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Do China and Russia undermine Western sanctions? Evidence from DiD and event study estimation

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Abstract

Motivated by the claim that China and Russia purposefully and systematically undermine Western sanction efforts, we study the effects of US and EU sanctions on trade flows between sanctioned and third countries during the period 2002–2019. We find no evidence of systematic sanction busting by Russia. For China, our results are more ambiguous. While we do not find robust evidence for an increase in overall trade between China and countries targeted by Western sanctions, trade in (raw) materials and critical goods increases notably.

KEYWORDS

geopolitics, international political economy, international sanctions, trade substitution

JEL CLASSIFICATION

F13, F14, F50, F51, F52, F53, K33

1 | INTRODUCTION

With the rise of globalization in the post-Cold War era, international sanctions have become one of the most important instruments of international politics. Due to their coercive character, sanctions can address externalities in international relations that cannot be internalized via contracts or only at very high transaction costs (Aidt et al., 2021; Eaton & Engers, 1992). At the same time,

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international sanctions are a more measured response to international political disagreements than the use of military force.

The public debate on this contentious policy tool is characterized by disagreement regarding its effectiveness, its side effects, and its legal proportionality. On the one hand, it is argued that sanctions are often ineffective in achieving aspired policy changes and that this is, among other things, because sanction-busting political superpowers and opportunists undermine international sanctions for both economic and political reasons (Early, 2015; Levy, 1999). On the other hand, the empirical literature shows significant economic effects of sanctions on target economies. For example, sanctions are found to decrease economic growth, private investment, and trade (Biglaiser & Lektzian, 2020; Draca et al., 2023; Ghomi, 2022; Gutmann et al., 2023; Hatipoglu & Peksen, 2018; Mirkina, 2018; Moteng et al., 2023; Neuenkirch & Neumeier, 2015; 2016; Peksen & Son, 2015). There is also evidence of dramatic side effects in terms of harm to the health and life expectancy of the target countries' population (Allen & Lektzian, 2013; Gutmann et al., 2021) and the policy response of the targeted regime, which may use repression to hold on to power (Adam & Tsarsitalidou, 2019; Gutmann et al., 2020; Lee et al., 2023; Marinov, 2005; Peksen & Drury, 2009; Wood, 2008). While it is possible that sanctions are undermined and still cause significant harm to the target country, they cannot be both powerful and without teeth. This motivates us to ask whether competing superpowers do indeed systematically undermine Western sanctions by increasing their trade with targets of US or EU-imposed sanctions.

To answer this question, we conduct a panel data analysis of the effects of Western sanctions on trade flows of 187 countries in the period 2002–2019. We complement standard panel difference-in-differences estimations with an event study design that ensures a causal interpretation of our results. Combining information from the Global Sanctions Database and UN Comtrade data, we analyze the effects of Western sanctions on target countries' total exports and imports as well as on their trade with (i) the US, (ii) the EU, (iii) Brazil, (iv) Russia, (v) India, (vi) China, (vii) South Africa, and (viii) the “rest of the world.” We separately analyze sanctions imposed by different senders, different types of sanctions, and trade in different types of commodities. First, we evaluate the effects of (i) US or EU unilateral sanctions and (ii) joint sanctions by the US and the EU, while controlling for (iii) sanctions enacted by the United Nations Security Council (UNSC). Second, we study the effects of (US or EU) export sanctions and (US or EU) import sanctions on the exports and imports of target countries. Third, we analyze the effects of sanctions on trade flows in five major categories of commodities: (i) agricultural products, (ii) (raw) materials, (iii) machines, (iv) critical goods, such as explosives, arms, and nuclear-related items, and (v) other goods.

Our results indicate no systematic sanction busting by Russia. This result holds when studying different groups of commodities and when analyzing the effect on the quantity (instead of the value) of traded goods. Similar results can be found for the regional powers Brazil, India, and South Africa. For China, however, we find some indication of sanction-busting behavior. While we do not find robust evidence for an increase in overall trade between China and countries targeted by Western sanctions, trade in (raw) materials and critical goods increases notably.

Further results indicate that the effect of Western sanctions on exports from the sanctioned countries is more persistent than the effect on imports to these countries. We find some evidence of a reduction in industrial value added and a depreciation (or devaluation) of the domestic currency as potential transmission channels through which Western sanctions affect trade. Finally, our findings can be interpreted as causal in the sense that they appear to meet the assumptions of a DiD analysis: we do not observe a change in trade flows in the years before the imposition of sanctions, indicating that changes during sanction episodes are a significant deviation from

the pre-trend. Our analysis adds to the growing empirical evidence that sanctions have important adverse effects on a country's economy and society and it provides some novel insights into the prevalence of sanction-busting behavior by superpowers and other regional powers (see also the literature review in Section 2).

The remainder of this article is structured as follows. Section 2 provides some theoretical considerations regarding the effects of economic sanctions and links them to existing empirical studies, thereby clarifying our contribution to the literature. Section 3 describes our empirical approach and the data employed in our empirical analysis. In Section 4, we present our empirical results on overall trade, trade in different categories of commodities, and two potential transmission channels through which sanctions could affect trade volumes. Section 5 concludes.

2 | THEORETICAL CONSIDERATIONS AND STATE OF THE LITERATURE

International sanctions are used to achieve various goals. They are central to enforcing international law (Garoupa & Gata, 2002; Posner & Sykes, 2013). Examples include the sanctions imposed on Iraq after its 1990 invasion of Kuwait or sanctions against Russia after its invasion of Ukraine in 2022. Sanctions can also serve national political interests, which is the motive behind the China-US trade war and US sanctions against the Nord Stream 2 gas pipeline project between Germany and Russia (Fajgelbaum & Khandelwal, 2022; Yang et al., 2004). The imposition or design of sanctions may also be a result of lobbying efforts of economic special interests (Halcoussis et al., 2021; Kaempfer & Lowenberg, 1986; 1988; McLean & Whang, 2014; Pond, 2017). European Union sanctions against Russia after its illegal annexation of Crimea in 2014, for example, were weak due to lobbying efforts of American and European producers. At the same time, Russian counter-sanctions were designed to serve the interests of Russian producers at the expense of domestic consumers (Bělin & Hanousek, 2021a; 2021b; Kholodilin & Netšunajev, 2019).

Economic sanctions serve to block target countries' access to capital, resources, goods, services, and technology. They have the potential to substantially weaken the target's economy and harm its political regime. But sanctions' effects are not limited to target countries. They produce both positive and negative spillovers into other countries and provide opportunities for politically motivated interventions. Harm to the target economy spills over into other countries via reduced demand for production inputs and intermediate products and increased production prices (Hatipoglu et al., 2023). At the same time, sanctions create business opportunities for sanction busters (Early, 2015).¹ For example, sanctions limiting oil imports from Russia to the EU after its invasion of Ukraine have allowed China to buy Russian oil at a dramatic discount, while Chinese car prices in Russia increased by up to 50% (see Haidar, 2016; 2017, for corresponding evidence based on sanctions against Iran). In other words, depending on the trade relationship between two countries T and O and the type of sanctions adopted against T , trade between T and O could be either incentivized or discouraged. To change this balance in favor of discouraging trade between target states and other countries, secondary sanctions and extraterritorial effects of sanctions are used to widen the scope of economic actors who are bound to comply with sanctions (Kwon et al., 2022). US sanctions, for example, extend automatically to all parties subject to US jurisdiction, independent of their location. This includes all firms that do business or have a branch/subsidiary in the US. Also affected are foreign entities that process payments in USD through a US bank. Sanctions imposed by the Biden administration in the Fall of 2022 to cripple China's semiconductor

industry, for example, have banned all US citizens and residents from servicing Chinese customers with the relevant technologies.

Aside from pure economic incentives to engage in or avoid trade with sanctioned states, political motives may exist for sanction busting. It has, for example, been speculated that China would intentionally undermine EU and US sanctions against Russia in order to weaken these sender countries and to gain political influence on Russia (Allen, 2022). Only two weeks after the invasion of Ukraine, the Wall Street Journal claimed that “China opposes sanctions and has a reputation for busting them” (Areddy, 2022). Two weeks before the invasion, The Hill even published the opinion that “China is making sanctions on Russia irrelevant” (Chang, 2022). China and Russia have been suspected in the past of systematically undermining US sanctions against countries such as Cuba, North Korea, Syria, and Venezuela. Both countries have themselves been the target of Western sanctions before (Bělin & Hanousek, 2021b; Crozet & Hinz, 2020; Yang et al., 2004; 2009). In this article, we are interested in identifying the extent to which China and Russia undermine Western sanction efforts.

Much of the empirical literature has so far focused on the direct negative trade effects of sanctions on target countries without decomposing these altered trade flows according to potential trade partners’ economic and political ambitions (Afesorgbor, 2019; Caruso, 2003; Dai et al., 2021; Du & Wang, 2022; Felbermayr et al., 2021; Felbermayr, Kirilakha, et al., 2020; Felbermayr, Syropoulos, et al., 2020; Kirikakha et al., 2021; Peterson, 2021). There is also literature on how individual firms adjust their trade in response to sanctions (Crozet et al., 2021; Crozet & Hinz, 2020; Gullstrand, 2020; Haidar, 2016; 2017). Some recent studies have focused on the question of whether sanctions also affect economic relations with third countries (Baronchelli et al., 2022; Bove et al., 2023; Hatipoglu et al., 2023).

Most relevant to our research question is the empirical literature on sanction busting (see Early, 2015). In this literature, sanction busters are identified based on a significant increase in trade with the target state following the imposition of sanctions and studies try to explain which countries become sanction busters and whether they influence the success of sanctions (Early, 2009; 2011). Early (2012) shows that members of defense alliances are likely to bust sanctions to support other members of the alliance, especially if commercial benefits are high. Early and Peterson (2022) study US trade with targets of US sanctions and find that trade decreases after the US Department of Treasury’s Office of Foreign Asset Control penalizes US or foreign sanction violators.

