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Abstract

A frequently employed argument against imposing international sanctions is that rival superpowers are likely to bust sanctions to simultaneously shield the target, harm the sender, and make a profit. We evaluate the legitimacy of this concern by studying the effect of US sanctions on trade flows between sanctioned and third countries during the period 1995–2019 using panel difference-in-differences estimations and an event study design. Motivated by the claim that China and Russia purposefully undermine US sanction efforts, we test whether target countries' trade with China and Russia increases under US trade sanctions. We find no evidence for systematic sanction busting. Russia does not change its trade patterns with sanctioned countries. Trade of targets of US sanctions with China declines even more than trade with the US. These general patterns are reconfirmed for trade in different groups of commodities. In addition, we find some evidence that a reduction in industrial value added and a devaluation of the domestic currency of the target country are transmission channels through which US sanctions hamper trade with third countries.

JEL-Codes: F130, F140, F500, F510, F520, F530, K330.

Keywords: geopolitics, international political economy, international sanctions, trade substitution.

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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 and Engers 1992). At the same time, 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 and Lektzian 2020; Draca et al. 2022; Ghomi 2022; Gutmann et al. 2021b; Hatipoglu and Peksen 2018; Mirkina 2018; Neuenkirch and Neumeier 2015, 2016; Peksen and 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 and Lektzian 2013; Gutmann et al. 2021a) and the policy response of the targeted regime, which may use repression to hold on to power (Adam and Tsarsitalidou 2019; Gutmann et al. 2020; Marinov 2005; Peksen and 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 superpowers and other countries do indeed systematically undermine US-imposed sanctions by increasing their trade with targets of US sanctions.

To answer this question, we conduct a panel-data analysis of the effects of US sanctions on trade flows of 184 countries in the period 1995–2019. More specifically, we complement standard panel difference-in-differences estimations with an event study design to ensure a causal interpretation of our results. Combining information from the Global Sanctions Database and UN Comtrade data, we analyze the effects of US sanctions on target countries'

exports to and imports from the US, the European Union (EU), China, Russia, and the rest of the world in order to uncover potential substitution patterns. Along three dimensions, we distinguish between different sanction senders, different types of sanctions, and trade in different types of commodities. First, we evaluate the effects of (i) US unilateral sanctions and (ii) joint sanctions by the US and the EU, while controlling for (iii) EU unilateral sanctions and (iv) sanctions enacted by the United Nations Security Council (UNSC). Second, we study the effects of US export sanctions and US import sanctions on the exports and imports of target countries, respectively. Third, we analyze the effects of sanctions on trade flows in five major categories of commodities: (a) agricultural products, (b) (raw) materials, (c) machines, (d) critical goods, such as explosives, arms, and nuclear-related items, and (e) other goods.

Our results indicate no sanction-busting behavior by China or Russia. Russia does not change its trade patterns with countries targeted by US sanctions. The negative effect of US sanctions on trade with China is even larger than that on trade with the US itself. These overall patterns are also confirmed when studying the different groups of commodities. In addition, we find some evidence for a reduction in industrial value added and, in particular, a depreciation or devaluation of the domestic currency as potential transmission channels through which US sanctions affect trade. Lastly, our findings can be interpreted as causal, since we do not observe a reduction 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 provides some novel insights on the (non-)prevalence of sanction-busting behavior among superpowers (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 the existing literature, thereby highlighting our contribution. 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 po-

tential 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 and Gata 2002; Posner and 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 (Yang et al. 2004; Fajgelbaum and Khandelwal 2022). The imposition or design of sanctions may also be a result of lobbying efforts of economic special interests (Halcoussis et al. 2021; Kaempfer and Lowenberg 1986, 1988; McLean and 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 (Bělín and Hanousek 2021a, 2021b; Kholodilin and 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. 2022). At the same time, sanctions create business opportunities for sanctions busters (Early 2015). 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. 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. In this paper, we are interested in identifying the extent to which these superpowers undermine US sanction efforts.

