of our analysis in this section. First, our results demonstrate that the impact of sanctions is quite heterogeneous across sanctions (e.g., the sanction on Iran vs. all other trade sanctions). Second, we find that the effects of sanctions vary across country-pairs within sanctions (e.g., USA-Iran vs. China-Iran). Third, our estimates reveal that the impact of sanctions vary within pairs depending on the direction of trade flows (e.g., Turkey-Iran vs. Iran-Turkey). Finally, we obtain mostly negative and significant estimates of the impact of country-specific sanctions. However, we also obtain some estimates that are not statistically significant (e.g., Turkey-Iran and China-Iran), reflecting sanctions waivers, and even some positive estimates (e.g., United Arab Emirates-Iran), reflecting possible sanction evasion.

4.4 On the General Equilibrium Effects of the Sanctions on Iran

We conclude by quantifying the general equilibrium effects of the sanctions on Iran on trade, real GDP, and sectoral value added. To this end, we rely on the gravity framework of Aichele and Heiland (2016) who calibrate the multi-sector model with intermediate goods of Caliendo and Parro (2015) for 130 countries and 57 sectors using the GTAP data.[27] The baseline year for the analysis is 2014 and the counterfactual experiment employs our pair-and-direction-specific estimates from the previous section to simulate a hypothetical world in the absence of the sanctions on Iran. Since our empirical estimates relate only to the goods market and do not vary across sectors, in the counterfactual simulations, we assume a uniform shock on trade costs for all goods sectors and a uniform trade elasticity of 3.5 (the average value across sectors from Aichele and Heiland, 2016). The sectoral trade cost shocks relate the counterfactual level of iceberg trade costs $\tau_{i,j}^{'}$ to their baseline levels $\tau_{i,j}$ such that $\hat{\tau}_{i,j} \equiv \tau_{i,j}^{'}/\tau_{i,j}$.[28]

First we describe the effects on bilateral trade. The estimates in Table 5 are constructed as the ratio of counterfactual to baseline expenditure shares $\hat{\pi}_{i,j} \equiv \pi_{i,j}^{\prime}/\pi_{i,j}$.

For brevity and clarity of exposition, we focus on four countries: Iran, Germany, USA and China. For $i = j = \{IRN\}$, $\pi_{IRN,IRN} = 63.8$ and $\pi_{IRN,IRN}^{\prime} = 68.1$, implying $\hat{\pi}_{IRN,IRN} = 0.94$, which means that undoing the sanctions makes the country substantially more open to international trade. The share of German expenditure that falls on Iranian goods would go up from 0.01 to 0.19 percent, so that $\hat{\pi} = 27$, whereas the share of US expenditure falling on Iranian goods would increase from virtually zero to 0.06 percent, an increase by a factor of 176. These trade changes are dramatic, but the new levels of trade are still very low.

[27] The model assumes perfect competition. Trade is Ricardian in the sense that countries purchase only the cheapest available variety of each good. A key feature of the model is the intersectoral linkages, both intra- and internationally. Production requires labor and a composite of inputs drawn from other sectors. Wages are equalized across sectors so that sectoral variation results only from reallocation effects. While the values of imports and exports need not coincide at the country level, the trade balance normalized by GDP is assumed constant. See Aichele and Heiland (2016) and Caliendo and Parro (2015) for additional details.

[28] For the pairs involving Iran, the average trade cost shock is 0.84; that is, in the counterfactual, trade costs are 16 percent lower than in the baseline. The median is 0.79, the minimum of 0.24 is for US imports from Iran; the maximum of 1.22 is for Iranian imports from the United Arab Emirates.