So far, there are no empirical studies that systematically analyze how other economic and political superpowers, specifically China and Russia, adjust their trade relationships with targets of US or EU sanctions. This is important to understand, as the expectation of sanction busting by China or Russia is frequently used as an argument against the effectiveness (and thus against the application) of Western sanctions—seemingly without any systematic empirical evidence to support the claim. We are providing this systematic empirical evidence based on a large panel dataset and state-of-the-art research designs.

From the formulated considerations, we can derive two opposing theoretical expectations. On the one hand, Western sanctions might lead to increased trade between other major powers and the targeted state. This is consistent with their economic incentives and geopolitical ambitions but runs the risk that sanction-busting firms themselves may become subject to Western sanctions. On the other hand, the empirical literature stresses the dramatic adverse economic and political effects of sanctions on their targets. This observation would be more consistent with the other major powers not successfully undermining Western sanctions. Moreover, if the target economy is harmed to such an extent that firms demand fewer production inputs and consumers can afford

fewer consumption goods, third countries might even reduce trade flows with targets of Western sanctions despite other political or economic ambitions.

3 | ESTIMATION APPROACH AND DATA

3.1 | Estimation approach

Identifying the causal effect of US and EU sanctions on trade volumes is challenging (Felbermayr et al., 2021). Western sanctions are typically imposed on countries that are characterized by unstable political and social conditions in the first place (Gutmann et al., 2021; Jing et al., 2003). This implies that countries subject to sanctions could have exhibited a poor economic performance and reduced trade, even if sanctions had not been imposed. Our empirical strategy to tackle the issue of identification combines two elements.

First, we estimate a standard *panel difference-in-differences* model using the following specification:²

$$y_{i,t} = \exp \left[\sum_{s=1}^k \beta_{\text{sanc}}^s D_{\text{sanc},i,t}^s + \gamma X_{i,t} + \alpha_i + \tau_t \right] \times \epsilon_{i,t}. \quad (1)$$

Our unit of analysis is the country-year. The dependent variable $y_{i,t}$ is one of our trade indicators of interest, measured as trade flows between country i in year t and a country (group) of interest: the global aggregate, the US, the EU, Brazil, Russia, India, China, South Africa, or the rest of the world. $X_{i,t}$ is a vector of economic and political control variables, α_i and τ_t are country- and year-fixed effects, and $\epsilon_{i,t}$ is the error term. All variables are described in Section 3.2 below.

Depending on the model specification, we employ two alternative sets of dummies $D_{\text{sanc},i,t}^s$. In the first specification, we estimate the average annual treatment effect for different *sanction senders*. We employ binary variables that take the value 1 in each year in which country i is subject to (i) US or EU unilateral sanctions, (ii) joint sanctions by the US and the EU, and (iii) UN sanctions. These categories are disjunctive, that is, categories (i) and (ii) do not include sanction episodes enacted by the UNSC.³

In the second specification, we look specifically into *US and EU trade sanctions*. We include a dummy variable for US or EU export (/import) sanctions when we study exports (/imports) and control for US or EU non-export (/non-import) sanctions as well as UN sanctions. From a theoretical point of view, trade sanctions have the most immediate effect on trade flows and could be countered by trade substitution. Due to the presence of a significant number of zero trade flows in the data, Equation (1) is estimated using Poisson-pseudo maximum likelihood (PPML) techniques. Standard errors are clustered at the country level.

As the second element of our identification strategy, we estimate *event study* models to test whether countries subject to sanctions follow the same trend before the imposition of sanctions as non-sanctioned countries (Dai et al., 2021; Gutmann et al., 2023; Schmidheiny & Sieglösch, 2023). This design captures trends up to three years before and after each sanction episode and compares them to non-sanctioned countries. Thereby, we can test whether trade flows are already on a (downward) trajectory before the imposition of sanctions, which allows us to disentangle the treatment effect of sanctions from the selection effect into sanctions.⁴ An additional value added of the event study design is that we can study the development of the treatment effect over

the course of a sanction episode, rather than estimating only the average treatment effect. The specification of our event studies looks as follows:

$$y_{i,t} = \exp \left[\sum_{j=1}^3 \beta_{\text{pre},-j} D_{\text{pre},i,t-j} + \sum_{j=1}^{9+} \beta_{\text{sanc},j} D_{\text{sanc},i,tj} + \sum_{j=1}^3 \beta_{\text{post},+j} D_{\text{post},i,t+j} + \sum_{s=1}^k \beta_{\text{sanc}}^s D_{\text{sanc},i,t}^{\text{oth}} + \gamma X_{i,t} + \alpha_i + \tau_t \right] \times \epsilon_{i,t}, \quad (2)$$

$y_{i,t}$, $X_{i,t}$, α_i , τ_t , and $\epsilon_{i,t}$ are defined as in Equation (1). Our event study indicators $D_{\text{sanc},i,tj}$ are dummy variables that equal 1 if a specific sanction episode targeting country i was in place for the j th (consecutive) year. We include individual dummies for each of the first 8 years in which a country was subject to US or EU export (/import) sanctions within an episode ($t1$ to $t8$) and we summarize the average effect of sanctions after 8 years in one dummy variable ($t9+$), as longer sanctions are rare.⁵ $D_{\text{pre},t-j}$ and $D_{\text{post},t+j}$ are six dummy variables that identify one of the three years before or after a sanction episode. Their inclusion allows us to assess the economic condition in a sanctioned country before sanctions become effective and after they have been lifted. We control for US or EU non-export (/non-import) sanctions and UN sanctions, summarized as $D_{\text{sanc},i,t}^{\text{oth}}$.

To summarize the rationale of our research design: the panel difference-in-differences model serves as a baseline specification and allows us to estimate the average annual treatment effects of sanctions for different senders, trade partners, and categories of traded goods. The event study approach allows us to zoom in on the treatment effect pattern over time and to further validate our identification strategy by testing for a common trend before the imposition of sanctions.

3.2 | Data and descriptive statistics

We employ a number of dependent variables ($y_{i,t}$) for differently delineated trade flows. These include the target country's value of exports to and imports from the world, the US, the EU, Brazil, Russia, India, China, South Africa, and the rest of the world. Our analysis aims at uncovering potential trade substitution patterns. As outlined in Section 2, one might, for instance, expect that China and Russia substitute exports to or imports from the US when a third country is subject to Western sanctions. To study this substitution behavior in more detail, we split all exports and imports into five groups of commodities based on their Harmonized System (HS) 2 codes: (i) agricultural products, (ii) (raw) materials, (iii) machines, (iv) critical goods, such as explosives, arms, and nuclear-related items, and (v) all other goods.

Distinguishing more homogeneous groups of goods is also helpful when studying the effects of sanctions on the quantity of traded goods. The value of exports to a country could, for example, remain constant while the traded quantity increases, as the sanctioned country has to offer a price discount. This would also be indicative of sanction-busting behavior. An aggregation of quantities (measured in metric tons) across all types of goods is problematic. Within a group of commodities, the distribution of weights should be less heterogeneous and aggregation thus more reasonable, providing more meaningful estimates of the prevalence of sanction busting. A list of all variables along with their definitions and data sources can be found in Table A1 in the Appendix.

We control for the natural logarithm of real GDP, as is standard in gravity models. As a proxy for multilateral resistance, we control for a country's lagged remoteness (in logs), defined as GDP-weighted geographical distance to its potential trading partners (Wei, 1996). Both variables

are lagged by one year to mitigate potential problems with reverse causality. We also control for the number of regional trade agreements a country is a party to. Finally, we account for the main reasons for the imposition of international sanctions by including indicators for the protection of human rights, electoral democracy, and the presence of major or minor conflicts. Country-fixed effects absorb all time-invariant factors, such as the geographic distance to other countries, common borders, common languages, cultural characteristics, as well as very stable political and social conditions beyond the aforementioned covariates. Year-fixed effects account for differences in foreign policy stances of US presidents (Clinton, Bush Jr., Obama, and Trump) and legislative majorities, for changes in the global political environment, and for a global (nonlinear) economic trend.

Our indicators for international sanctions come from the novel Global Sanctions Database (Felbermayr, Kirilakha, et al., 2020; Kirilakha et al., 2021). Our main variables of interest identify sanctions imposed by the United States or the European Union. Since we are specifically interested in detecting substitution patterns, we focus on sanctions that have not been approved by the UNSC. The latter are included separately as a binary control variable. We do not control for sanctions by other senders as they do not occur frequently enough and can be expected to be less consequential (see also footnote 3 above).

Our dataset covers 187 countries and starts in 2002—1 month after China's WTO accession. Some of our political controls (e.g., the human rights data) are only available until 2019, restricting the endpoint of our analysis. However, this endpoint also rules out that the consequences of the COVID-19 pandemic confound our results. The dataset comprises 3311 observations for which data is available for all control variables. In total, 83 countries and 612 country-years in our sample were subject to US or EU sanctions (that were not enacted by the UNSC).⁶ Tables A2 and A3 in the Appendix provide a detailed overview of the countries in our sample, the number of observations in each sanction category, as well as the pre- and post-event trend indicators.

Table A4 shows descriptive statistics for the value of trade flows. The picture is mixed. For some countries (e.g., China) trade is lower under US or EU sanctions as compared to non-sanctioned country-years, whereas for others (e.g., Russia) we observe the opposite. Under UN sanctions, we generally find lower levels of trade than for non-sanctioned country-years. Most strikingly, we find more infringements of human rights, more conflict, and fewer cases of democracy in observations with sanctions in place. Taken together, this underscores the importance of separating the treatment effect from the selection effect. The bottom part of Table A4 also lists the mean values of the nominal effective exchange rate and the industrial value added per capita. The domestic currency is weaker for countries subject to sanctions and the industrial value added is lower, pointing at two potential transmission channels through which sanctions could affect trade.