Much of the empirical literature so far has 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 and Wang 2022; Felbermayr et al. 2020a; Felbermayr et al. 2020b; Felbermayr et al. 2021; Kirikakha et al. 2021; Peterson 2021). There is also literature on how individual firms adjust their trade in response to sanctions (Crozet and Hinz 2020; Crozet et al. 2021; Gullstrand 2020; Haidar 2016, 2017). Some recent studies have focused on the question of whether trade with sanctioned countries is rerouted via their neighbors (Baronchelli et al. 2022; Hatipoglu et al. 2022).

Most relevant to our research question is the empirical literature on sanction busting (see Early 2015). In this literature, sanctions 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 sanctions 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 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 US 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, US sanctions might lead to increased trade between China or Russia and the targeted state. This is consistent with their economic incentives and geopolitical ambitions but runs the risk that Chinese and Russian firms themselves may become subject to US sanctions. On the other hand, the empirical literature stresses the dramatic adverse economic and political effects of US sanctions on their targets. This observation would be more consistent with China and Russia not successfully undermining US 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, China and Russia might even reduce trade flows with targets of US sanctions.

3 Estimation Approach and Data

3.1 Estimation Approach

Identifying the causal effect of US sanctions on trade volumes is challenging (Felbermayr et al. 2021). Sanctions are typically imposed on countries that are characterized by unstable political and social conditions in the first place (Gutmann et al. 2021a; Jing et al. 2003). This implies that countries subject to sanctions could have exhibited a poor economic perfor-

mance 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:

$$y_{i,t} = \sum_{s=1}^{k} \beta^{s}_{sanc} D^{s}_{sanc,i,t} + \gamma X_{i,t} + \alpha_i + \tau_t + \epsilon_{i,t} \tag{1}$$

The unit of analysis is the country-year. The dependent variable $y_{i,t}$ is one of our trade indicators of interest, measured as log-trade flows between country i in year t and a country (group) of interest, such as China, the EU, Russia, the US, 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 defined in Section 3.2 below.

Depending on the model specification, we employ two alternative sets of dummies $D^{s}_{sanc,i,t}$. 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 unilateral sanctions, (ii) joint sanctions by the US and the EU, (iii) UN sanctions, and (iv) EU unilateral sanctions. These categories are disjunctive, that is, category (ii) does not include sanction episodes enacted by the UNSC.[1]

In the second specification, we look specifically into *US trade sanctions*. We include a dummy variable for US export (/import) sanctions when we study the response of exports (/imports), while controlling for US non-export (/non-import) sanctions, as well as EU unilateral and 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. Eq. (1) is estimated with ordinary least squares and 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. 2021b; Schmidheiny and Siegloch 2022). This design captures trends up to three years before and after each sanction episode and compares them to other countries at the same point in time. This

[1] 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 to EU countries and their partners after the annexation of Crimea. Hence, these do not coincide with US sanctions anyway.

way, 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.[2] An additional value added of using 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 is as follows:

$$y_{i,t} = \sum_{j=1}^{3} \beta_{pre,-j} D_{pre,i,t-j} + \sum_{j=1}^{9+} \beta_{sanc,j} D_{sanc,i,tj} + \sum_{j=1}^{3} \beta_{post,+j} D_{post,i,t+j} + \sum_{s=1}^{k} \beta^{s}_{sanc} D^{s}_{sanc,i,t} + \gamma X_{i,t} + \alpha_i + \tau_t + \epsilon_{i,t} \tag{2}$$

$y_{i,t}$, $X_{i,t}$, α_i, τ_t, and $\epsilon_{i,t}$ are defined as in Eq. (1). Our event study indicators $D_{sanc,i,tj}$ 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 eight years in which a country was subject to US export (/import) sanctions within an episode ($t1$ to $t8$) and we summarize the average effect of sanctions after eight years in one dummy variable ($t9+$), as longer sanctions are rare.[3] $D_{pre,t-j}$ and $D_{post,t+j}$ 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 non-export (/non-import) sanctions, EU unilateral sanctions, and UN sanctions, summarized as $D^{s}_{sanc,i,t}$.

To summarize our research design: The panel difference-in-differences model serves as a baseline specification and allows for a detailed overview of 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 pattern over time and to further validate our identification strategy by testing for a common trend before the imposition of sanctions.

[2]Note that a significant pre-trend could also emerge due to the anticipation of the treatment (see Malani and 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.

[3]Note that the frequency of EU unilateral or UN sanctions is too small for a meaningful event study.