Table 5: Counterfactual Analysis: Trade Effects (% of Baseline)

Exporter	Importer	π'	π	π'/π
IRN	CHN	0.16	0.38	0.42
IRN	DEU	0.19	0.01	26.89
IRN	USA	0.06	0.00	165.71
IRN	IRN	63.84	68.05	0.94
DEU	CHN	0.21	0.21	1.00
DEU	IRN	0.71	0.08	8.64
DEU	USA	0.28	0.28	1.00
DEU	DEU	50.41	50.51	1.00
USA	CHN	1.03	1.03	1.00
USA	DEU	1.54	1.56	0.99
USA	IRN	0.81	0.03	28.75
USA	USA	67.57	67.73	1.00
CHN	DEU	1.94	1.94	1.00
CHN	IRN	3.61	4.79	0.75
CHN	USA	2.29	2.29	1.00
CHN	CHN	72.51	72.45	1.00

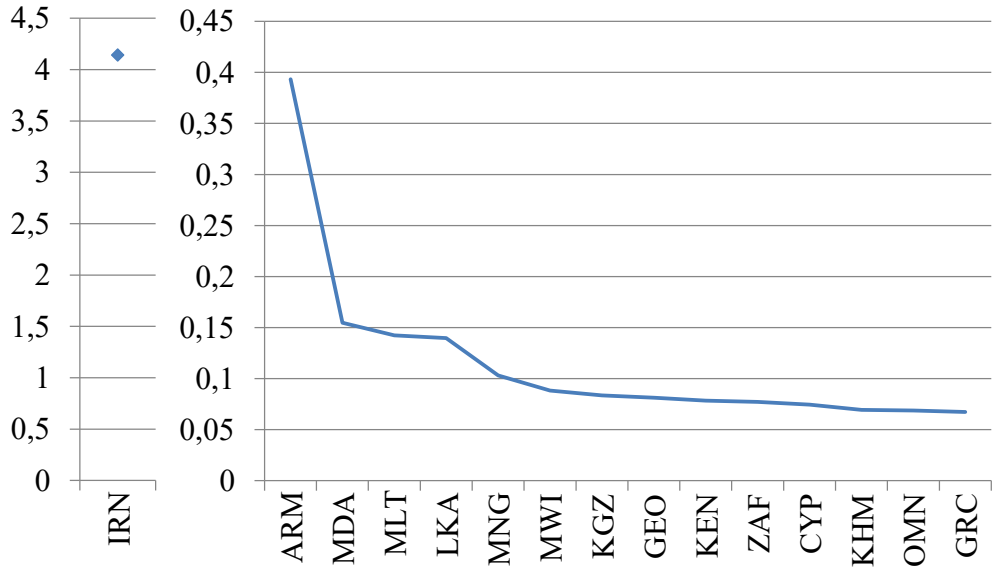
Notes: This table reports the results of counterfactual simulations. π'/π relates counterfactual (no sanctions) to baseline (sanctions) equilibrium.

Similarly, Iran's expenditure on German and US products goes up as well, by a factor of 9 and by a factor of 29, respectively. The share of Iran's spending on Chinese goods goes down from 4.8 to 3.6 percent, reflecting the reduction in trade diversion due to sanctions. This loss of trade is even more pronounced for Chinese spending on Iranian goods, where the expenditure share falls from 0.38 to 0.16 percent. For country pairs not directly affected by sanctions, such as USA-Germany or Germany-China, expenditure shares do not change significantly.

Next, we turn to the effects of undoing sanctions on real income, our welfare measure. The results are visualized in Figure 7. The biggest winner of terminating sanctions, not surprisingly, is Iran. It's real per capita income is predicted to rise by about 4.2 percent. This might seem small; but the overall gains from trade in this quantitative model are usually estimated to be rather small; see Costinot and Rodriguez-Clare (2015). So, it may not be overly surprising that the termination of sanctions does not imply higher gains for Iran. Also note that services sectors are affected only indirectly, as demand for their output in manufacturing sectors may fall. Moreover, the sanctions have led to considerable trade diversion, especially to China, so that Iran's overall openness has not been reduced by much either. The country with the next largest welfare gain from the removal of the sanctions on Iran is Armenia, a neighboring country to Iran. This is intuitive, since Armenia has difficult political and economic relations with its other neighbors such as Azerbaidjan and Turkey. So, it relies overproportionately on trade with Iran, and lower income in Iran worsens Armenia's terms of trade.