4 | EMPIRICAL RESULTS

4.1 | Sanctions and overall trade

Average treatment effects. Tables 1 and 2 show the results of estimating Equation (1) for the value of exports and imports. Panel A distinguishes between different senders, whereas Panel B separates US/EU trade sanctions from other types of US/EU sanctions. “Exports/Imports % sanctions_{*t-1*}” indicates the share of exports/imports to/from a country (group) as a percentage of total exports/imports in the year before the imposition of sanctions.⁷

TABLE 1 Average treatment effects of sanctions on exports.

	World	US	EU	BRA	RUS	IND	CHN	ZAF	Rest
Panel A: Different senders									
US/EU sanctions	−0.036 (0.042)	−0.053 (0.078)	0.027 (0.045)	−0.081 (0.060)	−0.065 (0.065)	−0.111 (0.084)	−0.102 (0.111)	−0.095 (0.080)	−0.086* (0.040)
US & EU sanctions	−0.056(*) (0.029)	−0.059 (0.093)	−0.085 (0.061)	0.195 (0.176)	−0.398** (0.113)	0.063 (0.103)	0.143* (0.071)	0.036 (0.134)	−0.064* (0.030)
Panel B: US/EU trade sanctions									
US/EU export sanctions	−0.098** (0.032)	−0.144(*) (0.076)	−0.075(*) (0.045)	−0.010 (0.112)	−0.200* (0.101)	−0.055 (0.080)	0.038 (0.096)	−0.153(*) (0.081)	−0.114** (0.035)
Exports % sanctions _{t−1}	100% 3311	17.7% 3293	27.3% 3311	0.7% 3288	7.0% 3293	2.7% 3293	1.3% 3293	0.7% 3293	42.5% 3311

Note: Coefficient estimates for Equation (1) based on different dependent variables. Standard errors (in parentheses) are clustered at the country level. All models include country- and year-fixed effects as well as control variables (lagged log-GDP, lagged log-remoteness, log-RTA, human rights protection indicator, and dummies for democracy, major conflicts, minor conflicts, and UN sanctions; additional control variable in Panel B: dummy for US/EU non-export sanctions). **, *, and (*) indicate significance at the 1%, 5%, and 10% level. Exports % sanctions_{t−1} indicates the share of exports to a country (group) in total exports in the year before the imposition of sanctions.

TABLE 2 Average treatment effects of sanctions on imports.

	World	US	EU	BRA	RUS	IND	CHN	ZAF	Rest
Panel A: Different senders									
US/EU sanctions	−0.052 (0.033)	0.036 (0.052)	−0.001 (0.042)	−0.084 (0.052)	0.029 (0.075)	−0.021 (0.049)	−0.029 (0.034)	−0.130(*) (0.068)	−0.119** (0.042)
US & EU sanctions	−0.089(*) (0.046)	0.034 (0.079)	−0.160(*) (0.083)	−0.178(*) (0.100)	−0.253(*) (0.146)	−0.042 (0.071)	0.032 (0.049)	0.287** (0.110)	−0.103** (0.039)
Panel B: US/EU trade sanctions									
US/EU import sanctions	−0.072(*) (0.038)	0.032 (0.059)	−0.033 (0.062)	−0.093 (0.062)	−0.017 (0.132)	−0.104(*) (0.060)	0.017 (0.036)	0.049 (0.079)	−0.134** (0.037)
Imports % sanctions _{t−1}	100.0% 3311	13.0% 3293	26.5% 3311	1.1% 3293	12.9% 3293	2.2% 3293	3.1% 3293	0.6% 3293	40.6% 3311

Note: Coefficient estimates for Equation (1) based on different dependent variables. Standard errors (in parentheses) are clustered at the country level. All models include country- and year-fixed effects as well as control variables (lagged log-GDP, lagged log-remoteness, log-RTA, human rights protection indicator, and dummies for democracy, major conflicts, minor conflicts, and UN sanctions; additional control variable in Panel B: dummy for US/EU non-import sanctions). **, *, and (*) indicate significance at the 1%, 5%, and 10% level. Imports % sanctions_{t−1} indicates the share of imports to a country (group) in total imports in the year before the imposition of sanctions.

Our first finding is that sanctions are reducing total exports and imports from and to sanctioned countries. This holds in particular for joint US & EU sanctions and for US/EU export and import sanctions. A sanctioned country's exports are on average 5.6% lower under joint US & EU sanctions and 9.8% lower under export sanctions. The corresponding figures for imports are -8.9% for joint US & EU sanctions and -7.2% for import sanctions.

When studying the effects of sanctions on different (groups of) countries, all countries covered in our analysis are negatively affected by at least one category of sanctions. Exports to the US (-14.4%), the EU (-7.5%), and South Africa (-15.3%) are significantly lower under export sanctions; the same holds for imports from India (-10.4%) under import sanctions and imports from the EU (-16.0%) and Brazil (-17.8%) when joint US & EU sanctions are in place. Most notable are the detrimental effects on trade with Russia—in particular after joint US & EU sanctions, when exports decline by 39.8% and imports by 25.3%. We also detect a negative effect of export sanctions on exports to Russia (-20.0%).

The sole exception to this pattern is China, where we observe only one significant coefficient, as a target's exports to China are 14.3% higher if joint US & EU sanctions are in place. This figure provides a first indication that China may be undermining Western multilateral sanctions, whereas Russia is not.⁸

Another interesting finding from Tables 1 and 2 is that trade between targets of sanctions and the “rest of the world” is more strongly affected by sanctions than the total trade of targets. This indicates that trade with the major powers under investigation is less affected by sanctions than trade with other countries on average, with Russia being the exception. Notably, trade with the US and the EU is not harmed overproportionately by their own sanctions, although European and American firms have to comply with them. This strongly indicates that US and EU sanctions are designed to limit adverse effects on their own economies.

Not surprisingly, we find stronger effects for joint US & EU sanctions as compared to unilateral sanctions by one of the two senders (trade with the rest of the world being the only exception). This pattern is more pronounced for the effects on imports, as compared to the effects on exports. However, we observe a clearer pattern of negative effects after export sanctions than after import sanctions.

Effects of trade sanctions over time. Next, we visualize the results of estimating Equation (2). These allow us to zoom in on the treatment pattern over time for US/EU export and import sanctions and to further validate our identification strategy by testing for a common trend before the imposition of sanctions. Figures 1 and 2 plot the coefficient estimates for exports and imports, respectively, alongside 95% confidence intervals.⁹ The pre-treatment years (“pre-trend”) are labeled -3 , -2 , and -1 and the post-treatment years (“post-trend”) $+1$, $+2$, and $+3$. The effect of sanctions on the dependent variable during the first, second, ..., and ninth-plus year of a sanction episode is labeled 1, 2, ..., and 9+ on the horizontal axis. We only show the results for trade with the US, the EU, China, Russia, and the world in an effort to conserve space and also in light of the lack of evidence for sanction-busting behavior based on the average effects of sanctions on the other countries (see Tables 1 and 2). When we study the dynamic effect of sanctions on traded quantities, we only show the results for the world in order to motivate the more granular estimations in Section 4.2, where we aggregate quantities only within categories of goods.

The results in Figures 1 and 2 are consistent with our findings in Tables 1 and 2 insofar as there is no significant negative effect on trade with China. If at all, we observe a tendency for exports to (years 9+ of a sanction episode) and imports from China (years 3 and 4 of a sanction episode) to increase. We also reconfirm the detrimental effects of Western sanctions on exports