3.2 Data and Descriptive Statistics

We employ ten different dependent variables ($y_{i,t}$) for differently delineated trade flows. These are the natural logarithms of exports per capita from and imports per capita to the US, the EU, China, Russia, 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 US sanctions. To study this substitution behavior in more detail, we split all exports and imports into five groups of commodities: (a) agricultural products, (b) (raw) materials, (c) machines, (d) critical goods, such as explosives, arms, and nuclear-related items, and (e) all other goods. A list of all variables along with their definitions and data sources can be found in Table A1 in the Appendix.

As controls, we include the natural logarithm of real GDP per capita, as it is standard in gravity models. We lag this variable by one year to mitigate potential problems with reverse causality. We also control for the number of regional trade agreements a country is subject to in a given year. In addition, we account for the main reasons for the imposition of international sanctions by including an indicator for the protection of human rights, a binary indicator for electoral democracies, and dummies for the presence of major or minor conflicts. The inclusion of country-fixed effects into Eqs. (1) and (2) absorbs 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. The inclusion of year-fixed effects accounts for differences in the 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 (non-linear) economic trend.

Our indicators for international sanctions come from the novel Global Sanctions Database (Felbermayr et al. 2020a; Kirikakha et al. 2021). Our main variables of interest identify sanctions imposed by the United States. 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 in Eqs. (1) and (2) alongside another binary control variable for EU sanctions that do not coincide with US

sanctions. 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 1 above).

Our dataset covers 184 countries over the period 1995–2019. It comprises 4,425 observations for which data is available for all control variables. In total, 78 countries and 653 country-years in our dataset were subject to US sanctions (that were not enacted by the UNSC).[4] 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. It is evident that the volume of trade is lower for country-years subject to US sanctions. However, we also find a lower level of economic development, more infringements of human rights, more conflicts, and fewer cases of democracy in observations with sanctions. Taken together, this underscores the importance of disentangling the treatment effect from the selection effect. The bottom part of Table A4 also lists the mean values of the exchange rate to the USD 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

Table 1 shows the results for Eq. (1). Panel A distinguishes between different senders, whereas Panel B separates US trade sanctions from other types of US sanctions. "Trade pc Sanc_{t-1}" indicates the average level of trade per capita (in USD) in the year before the imposition of sanctions to facilitate the evaluation of effect sizes.

[4]Three countries (Cuba, Haiti, and Togo) were subject to US 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.

Table 1: Average Treatment Effects of Sanctions on Exports and Imports

Panel A: Sanctions by Senders

	Exports					**Imports**				
	US	EU	CHN	RUS	Rest	US	EU	CHN	RUS	Rest
US Unilateral	–0.004	0.014	–0.023	0.003	–0.028	–0.007	0.001	–0.013	0.008	–0.007
	(0.008)	(0.022)	(0.014)	(0.006)	(0.021)	(0.010)	(0.018)	(0.018)	(0.011)	(0.015)
US & EU	–0.030*	0.007	–0.048*	0.012	–0.058(*)	–0.028*	0.011	–0.055(*)	0.017	–0.055(*)
	(0.012)	(0.025)	(0.023)	(0.017)	(0.030)	(0.012)	(0.026)	(0.029)	(0.023)	(0.028)
UN	–0.027(*)	–0.037	–0.081**	–0.000	–0.075*	–0.042**	–0.033	–0.098*	–0.002	–0.071(*)
	(0.014)	(0.033)	(0.031)	(0.008)	(0.036)	(0.015)	(0.029)	(0.040)	(0.014)	(0.039)
EU Unilateral	–0.043**	0.033	–0.090**	–0.002	–0.061	–0.028**	0.058	–0.057*	0.016	–0.049(*)
	(0.016)	(0.047)	(0.023)	(0.007)	(0.037)	(0.008)	(0.044)	(0.023)	(0.018)	(0.027)
R^2 (overall)	0.914	0.930	0.753	0.779	0.930	0.937	0.940	0.741	0.719	0.925
Trade pc $Sanc_{t-1}$	137.5	240.2	37.2	18.0	314.2	153.5	272.2	81.1	37.9	425.2