Amongst the 15 countries most positively affected form the removal of the Iran sanction, are small nations such as Malta, Cyprus and Greece, which provide shipping services to Iran's oil industry, and other geographically close countries such Georgia or the centralasian countries Mongolia and Kyrgyzstan. Gains for third countries are typically small: they lie between about 0.4 percent for Armenia and 0.07 percent for Greece. The Western initiators of the sanctions against Iran and the UN Security Council members, such as the USA,

Figure 7: Counterfactual Analysis: Welfare Effects (% of baseline)



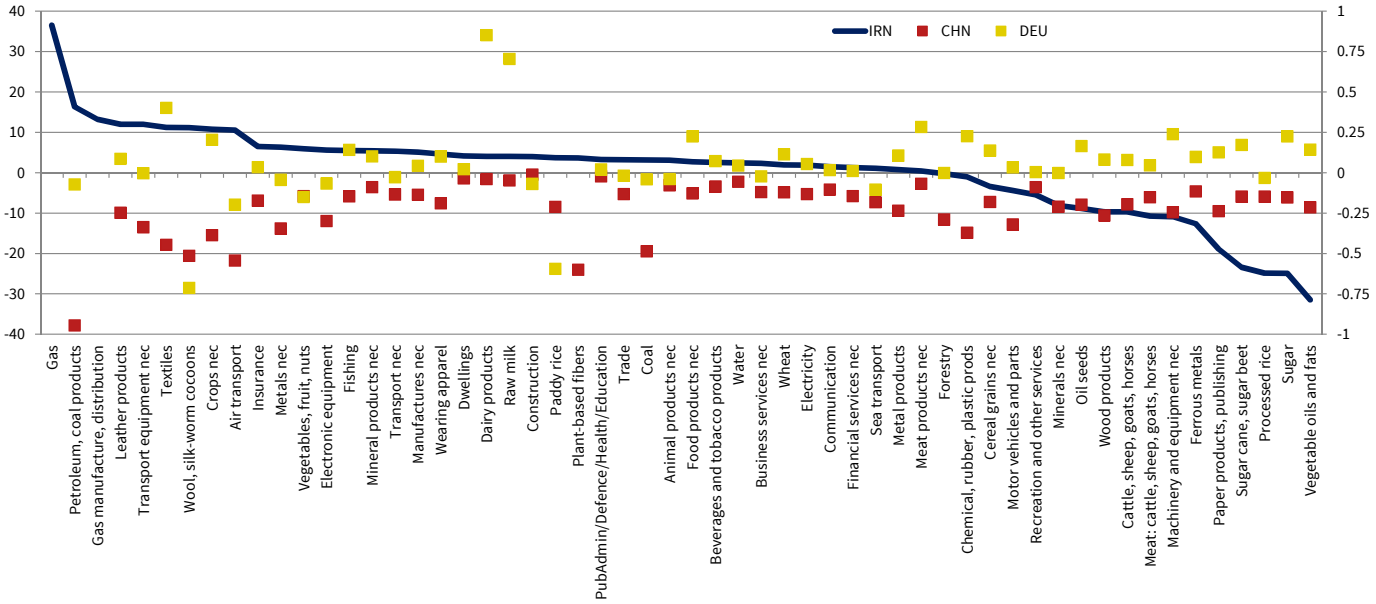
Note: Percent changes in real per capita income resulting from an end of sanctions against Iran. Only countries with largest effects are shown: Iran (IRN), Armenia (ARM), Moldova (MDA), Malta (MLT), Sri Lanka (LKA), Mongolia (MNG), Malawi (MWI), Kyrgisistan (KGZ), Georgia (GEO), Kenia (KEN), South Africa (ZAF), Cyprus (CYP), Camboidua (KHM), Oman (OMN), Greece (GRC).

France, and Great Britain, are barely affected; gains from undoing the sanctions lie below 0.03 percent of GDP; the UK is even predicted to lose a tiny amount. In contrast, the normalization of trade relationships between these countries and Iran hurts those who have benefitted from trade diversion. The largest losses are predicted to occur in Korea, Panama and the Ukraine. Oil producing countries also tend to lose from undoing the sanctions as the additional supply of Iranian oil drives down the world price of oil.

Finally, we briefly turn to the effects on sectoral value added, which appear in Figure 8. Even though, by design, the trade cost shocks are uniform across sectors, the sectoral structure of comparative advantage of Iran and its trading partners implies a rich pattern of changes in their terms of trade which, in turn, affect sectoral value added.