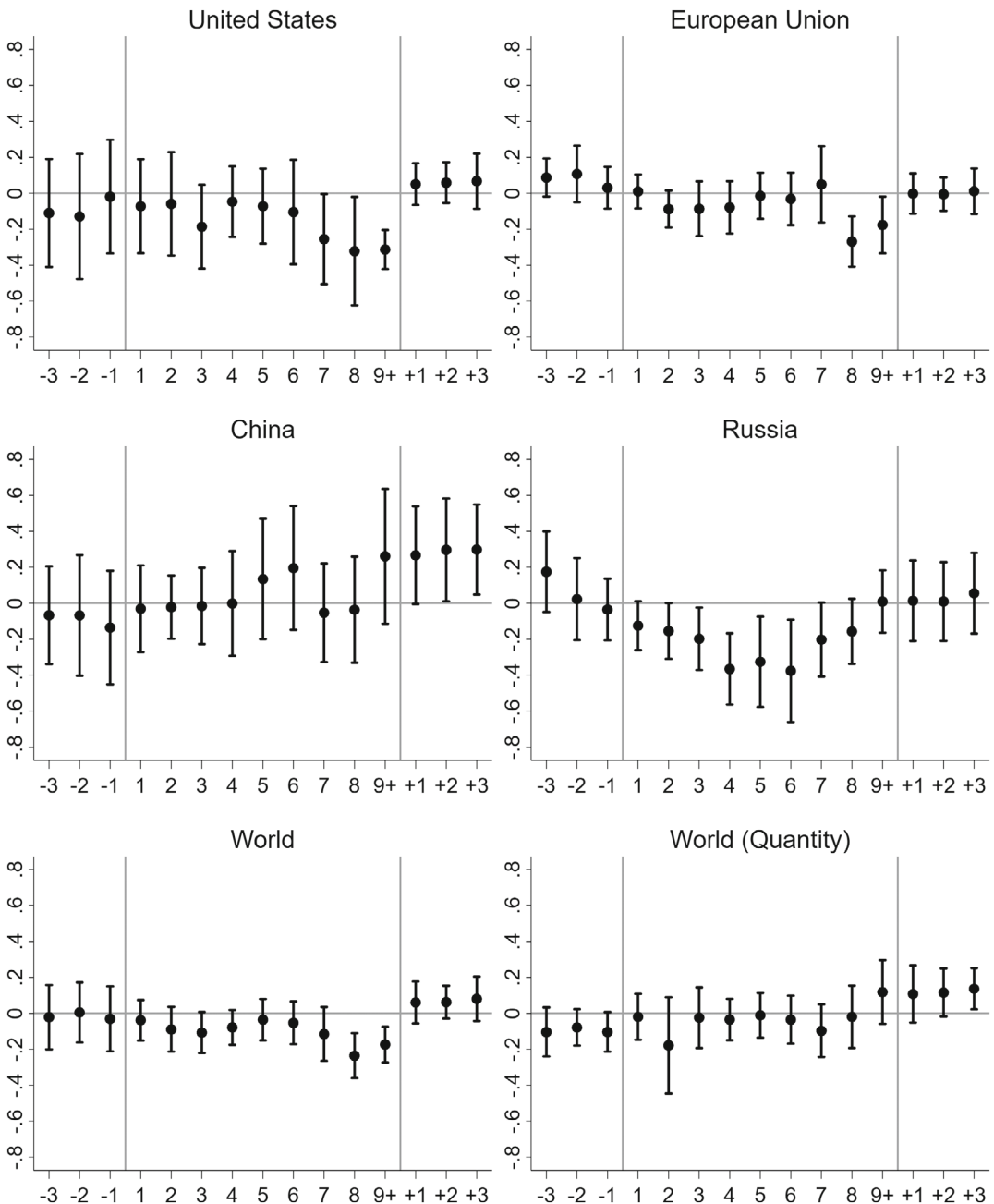


FIGURE 1 Event study of the effect of US or EU export sanctions on exports. Coefficient estimates for US or EU export sanctions over the course of a sanction episode (1, 2, ..., 9+) alongside the pre-trend (-3, -2, -1) and the post-trend (+1, +2, +3) based on Equation (2). The dependent variable is the value (in bn USD) of exports to the US, the EU, China, Russia, and the world or the quantity (in metric tons) of exports to the world (bottom right panel). 95% confidence intervals based on cluster-robust standard errors are indicated by whiskers. All models include country- and year-fixed effects as well as control variables (lagged log-GDP, lagged log-remoteness, log-RTA, human rights protection indicator, and dummies for democracy, major conflicts, minor conflicts, US/EU non-export sanctions, and UN sanctions). Number of observations: 3311 (world and EU) and 3293 (US, China, and Russia).

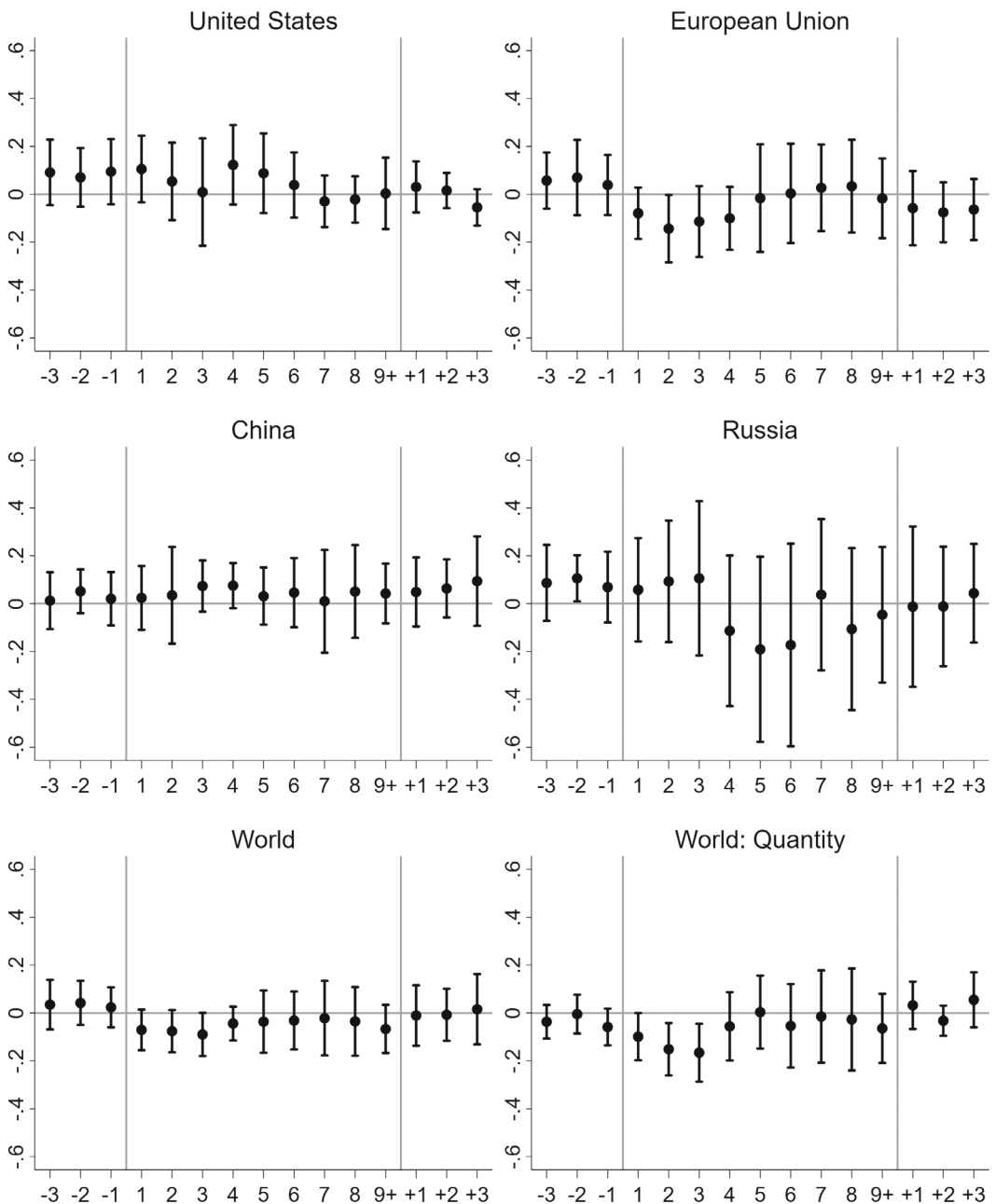


FIGURE 2 Event study of the effect of US or EU import sanctions on imports. Coefficient estimates for US or EU import sanctions over the course of a sanction episode (1, 2, ..., 9+) alongside the pre-trend (−3, −2, −1) and the post-trend (+1, +2, +3) based on Equation (2). The dependent variable is the value (in bn USD) of imports from the US, the EU, China, Russia, and the world or the quantity (in metric tons) of imports from the world (bottom right panel). 95% confidence intervals based on cluster-robust standard errors are indicated by whiskers. All models include country- and year-fixed effects as well as control variables (lagged log-GDP, lagged log-remoteness, log-RTA, human rights protection indicator, and dummies for democracy, major conflicts, minor conflicts, US/EU non-import sanctions, and UN sanctions). Number of observations: 3311 (world and EU) and 3293 (US, China, and Russia).

to Russia during the third to sixth year of a sanction episode with a maximum effect of -37.6% in year six. Negative effects of export sanctions on exports to the US (years 7 to 9+; maximum of -32.2% in year 8), the EU (years 8 to 9+; maximum of -26.8% in year 8), and the world (years 8 to 9+; maximum of -23.6% in year 8) are found specifically for longer-lasting sanctions.

Import sanctions exhibit only one significantly negative coefficient for imports from the EU (year 2; -14.3%). One potential explanation for this might be the reduced import quantities, which can be observed in the bottom right panel of Figure 2. During the first three years of a sanction episode, the overall quantity of imports significantly declines (maximum of -16.6% in year 3), whereas the corresponding value of imports is not significantly reduced (bottom left panel of Figure 2). Accordingly, fewer goods are imported at a higher price, providing further evidence of the detrimental effect of sanctions on their target's economy. Finally, when comparing the effects of import and export sanctions and their dynamics over time, the effect on exports is more persistent, whereas the effect on imports is—if at all—concentrated in the first years of a sanction episode. This is consistent with the findings of Felbermayr, Kirilakha, et al. (2020) that export sanctions are enforced more strictly than import sanctions.

Our results are not indicative of a significant downward trajectory before the imposition of sanctions. A joint exclusion test of the three pre-trend coefficients (cf. Callaway & Sant'Anna, 2021) supports this notion for all six import estimations in Figure 2.¹⁰ In the case of our export estimations in Figure 1, the joint exclusion tests cannot be rejected for the US and the world (value and quantity), but they are rejected for the EU, China, and Russia.¹¹ These results, however, should be of no concern, as we have different signs for the pre-trend coefficients (positive and individually insignificant) and the treatment effect (significantly negative for sanctions lasting longer than seven years) for exports to the EU. A similar pattern emerges for exports to China with (individually insignificant) negative coefficients for the pre-trend and a tendency for positive treatment effects, in particular for longer-lasting sanctions and the post-trend. Finally, the rejection of the exclusion test for Russia is driven by the positive coefficient in the third year before the onset of a sanction episode.¹² Hence, a visual inspection of the pre-trends and the joint exclusion tests corroborate the parallel trend assumption and support a causal interpretation of our empirical results based on the event study design and the panel difference-in-differences estimations.

Finally, we do not detect any significant negative coefficients for the post-trend. This indicates that the detrimental effects of US/EU trade sanctions do not last beyond the duration of the sanction episode. In contrast, we find a significant increase in the value of exports to China in the second and third year after US/EU trade sanctions have been lifted. A similar result is found for exported quantities to the world in the third year after the end of Western sanctions.

Robustness test. Our analysis relies on all sanction episodes listed in the Global Sanctions Database (version 3). This comprehensive database also covers US sanctions against EU countries or other close allies (see Table A2 in the Appendix). It can neither be expected that these sanctions exert a strong effect on trade with the US or the EU in the first place, nor that Russia or China would be busting these sanctions. Hence, as a robustness test, we repeat the event study analysis (cf. Figures 1 and 2) but without considering sanctions targeting EU countries or Canada. The results can be found in Figures A1 and A2 in the Appendix. They are qualitatively very similar to the baseline event study estimates. Hence, our identification does not crucially depend on the composition of the treatment group. Quantitatively, some of our baseline estimates are attenuated towards zero as the negative effects on trade with the US, the EU, Russia, and the world are more pronounced in the robustness test, in particular for imports from these countries. The aggregate effects on trade with China are virtually unaffected by the change in the treatment group. If at

all, we detect a more pronounced positive post-trend for trade with China after US or EU trade sanctions are lifted.