Panel B: US Trade Sanctions

	Exports					**Imports**				
	US	EU	CHN	RUS	Rest	US	EU	CHN	RUS	Rest
US Export	–0.036*	–0.008	–0.090**	0.010	–0.095*					
	(0.016)	(0.045)	(0.024)	(0.031)	(0.041)					
US Import						–0.032*	–0.019	–0.071*	0.016	–0.073**
						(0.014)	(0.036)	(0.028)	(0.041)	(0.028)
US Other	–0.003	0.019	–0.008	0.004	–0.015	–0.005	0.015	–0.005	0.008	0.001
	(0.008)	(0.020)	(0.013)	(0.004)	(0.018)	(0.010)	(0.017)	(0.020)	(0.008)	(0.017)
R^2 (overall)	0.914	0.930	0.755	0.779	0.930	0.937	0.940	0.742	0.719	0.925
Trade pc $Sanc_{t-1}$	137.5	240.2	37.2	18.0	314.2	153.5	272.2	81.1	37.9	425.2

Note: Coefficient estimates for Eq. (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. **, *, and (*) indicate significance at the 1%, 5%, and 10% level. Number of observations: 4,425. Trade pc $Sanc_{t-1}$ indicates the level of trade per capita (in USD) in the year before the imposition of sanctions.

Our first result is that trade with Russia is unaffected by US, UN, and EU sanctions. However, Russia also has the lowest pre-sanctions level of trade per capita, indicating that Russia was possibly not an important trade partner for these countries in the first place. Perhaps more striking is our finding that trade with EU countries is also unaffected by sanctions, even by those imposed by the EU. This might be due to the collective action problem faced by EU member states in both the design and enforcement of sanctions (Dorussen et al. 2009). Individual members will not agree to most sanctions if their economy is too heavily or disproportionately affected and the adoption of EU sanctions has to be decided unanimously in the Council of the EU.

In contrast to trade with Russia and the EU, we find a significant decrease in trade with the US, China, and the rest of the world due to joint sanctions by the US and the EU, EU sanctions without the US, and UN sanctions. The strongest reduction is found for trade with China, as exports to China are 4.8% lower when joint US & EU sanctions are in place, 8.1% lower under UN sanctions, and 9.0% lower under EU sanctions. The corresponding figures for imports from China are −5.5% for joint US & EU sanctions, −9.8% for UN sanctions, and −5.7% for EU sanctions. The drop in trade with the rest of the world is of comparable magnitude.

The effect on trade with the US is much smaller (although still significant), even when we focus on US export or import sanctions. Here, the rest of the world (−9.5% for exports; −7.3% for imports) and China (exports: −9.0%; imports: −7.1%) are also more strongly affected than the US itself (exports: −3.6%; imports: −3.2%). This may be due to the types of goods the US trades with these countries, since not all types of goods are subject to sanctions. Another explanation could be that the US uses its influence in the design of sanctions to reduce the damage they cause to its economy. US unilateral sanctions do not show a significant effect on trade with any of the studied (groups of) countries. A final important insight from our results in Table 1 is that non-trade sanctions do not have a significant effect on either imports or exports to any of the (groups of) countries we are interested in. Thus, our analysis hereafter focuses on the effects of US trade sanctions.

Next, we visualize the results of estimating Eq. (2). These allow us to zoom in on the treatment pattern over time for US 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.[5] 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.