Not surprisingly, the model predicts that an end to the sanctions would benefit Iran's oil and gas sectors most strongly. Value added would rise most in this area, reaching almost 40 percent in the gas sector, where substitution effects in the face of sanctions are difficult due to a rigid system of pipelines.

Figure 8: Counterfactual Analysis: Sectoral Value Added Effects (% of baseline)



Note: Percent changes in sectoral value added resulting from an end of sanctions against Iran in Iran (IRN), China (CHN), and Germany (DEU).

Sizable gains also occur in Iran's leather, textile, and transportation sectors. In the former two, the country enjoys a comparative advantage relative to its trade partners; in the latter, the effects are driven by additional demand for transportation services as trade picks up. Some positive effects are predicted in agri-food, in particular in nuts production. Iran is an important producer of almonds. But those gains lie below 10 percent. In contrast, losses are concentrated in comparative disadvantage sectors. Again, the impact on agri-food looms large. Arid Iran is a net importer of vegetables, sugar and rice, so that ending the sanctions drives up imports even more in these sectors leading to their shrinkage. For many services sectors, which are not directly affected by sanctions as modeled in our exercise, value added effects are very close to zero. The transportation sector mentioned above is an interesting exception. Sectoral value-added effects are smaller by almost two orders of magnitude in the US, China or Germany. They do not exhibit any clear sectoral pattern, but they tend to be positive for Germany and negative for China, reflecting trade creation and trade diversion, respectively.

5 Conclusion

Through their imposition of various restrictions on trade, financial transactions and travel, sanctioning countries aim to induce sanctioned countries to comply with policy requests by raising the economic costs of noncompliance. According to this logic, the effectiveness of sanctions policies crucially depends on the strength of their adverse effects on sanctioned countries.

This study illustrates that sanctions policies can be effective in the sense that they significantly reduce trade with the target. The impact of trade sanctions turns out to be heterogeneous depending on whether they are bilateral or directional (on imports and on exports). Complete bilateral trade sanctions are effective. In fact, the empirical analysis indicates that these are the most effective sanctions. All else equal, on average complete bilateral sanctions have the potential to reduce trade among participants by 85% to 86%.

The specific sanctions on Iran we have analyzed in this study, however, illustrate that their effects on bilateral trade differ significantly across countries. The point is that countries differ significantly regarding their initial levels of trade with Iran. Our analysis illustrates that Germany has suffered the biggest export losses to Iran since the introduction of the restrictive Iran sanctions in 2006. In particular, the cooperative ban on trade in oil resulted in a strong drop in bilateral trade with Iran. At the same time trade losses for the US turn out to be significantly lower in absolute terms. These differences in economic relations between important powers like EU countries and US have implications for the policy objectives standing behind the sanctions policies. Given these differing economic interests between various countries, it is no surprise that the assessment of whether the Iran sanctions have been successful or not, also differs. While the EU considers the Iran deal that followed the sanctions as a major success, the US administration has started to increase pressure on Iran to renegotiate the conditions for removing the sanctions. In light of the extensive heterogeneity in economic interests, it is not obvious how countries can resolve their differences.

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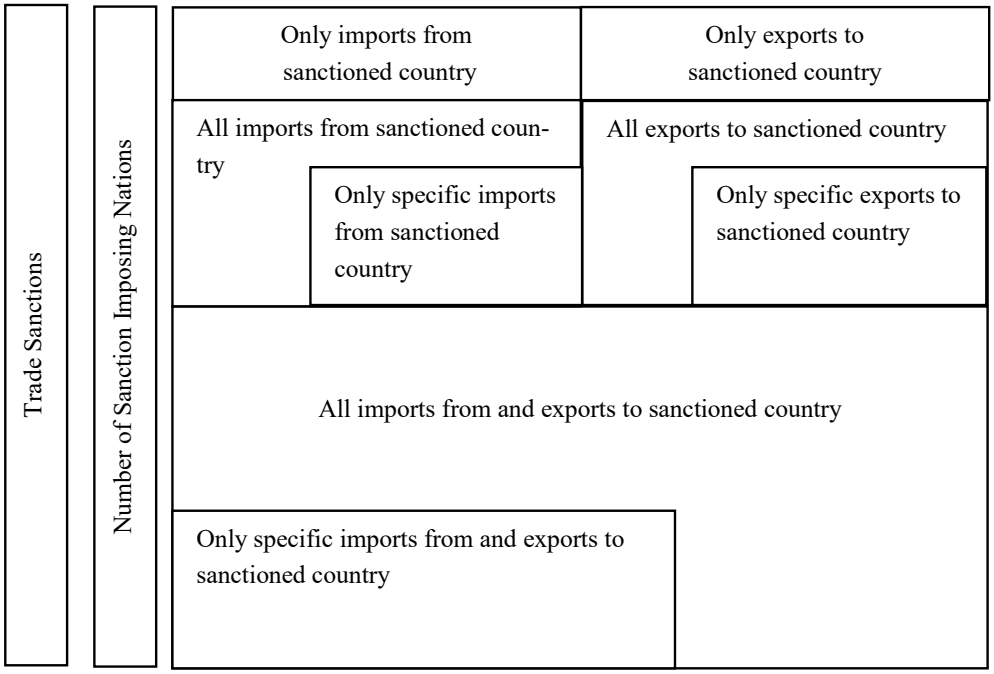
Appendix