4.2 | Sanctions and trade in different types of commodities

As indicated in the previous subsection, analyzing the effects of sanctions on trade only at the aggregate level might be problematic, in particular when studying the effects on the quantity of traded goods (in metric tons). To gain a better understanding of why trade flows change under Western import and export sanctions, we now distinguish trade in five categories of goods: agricultural goods, (raw) materials, machines, critical goods (such as arms, explosives, and nuclear items), and other goods. Table A1 in the Appendix explains the construction of these categories in more detail. Tables 3 and 4 show the results of estimating Equation (1) with dependent variables based on trade in the five categories of goods. Panel A shows the results for the value of exports and imports, Panel B for the corresponding quantities. In Spec. 1, we study joint US & EU sanctions, whereas Spec. 2 focuses on US/EU export or import sanctions (corresponding to the dependent variable). In both specifications, we control for our set of control variables, for other types of sanctions, and for UN sanctions. To conserve space and focus on the most interesting trade partners, we only show the results for trade with Russia (Table 3) and China (Table 4).

The strong negative results for exports to Russia from the previous subsection are replicated in Table 3 for four categories of goods (materials, machines, critical goods, and other goods). We observe detrimental effects on both, the value of traded goods and their quantity. The effects on imports remain weaker than the effects on exports in this more granular analysis. The value of agricultural imports from Russia is reduced under US & EU sanctions, as is the value of other imports in both specifications and the quantity of critical goods imports under US & EU sanctions. Maybe surprising is the null result for imports of (raw) materials from Russia in terms of both, value and quantity, as this is the commodity group where Russia has the highest pre-sanction trade share. With respect to trade substitution, this analysis reconfirms that Russia does not conduct systematic sanction busting against Western (trade) sanctions. This means that Russia reacts to Western sanctions like the typical non-superpower country—it reduces trade with the target state. Russian firms might be concerned about breaching US sanctions, as they could be doing business in USD or in the US, which makes them vulnerable to extraterritorial and secondary US sanctions.¹³ In addition, Russia does not play a major role as a trade partner of sanctioned countries in the first place. The only category of goods in which trade with Russia is non-negligible is the import of Russian raw materials and these imports do not decline. One explanation is that it is more difficult to impose sanctions on individual producers of oil and gas than on an economy's entire energy sector. Another possible explanation is that Russian oil and gas producers do not expect to be targeted by Western secondary sanctions, as Western countries depend on Russian oil and gas.¹⁴

The results for trade with China (Table 4) are more differentiated. For machines and other goods, we observe lower export values and quantities after Western export sanctions.¹⁵ The remaining significant estimates, however, are positive and thus consistent with China busting Western sanctions. The most striking result is found for trade in (raw) materials where we find an increase in the value of trade with China after joint US & EU sanctions and an even stronger effect on the quantity of traded (raw) materials in both specifications. This result matches the narrative that China imported additional natural resources from Russia at a price discount after

T A B L E 3 Average treatment effects of sanctions on trade in different commodities: Russia.

	Exports to Russia				Imports from Russia					
	Agric.	Mat.	Mach.	Crit.	Other	Agric.	Mat.	Mach.	Crit.	Other
Panel A: Value of exports and imports										
Spec. 1: US & EU sanctions	-0.366 (0.239)	-0.508** (0.127)	-0.445(*) (0.263)	-0.431** (0.108)	-0.412** (0.106)	-0.305* (0.126)	-0.268 (0.191)	-0.230 (0.223)	-0.039 (0.166)	-0.302* (0.137)
Spec. 2: US/EU exp./imp. sanct.	0.008 (0.193)	-0.404** (0.128)	-0.189 (0.227)	-0.241* (0.105)	-0.287** (0.105)	-0.217 (0.171)	-0.002 (0.146)	-0.044 (0.218)	0.085 (0.183)	-0.284* (0.129)
Trade % sanctions _{t-1}	2.9%	0.7%	1.8%	2.5%	1.1%	2.9%	8.9%	0.5%	0.6%	0.8%
Panel B: Quantity of exports and imports										
Spec. 1: US & EU sanctions	-0.081 (0.275)	-0.838** (0.216)	-0.547* (0.221)	-0.259** (0.086)	-0.463** (0.103)	-0.249 (0.289)	-0.189 (0.153)	-0.265 (0.226)	-0.144 (0.108)	0.027 (0.143)
Spec. 2: US/EU exp./imp. sanct.	0.238 (0.213)	-0.685** (0.251)	-0.347 (0.231)	-0.018 (0.119)	-0.285* (0.129)	0.033 (0.308)	-0.103 (0.116)	-0.233 (0.197)	-0.290* (0.145)	0.011 (0.149)
Trade % sanctions _{t-1}	2.1%	1.6%	3.3%	3.0%	0.9%	9.3%	11.6%	1.5%	0.5%	2.7%
Observations	3163	3192	3257	3257	3269	3202	3239	3224	3224	3242

Note: Coefficient estimates for Equation (1) based on different dependent variables. Standard errors (in parentheses) are clustered at the country level. All models include country- and year-fixed effects as well as control variables (lagged log-GDP, lagged log-remoteness, log-RTA, human rights protection indicator, and dummies for democracy, major conflicts, minor conflicts, and UN sanctions; additional control variable for Spec. 1: dummy for US or EU sanctions; additional control variable for Spec. 2: dummy for US/EU non-export/non-import sanctions). **, *, and (*) indicate significance at the 1%, 5%, and 10% level. Trade % sanctions_{t-1} indicates the share of exports/imports in total exports/imports in the year before the imposition of sanctions.

TABLE 4 Average treatment effects of sanctions on trade in different commodities: China.

	Exports to China				Imports from China					
	Agric.	Mat.	Mach.	Crit.	Other	Agric.	Mat.	Mach.	Crit.	Other
Panel A: Value of exports and imports										
Spec. 1: US & EU sanctions	0.014 (0.203)	0.386** (0.083)	-0.165 (0.235)	0.088 (0.187)	-0.212 (0.138)	0.001 (0.056)	0.135** (0.051)	0.043 (0.046)	0.137(*) (0.071)	-0.069 (0.100)
Spec. 2: US/EU exp./imp. sanct.	0.087 (0.222)	0.181 (0.144)	-0.835(*) (0.449)	0.029 (0.306)	-0.243* (0.115)	-0.052 (0.051)	0.033 (0.038)	0.024 (0.047)	0.164** (0.062)	-0.057 (0.062)
Trade % sanctions _{t-1}	4.0%	9.4%	2.4%	6.2%	7.1%	3.9%	8.2%	14.4%	15.4%	18.8%
Panel B: Quantity of exports and imports										
Spec. 1: US & EU sanctions	0.317 (0.275)	0.463* (0.211)	-1.185** (0.314)	-0.103 (0.301)	-0.279** (0.077)	0.019 (0.131)	0.376* (0.158)	0.095 (0.103)	0.129** (0.033)	-0.032 (0.092)
Spec. 2: US/EU exp./imp. sanct.	0.613** (0.220)	0.433(*) (0.237)	-1.198** (0.292)	-0.643* (0.252)	-0.282** (0.096)	0.115 (0.155)	0.159(*) (0.094)	0.037 (0.051)	0.121** (0.044)	-0.067 (0.061)
Trade % sanctions _{t-1}	6.2%	11.2%	1.6%	1.5%	14.6%	2.3%	4.8%	13.1%	20.9%	16.0%
Observations	3288	3293	3288	3270	3293	3293	3293	3293	3293	3293

Note: Coefficient estimates for Equation (1) based on different dependent variables. Standard errors (in parentheses) are clustered at the country level. All models include country- and year-fixed effects as well as control variables (lagged log-GDP, lagged log-remoteness, log-RTA, human rights protection indicator, and dummies for democracy, major conflicts, minor conflicts, and UN sanctions; additional control variable for Spec. 1: dummy for US or EU sanctions; additional control variable for Spec. 2: dummy for US/EU non-export/non-import sanctions). **, *, and (*) indicate significance at the 1%, 5%, and 10% level. Trade % sanctions_{t-1} indicates the share of exports/imports in total exports/imports in the year before the imposition of sanctions.

Western countries imposed an energy embargo in response to Russia's invasion of Ukraine in 2022, although this time period is not covered by our dataset, which ends in 2019. Similarly, we observe an increase in both the value and quantity of imports of Chinese critical goods (arms, explosives, and nuclear items) in both specifications. Finally, the quantity of agricultural exports to China is higher under export sanctions, with an unchanged value indicating a reduced price of traded goods. In sum, the more granular results for different types of commodities provide evidence of Chinese sanction-busting behavior, as particularly trade in (raw) materials and imports of critical goods from China increase under US or EU sanctions.

4.3 | Sanctions and trade: Transmission channels

The final part of our empirical analysis is dedicated to studying two potential transmission channels through which sanctions could affect trade. First, we re-estimate Equation (1) with either the natural logarithm of the nominal effective exchange rate in quantity notation or the natural logarithm of real industrial value added per capita (including construction) as the dependent variable.¹⁶

The results in Table 5 show that the exchange rate is significantly lower when US/EU export sanctions (−13.9%) are in place, implying that export sanctions lead to a depreciation (or devaluation) of the domestic currency.¹⁷ Put differently, lower exports go hand-in-hand with a reduced demand for domestic currency (Itskhoki & Mukhin, 2022). This result is replicated for US/EU import sanctions (−12.8%), albeit only significant at the 10% level. In addition, we document a decline in industrial value added after US/EU import sanctions (−6.2%) and export sanctions (−4.8%), although the latter estimate is not statistically significant. These detrimental effects are not surprising given that trade sanctions can limit access to production inputs and block access to foreign markets for industrial products.

In a second step, we test whether accounting for the lagged nominal effective exchange rate or the lagged industrial value added in our models presented in Tables 1 and 2 changes our baseline estimates. Due to missing values in both variables, we first re-estimate Equation (1) using a restricted sample (Restricted) before adding both potential transmission variables individually and jointly (columns NEER, VA, and Both). Some patterns are visible in Table 6. Most importantly, the inclusion of industrial value added (columns VA) does not noticeably change the coefficients

TABLE 5 Average treatment effects of sanctions on exchange rate and industry value added.

	NEER	NEER	Industry VA	Industry VA
US/EU export sanctions	−0.139*		−0.048	
	(0.066)		(0.029)	
US/EU import sanctions		−0.128(*)		−0.062(*)
		(0.077)		(0.037)

Note: Coefficient estimates for Equation (1) using least squares. The dependent variable is either the natural logarithm of the nominal effective exchange rate (NEER) in quantity notation or the natural logarithm of real industrial value added (VA) per capita (including construction). Standard errors (in parentheses) are clustered at the country level. All models include country- and year-fixed effects as well as control variables (lagged log-GDP, lagged log-remoteness, log-RTA, human rights protection indicator, and dummies for democracy, major conflicts, minor conflicts, US/EU non-export/non-import sanctions, and UN sanctions). **, *, and (*) indicate significance at the 1%, 5%, and 10% level. Number of observations: 3110 (NEER) and 3120 (Industry VA).

TABLE 6 Exchange rate and industrial value added as transmission channels.

	Table 1/2	Restricted	NEER	VA	Both
Panel A: Dependent variable: Total exports					
Lag (log-NEER)			0.047 (0.050)		0.031 (0.051)
Lag (log-ind. VA)				0.261(*) (0.150)	0.255(*) (0.152)
US/EU export sanctions	−0.098** (0.032)	−0.065* (0.026)	−0.061* (0.028)	−0.067** (0.025)	−0.064* (0.026)
Panel B: Dependent variable: Total imports					
Lag (log-NEER)			0.063 (0.062)		0.055 (0.062)
Lag (log-ind. VA)				0.169 (0.117)	0.160 (0.114)
US/EU import sanctions	−0.072(*) (0.038)	−0.057 (0.039)	−0.051 (0.039)	−0.058 (0.040)	−0.052 (0.040)

Note: Estimates of Equation (1) based on different dependent variables. Standard errors (in parentheses) are clustered at the country level. All models include country- and year-fixed effects as well as control variables (lagged log-GDP, lagged log-remoteness, log-RTA, human rights protection indicator, and dummies for democracy, major conflicts, minor conflicts, US/EU non-export/non-import sanctions, and UN sanctions). **, *, and (*) indicate significance at the 1%, 5%, and 10% level. Number of observations: 3311 (Table 1) and 2944 (other columns). Column “Table 1/2” replicates the baseline results, column “Restricted” re-estimates the baseline model with a reduced sample in which data for the lagged nominal effective exchange rate and the lagged real industrial value added per capita (including construction) is available, and columns “NEER,” “VA,” and “both” test for the different transmission channels.

relative to the columns “Restricted.” In contrast, the inclusion of the exchange rate (columns NEER and Both) slightly shrinks the coefficients, providing further evidence for this variable acting as a potential transmission channel between sanctions and trade. Finally, we observe a direct positive effect of lagged industrial value added on exports, indicating that a reduced value added is linked to lower exports.

5 | CONCLUSION

In this study, we analyze the effect of US and EU sanctions on trade flows of 187 countries during the period 2002–2019 using standard panel difference-in-differences estimations and an event study design. Motivated by the claim that China and Russia purposefully and systematically undermine Western sanction efforts, we test whether trade with China, Russia, or other regional powers (Brazil, India, and South Africa) increases under Western (trade) sanctions.

Our results indicate no systematic sanction busting by Russia. This also holds for trade in different groups of commodities, both for the effect on the quantity and the value of traded goods. Similar results can be found for the regional powers Brazil, India, and South Africa. China, however, shows some signs of sanction-busting behavior. While we do not find robust evidence for an increase in overall trade between China and countries targeted by Western sanctions, trade in (raw) materials (in terms of value and quantity) with sanctioned countries and imports of critical

goods from China increase notably. Hence, our results are, on the one hand, consistent with the observation in the empirical literature that sanctions have important adverse effects on a country's economy and society, as we find no evidence of systematic sanction busting for most major powers. On the other hand, our evidence indicates that China is indeed undermining Western sanctions by increasing its trade with target countries in specific categories of goods.

Further results indicate that the effect of Western sanctions on exports from sanctioned countries is more persistent than the effect on imports to these countries (see also Felbermayr, Kirilakha, et al., 2020). In addition, we find some evidence of a reduction in industrial value added and a depreciation (or devaluation) of the domestic currency as potential transmission channels through which Western sanctions affect trade. Finally, our findings can be interpreted as causal, since we do not observe changes in trade flows in the years before the imposition of sanctions, indicating that changes during sanction episodes are a significant deviation from the pre-trend.

A serious limitation of all cross-country studies on the evasion of trade sanctions is that systematic data on off-the-books trade is lacking. In terms of sanctions data, a more precise measure of the intensity of sanctions regimes in state-of-the-art datasets, such as that of Felbermayr, Kirilakha, et al. (2020), is a major desideratum.

CONFLICT OF INTEREST STATEMENT

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DATA AVAILABILITY STATEMENT

The dataset and programs to replicate the results of this article are available on request from the corresponding author.

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ENDNOTES

- 1 In line with Early (2015), we define sanction busters as third-party states that increase their economic engagement with a target of sanctions in ways that mitigate the adverse effects of sanctions on the target state. However, the only form of economic engagement considered here is trade.
- 2 Since we estimate our empirical model using Poisson-pseudo maximum likelihood techniques, the correct descriptor would be “ratio-in-ratios” model. For simplicity, we use the more common term DiD. See Roth et al. (2023) for a recent survey of DiD methods.
- 3 The number of Chinese and Russian sanctions in the database, not counting those enacted by the UNSC, is too small for a meaningful analysis. In addition, Russian (counter-)sanctions mainly have been applied against

- EU countries and their partners after the annexation of Crimea. Hence, these do not coincide with Western sanctions anyway.
- 4 Note that a significant pre-trend could also emerge due to the anticipation of the treatment (see Malani & Reif, 2015). In such a case, trade patterns would change before the treatment and this change could be misattributed to the factors leading to the selection into sanctions. Hence, testing for a significant pre-trend can be interpreted as a conservative empirical design when it comes to disentangling the treatment effect from the selection effect in light of potential anticipation effects. However, the assumption that sanctions cannot be anticipated by the relevant economic actors is theoretically plausible. Arguably, investors price in the risk that sanctions might be imposed, just like they consider in their investment how likely a country will experience a natural disaster, a conflict, a coup, a revolution, and so forth without knowing if any of these events will actually happen in the foreseeable future. What also complicates the anticipation of sanctions is that it is almost impossible to know ex-ante which actors and activities exactly would be targeted by sanctions. Thus, it appears realistic that trade does not significantly change due to anticipation of a new sanction episode.
 - 5 Note that the frequency of UN sanctions is too small for a meaningful event study.
 - 6 Twelve countries (Belarus, China, Colombia, Costa Rica, Cuba, Cyprus, Haiti, Indonesia, Myanmar, Philippines, South Sudan, and Zimbabwe) were subject to US or EU sanctions throughout all country-years in our sample. Hence, the sanctions indicators are absorbed by the country-fixed effects in these cases. Nevertheless, the inclusion of these countries in our sample allows for estimating the vector of parameters γ more efficiently.
 - 7 Note that the difference in the number of observations is due to spells of zero or missing trade with a country. For instance, the US, Brazil, Russia, India, and China naturally have no cross-border trade with themselves, resulting in a loss of 18 observations. The remaining five missing observations for exports to Brazil are because South Sudan has not exported any goods to Brazil. See also the list of sample countries (Table A2 in the Appendix).
 - 8 For two reasons we think one should not overemphasize the significant positive coefficient for imports from South Africa when US & EU sanctions are in place. First, the other significant effects for South Africa are negative and, therefore, not indicative of sanction-busting behavior. Second, this estimate is based on rather small quantities of trade, as South Africa's share of total imports in the year before the imposition of sanctions is less than 1%.
 - 9 We choose the more conservative 95% confidence intervals since we are not testing for the average effect of sanctions (as, e.g., in Tables 1 and 2) but their varying impact over the course of a sanction episode.
 - 10 The corresponding $\chi^2(3)$ test statistics with p-values in brackets are the following. US: 2.43 [0.49]; EU: 1.91 [0.59]; China: 4.47 [0.21]; Russia: 5.24 [0.15]; World: 1.43 [0.70]; World (Quantity): 3.08 [0.38].
 - 11 The corresponding $\chi^2(3)$ test statistics with p-values in brackets are the following. US: 1.25 [0.74]; EU: 18.99 [0.00]; China: 9.04 [0.03]; Russia: 31.01 [0.00]; World: 4.20 [0.24]; World (Quantity): 3.47 [0.32].
 - 12 An exclusion test for the 2 years before the imposition of sanctions cannot be rejected in the case of exports to Russia: $\chi^2(2) = 2.41$ [0.30].
 - 13 On September 27, 2023, for instance, the US State Department announced sanctions on a network comprised of entities and individuals based in Iran, China, Hong Kong, Turkey, and the United Arab Emirates for supporting Iranian drone production for Russia's war against Ukraine in violation of US sanctions. Such secondary sanctions have become quite common.
 - 14 This has, for instance, been demonstrated by Russian firms' ability to sell oil and gas even under unprecedented Western sanctions following Russia's invasion of Ukraine. While other sectors of the Russian economy were seriously harmed by being cut off from trade with the West, Russia continued to sell its natural resources, even to members of NATO and the European Union, although at reduced prices.
 - 15 For exported quantities of machines, critical goods, and other goods, we also find significant negative effects under joint US & EU sanctions.
 - 16 The left-hand side variables do not contain zeros. Accordingly, we estimate Equation (1) using least squares. Due to missing values, the estimates are based on a slightly reduced sample.
 - 17 In our analysis, we do not distinguish between countries with floating and fixed exchange rates, since the latter could also be forced to devalue as a consequence of sanctions.