Figure 9: Possible structure of trade sanctions



Note: This figure illustrates the different dimensions of trade sanctions accounted for in the Global Sanctions Data Base. Trade sanctions can restrict only exports or imports from specific countries; or both exports and imports are restricted. Moreover, the GSDB distinguishes between sanctions on exports from the sender to the target, sanctions on imports from the target to the sender, and sanctions that simultaneously apply to both the exports and the imports between the two sides (sender and target country). Trade sanctions sometimes apply only to specific goods (partial trade sanctions) or to exports and/or imports as a whole (complete trade sanctions).

Classification of regions based on UN geoscheme

Africa: Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Cote d'Ivoire, DR Congo, Djibouti, Egypt, Eritrea, Ethiopia, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte, Morocco, Mozambique, Namibia, Niger, Nigeria, Reunion, Republic Congo, Rwanda, Saint Helena, Ascension and Tristan da Cunha, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Sudan, South Africa, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Western Sahara, Zambia, Zimbabwe.

Northern America: Bermuda, Canada, Greenland, Saint Pierre and Miquelon, United States of America.

Central America: Belize, Costa Rica, Clipperton Island, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Caribbean Anguilla, Antigua and Bermuda, Aruba,

Bahamas ,Barbados, Bonaire, Sint Eustatius and Saba, British Virgin Islands, Cayman Islands, Cuba, Curacao, Dominica, Dominican Republic, Grenada, Guadeloupe, Haiti, Jamaica, Marinique, Montserrat, Navassa Island, Puerto Rico, Saint-Barthelemy, Saint Kitts and Nevis, Saint Lucia, Saint Martin, Saint Vincent and the Grenadines, Sint Maarten, Trinidad and Tobago, Turks and Caicos Islands, United States Virgin Islands.

Southern America: Argentina, Bolivia, Bouvet Island, Brazil, Chile, Colombia, Ecuador, Falkland Islands, French Guiana, Guayana, Paraguay, Peru, Suriname, Uruguay, Venezuela.

Northwestern Europe: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Germany, Estonia, Faroe Island, Finland, France, Germany (Federal Republic), Guernsey, Hungary, Iceland, Isle of Man, Jersey, Latvia, Lichtenstein, Lithuania, Luxembourg, Monaco, Netherlands, Norway, Poland, Republic of Ireland, Romania, Slovakia, Sweden, Switzerland, United Kingdom.

Southern Europe: Albania, Andorra, Bosnia and Herzegovina, Croatia, Gibraltar, Greece, Italy, Republic of Macedonia, Malta, Montenegro, Portugal, San Marino, Serbia, Kosovo, Slovenia, Spain, Vatican.
Eastern Europe: Belarus, Republic of Moldova, Russian Federation, Ukraine.

Western Asia: Armenia, Azerbaijan, Bahrain, Cyprus, Georgia, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, State of Palestine, Syria, Turkey, United Arab Emirates, Yemen.

Central Asia: Kazakhstan, Kyrgystan, Tajikistan, Turkmenistan, Uzbekistan.