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APPENDIX

TABLE A1 Variable definitions and sources.

<p>Exports; imports. Value of exports/imports (in bn USD) and quantity of exports/imports (in metric tons). <i>Source:</i> UN Comtrade Database and Gaulier and Zignago (2010). Exports and imports are broken down along two dimensions:</p> <p><i>Trade partners:</i> US, EU, Brazil, Russia, China, India, South Africa, rest of the world.</p> <p><i>Types of goods:</i> Agricultural goods (HS 2-digit categories: 1–24), (raw) materials (HS 2: 25–29, 31, 38, 68, 72–76, 78–81, and 83), machines (HS 2: 82 and 85–90), critical goods (arms, explosives, and nuclear items; HS 2: 36, 84, and 93), other goods (remaining HS 2-digit categories).</p>
<p>Log-GDP. Natural logarithm of real GDP (in 1000 USD). <i>Source:</i> World Bank.</p>
<p>Log-remoteness. Natural logarithm of remoteness, defined as a country's GDP-weighted geographical distance to its (potential) trading partners. <i>Source:</i> World Bank for data on real GDP and Conte et al. (2022) for data on geographical distance.</p>
<p>Log-RTA. Natural logarithm of the number of regional trade agreements (plus one). <i>Source:</i> Mario Larch's Regional Trade Agreements Database (Egger & Larch, 2008).</p>
<p>Human rights. Latent human rights protection score with higher values indicating better protection. <i>Source:</i> Fariss (2019).</p>
<p>Democracy. Binary democracy indicator. <i>Source:</i> Bjørnskov and Rode (2020).</p>
<p>Major conflict; minor conflict. Armed conflicts resulting in at least 1000 battle-related deaths in a given year; conflicts resulting in between 25 and 999 battle-related deaths. <i>Source:</i> UCDP/PRIO Armed Conflict Dataset (Gleditsch et al., 2002).</p>
<p>Sanctions. Binary indicators for country-years with sanctions by specific senders in place (see Table A3). <i>Source:</i> Global Sanctions Data Base, Version 3 (Felbermayr, Kirilakha, et al., 2020; Kirilakha et al., 2021).</p>
<p>Log-NEER. Natural logarithm of the nominal effective exchange rate in quantity notation. <i>Source:</i> Darvas (2021).</p>
<p>Log-industrial value added pc. Natural logarithm of real industrial value added per capita (including construction). <i>Source:</i> World Bank.</p>

TABLE A2 List of countries.

<p> Afghanistan (17/0), Albania (18/0), Algeria (18/1), Angola (18/1), Antigua and Barbuda (18/2), Argentina (18/0), Armenia (18/0), Australia (18/0), Austria (18/0), Azerbaijan (18/1), Bahamas (18/0), Bahrain (18/0), Bangladesh (18/0), Barbados (18/0), Belarus (18/18), Belgium (18/0), Belize (18/12), Benin (18/12), Bhutan (18/0), Bolivia (18/9), Bosnia and Herzegovina (18/9), Botswana (18/0), Brazil (18/0), Brunei (18/0), Bulgaria (18/2), Burkina Faso (18/2), Burundi (18/5), Cambodia (18/9), Cameroon (18/1), Canada (18/3), Cape Verde (18/0), Central African Republic (18/5), Chad (18/2), Chile (18/0), China (18/18), Colombia (18/18), Comoros (18/0), Congo (18/0), Costa Rica (18/18), Cote d'Ivoire (18/2), Croatia (18/6), Cuba (18/18), Cyprus (18/18), Czech Republic (18/0), Democratic Republic of Congo (18/1), Denmark (18/0), Djibouti (6/0), Dominica (18/2), Dominican Republic (18/9), Ecuador (18/2), Egypt (18/9), El Salvador (18/1), Equatorial Guinea (18/0), Eritrea (11/2), Estonia (18/0), Ethiopia (18/0), Fiji (18/14), Finland (18/0), France (18/16), Gabon (18/0), Gambia (18/7), Georgia (18/0), Germany (18/0), Ghana (18/2), Greece (18/7), Grenada (18/0), Guatemala (18/13), Guinea (18/17), Guinea–Bissau (18/2), Guyana (18/0), Haiti (18/18), Honduras (18/2), Hungary (18/0), Iceland (18/0), India (18/7), Indonesia (18/18), Iran (18/7), Iraq (18/0), Ireland (18/13), Israel (18/0), Italy (18/0), Jamaica (18/9), Japan (18/0), Jordan (18/0), Kazakhstan (18/0), Kenya (18/3), Kiribati (18/0), Kuwait (18/0), Kyrgyz Republic (18/0), Laos (18/2), Latvia (18/1), Lebanon (18/0), Lesotho (18/5), Liberia (18/0), Libya (18/7), Lithuania (18/0), Luxembourg (18/0), Macedonia (18/0), Madagascar (18/9), Malawi (18/2), Malaysia (18/0), Maldives (18/0), Mali (18/2), Malta (18/0), Marshall Islands (18/0), Mauritania (18/4), Mauritius (18/0), Mexico (18/0), Micronesia (18/0), Moldova (18/17), Mongolia (18/0), Montenegro (13/0), Morocco (18/0), Mozambique (18/0), Myanmar (18/18), Namibia (18/0), Nauru (15/0), Nepal (18/1), Netherlands (18/0), New Zealand (18/0), Nicaragua (18/2), Niger (18/3), Nigeria (18/11), Norway (18/0), Oman (18/0), Pakistan (18/4), Palau (18/0), Panama (18/9), Papua New Guinea (18/0), Paraguay (18/0), Peru (18/0), Philippines (18/18), Poland (18/0), Portugal (18/0), Qatar (18/0), Romania (18/0), Russia (18/6), Rwanda (18/2), Saint Kitts and Nevis (18/0), Saint Lucia (18/0), Saint Vincent and the Grenadines (18/0), Samoa (18/0), Sao Tome and Principe (18/0), Saudi Arabia (18/2), Senegal (18/0), Seychelles (18/0), Sierra Leone (18/3), Singapore (18/0), Slovak Republic (18/0), Slovenia (18/0), Solomon Islands (18/0), Somalia (6/0), South Africa (18/1), South Korea (18/0), South Sudan (5/5), Spain (18/0), Sri Lanka (18/0), Sudan (18/2), Suriname (18/0), Swaziland (18/0), Sweden (18/0), Switzerland (18/0), Syria (18/13), Tajikistan (18/0), Tanzania (18/5), Thailand (18/9), Timor (17/0), Togo (18/6), Tonga (18/0), Trinidad and Tobago (18/0), Tunisia (18/9), Turkey (18/2), Turkmenistan (18/0), Tuvalu (18/0), Uganda (18/0), Ukraine (18/6), United Arab Emirates (18/0), United Kingdom (18/0), United States (18/0), Uruguay (18/0), Uzbekistan (18/10), Vanuatu (18/0), Vietnam (18/10), Yemen (18/2), Yugoslavia (17/13), Zambia (18/0), Zimbabwe (18/18). </p>

Note: The first figure in parentheses is the number of country-years for which all variables (excluding the transmission channels) are available. The second figure indicates the number of years with EU or US sanctions against that country. Sanctions enacted by the UNSC are not counted as EU or US sanctions.

TABLE A3 Frequency of sanctions.

Senders		Over time	
US/EU (without UN)	612	Pre-trend −3 years	48
Unilateral sanctions	428	Pre-trend −2 years	50
US & EU sanctions	184	Pre-trend −1 year	62
UN sanctions	196		
			Exp/imp
Types (US/EU)		Sanctions year 1	33 / 28
		Sanctions year 2	26 / 20
		Sanctions year 3	22 / 15
		Sanctions year 4	20 / 13
		Sanctions year 5	20 / 15
		Sanctions year 6	19 / 16
		Sanctions year 7	16 / 14
		Sanctions year 8	13 / 13
		Sanctions year 9+	71 / 77
		Post-trend +1 year	45
Non-trade sanctions	337	Post-trend +2 years	43
		Post-trend +3 years	43
Trade sanctions	275		
Export sanctions	240		
Import sanctions	211		

Note: Frequency of observations of the different sanctions indicators for which all variables (excluding the transmission channels) are available. Total number of observations in the dataset: 3311.

TABLE A4 Descriptive statistics (mean values).

Continuous indicators	(1) No sanctions	(2) US/EU sanctions	(3) UN sanctions
Exports to			
World	75.3	95.3	15.2
US	9.3	15.4	1.2
EU	28.5	25.9	3.7
Brazil	0.8	1.1	0.2
Russia	1.1	1.7	0.0
India	1.5	2.2	1.8
China	5.5	2.9	2.4
South Africa	0.4	0.6	0.3
Rest of the world	28.2	45.6	5.5
Imports from			
World	77.9	75.2	14.2
US	6.7	6.4	0.6
EU	28.7	21.1	2.9
Brazil	0.9	1.4	0.2
Russia	1.8	2.1	0.3
India	1.2	1.0	0.6
China	9.0	5.6	2.3
South Africa	0.5	0.5	0.1
Rest of the world	29.0	37.2	7.1
Lag (log-GDP)	17.044	17.668	16.937
Lag (log-remoteness)	2.080	2.070	2.043
Log-RTA	3.299	3.510	3.206
Human rights	1.128	−0.032	−1.000
Binary indicators			
Major conflict	0.010	0.044	0.296
Minor conflict	0.086	0.199	0.260
Democracy	0.668	0.516	0.168
Transmission channels			
Log-NEER	4.572 (2368)	4.494 (552)	4.508 (190)
Log-indust. VA pc	0.374 (2357)	−0.266 (583)	−1.210 (180)

Note: Mean values for dependent variables (in bn USD), control variables, and both transmission channels. Full sample (3311 obs.) is split into country-years without sanctions (Column 1; 2503 obs.), with US or EU sanctions in place (Column 2; 612 obs.), and with UN sanctions in place (Column 3; 196 obs.). Mean values for binary indicators equal the share of ones. Figures in parentheses are the (reduced) number of observations for the transmission channel indicators.

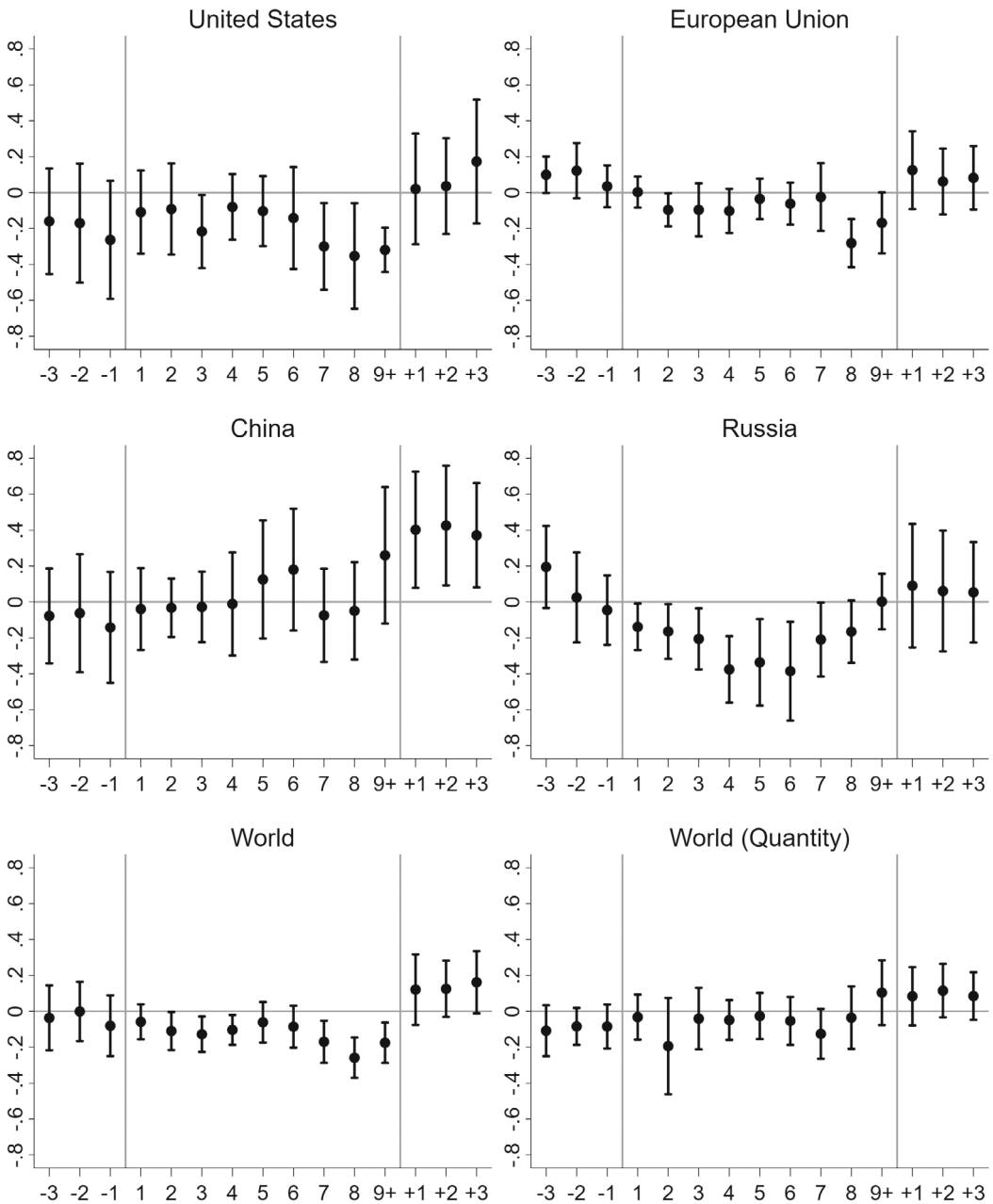


FIGURE A1 Effects of US or EU export sanctions on exports: Restricted set of targets. Coefficient estimates for US or EU export sanctions over the course of a sanction episode (1, 2, ..., 9+) alongside the pre-trend (-3, -2, -1) and the post-trend (+1, +2, +3) based on Equation (2). Sanction episodes against EU countries and Canada are excluded from the analysis. The dependent variable is the value (in bn USD) of exports to the US, the EU, China, Russia, and the world or the quantity (in metric tons) of exports to the world (bottom right panel). 95% confidence intervals based on cluster-robust standard errors are indicated by whiskers. All models include country- and year-fixed effects as well as control variables (lagged log-GDP, lagged log-remoteness, log-RTA, human rights protection indicator, and dummies for democracy, major conflicts, minor conflicts, US/EU non-export sanctions, and UN sanctions). Number of observations: 3311 (world and EU) and 3293 (US, China, and Russia).

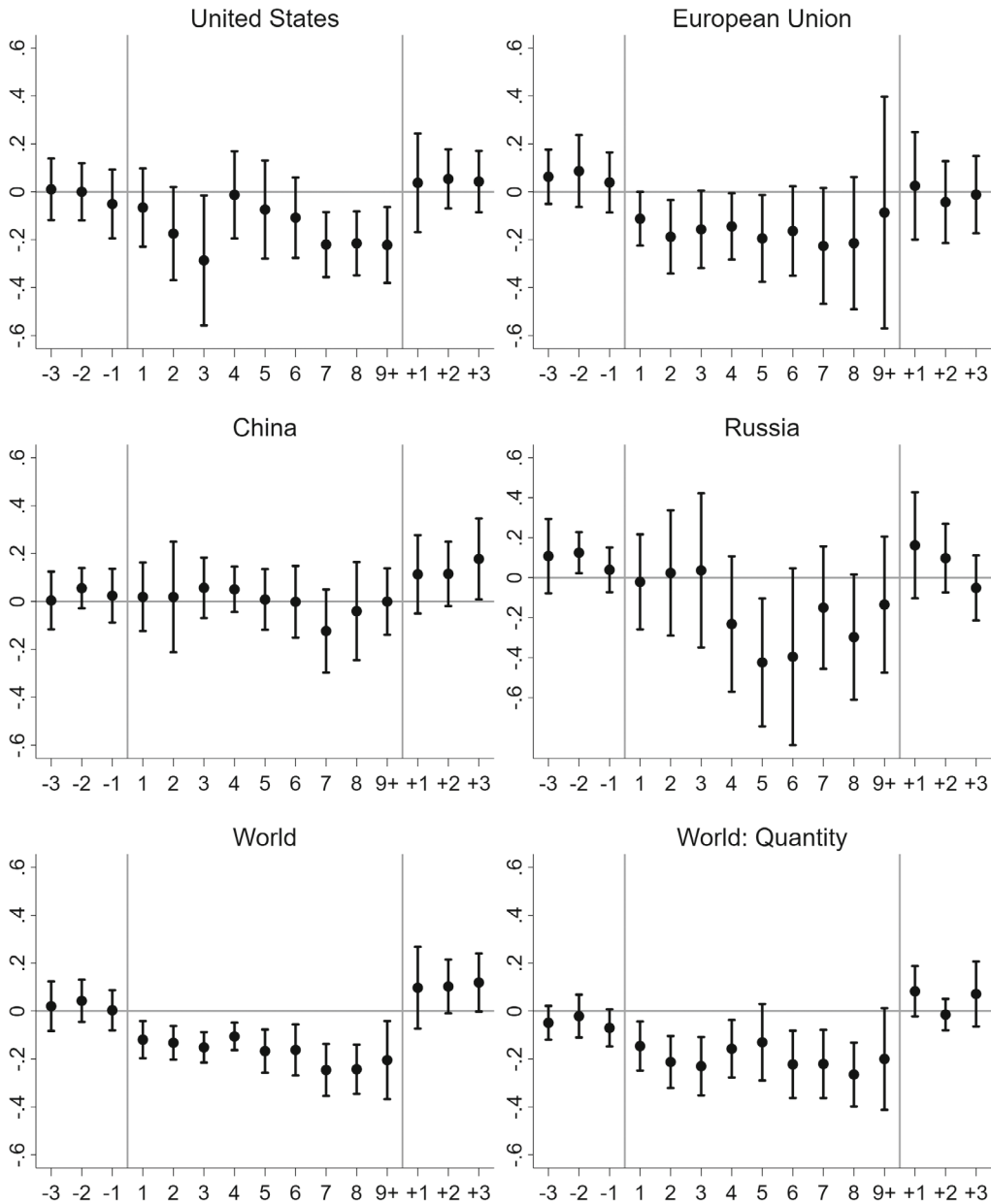


FIGURE A2 Effects of US or EU import sanctions on imports: Restricted set of targets. Coefficient estimates for US or EU import sanctions over the course of a sanction episode (1, 2, ..., 9+) alongside the pre-trend (-3, -2, -1) and the post-trend (+1, +2, +3) based on Equation (2). Sanction episodes against EU countries and Canada are excluded from the analysis. The dependent variable is the value (in bn USD) of imports from the US, the EU, China, Russia, and the world or the quantity (in metric tons) of imports from the world (bottom right panel). 95% confidence intervals based on cluster-robust standard errors are indicated by whiskers. All models include country- and year-fixed effects as well as control variables (lagged log-GDP, lagged log-remoteness, log-RTA, human rights protection indicator, and dummies for democracy, major conflicts, minor conflicts, US/EU non-import sanctions, and UN sanctions). Number of observations: 3311 (world and EU) and 3293 (US, China, and Russia).