Southern Asia: Afghanistan, Bangladesh, Bhutan, India, Iran, Maldives, Nepal, Pakistan, Sri Lanka.

Southeastern Asia: Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, Vietnam.

Eastern Asia: China, Taiwan, Hong Kong, Japan, Macau, Mongolia, DPR Korea, Republic of Korea.

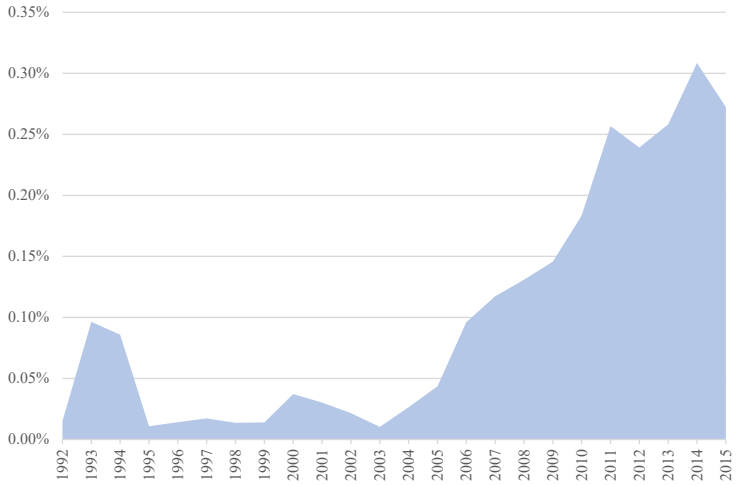
Oceania, Australia: Christmas Island, Cocos (Keeling) Island, New Zealand, Norfolk Island, Fiji, New Caledonia, Papua New Guinea, Solomon Islands, Vanuatu, Guam, Kiribati, Marshall Islands, Micronesia, Nauru, Northern Mariana Islands, Palau, American Samoa, Cook Islands, French Polynesia, Niue, Pitcairn Islands, Samoa, Tokelau, Tonga, Tuvalu, Wallis and Futuna.

Figure 10: Number of Countries by Sanction Type

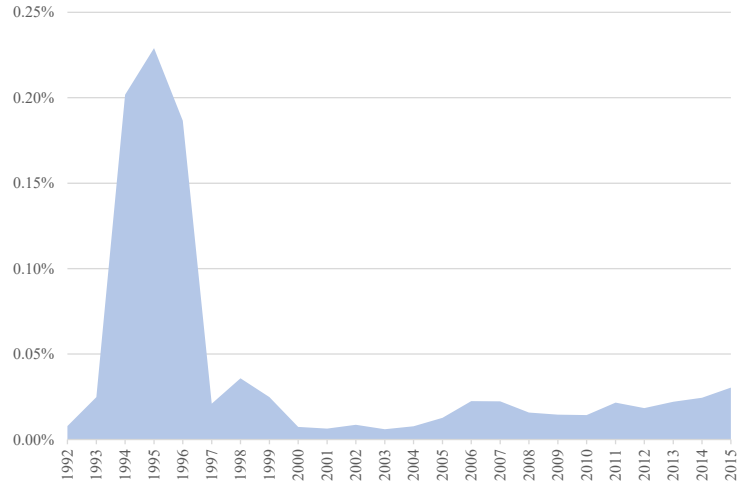
Year	Trade Sanctions	Arms Sanctions	Military Assistance Sanctions	Financial Sanctions	Travel Sanctions	Other Sanctions
1950	11	0	0	1	1	0
1955	14	1	0	3	3	2
1960	16	3	2	6	2	3
1965	19	3	2	12	3	3
1970	17	6	2	9	2	4
1975	19	4	3	12	2	3
1980	23	7	12	35	3	5
1985	23	6	6	31	4	5
1990	27	13	16	35	5	8
1995	24	24	19	43	13	13
2000	17	36	20	37	11	9
2005	13	32	13	39	16	9
2010	17	31	16	41	22	13
2015	22	41	24	52	26	10

Figure 11: Trade Exposure to Sanctions Continued

A. Share of World Trade Exposed to Chinese Sanctions



B. Share of World Trade Exposed to Russian Sanctions



C. Share of World Trade Exposed to Japanese Sanctions