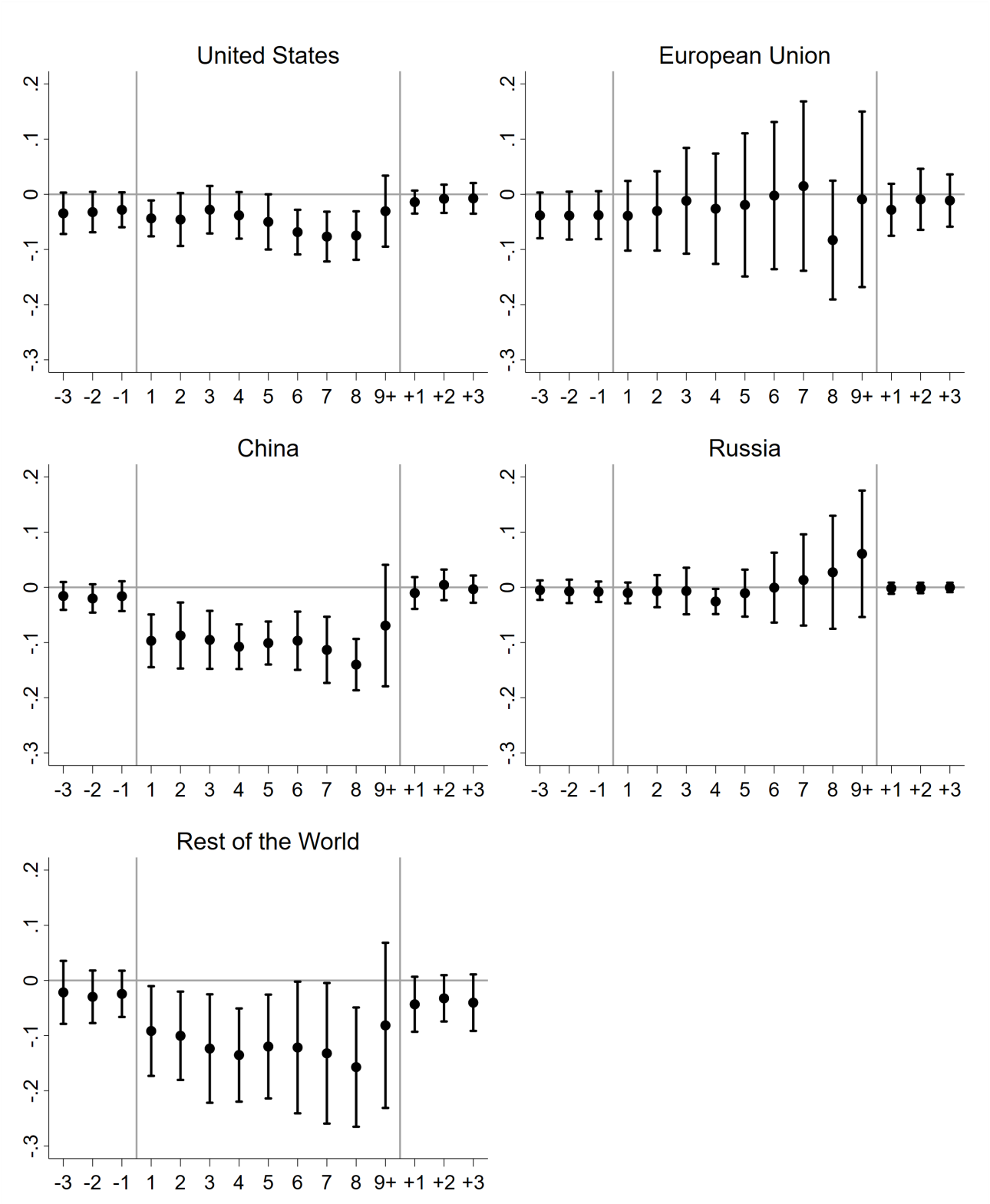
Our results are not indicative of a significant downward trajectory before the imposition of sanctions. This corroborates the parallel trend assumption and supports a causal interpretation of our empirical results based on the event study design and the panel difference-in-differences estimations. In addition, we do not detect any significant effects for the post-trend. This indicates that the detrimental effects of US trade sanctions do not last beyond their duration, but there is also no significant recovery after sanctions have been lifted.

The results in Figures 1 and 2 confirm our findings in Table 1, as there is no significant effect on trade with the EU and Russia at any point in time (the only exception being an estimated decline in exports to Russia in the fourth year of a sanction episode). We also confirm the detrimental effects of US sanctions on trade with China and the rest of the world, which are more sizable than the effect on trade with the US.

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 concentrated in the first years of a sanction episode. US sanctions affect exports to the US (only significant in the first and sixth to eighth year of an episode), China, and the rest of the world during the first eight years of a sanction episode. The peak effect on exports is found after seven (US: −7.7%) or eight years (China: −14.0%; rest of the world: −15.7%). The effect of import sanctions is smaller and less persistent. For imports from the US, we find a significant negative effect in the first to third and sixth year of a sanction episode with a maximum effect of −5.3% in year 2. For China, the effect is significant over the first five years of a sanction episode with a peak reduction of imports by 10.8% in the third year. Imports from the rest of the world are reduced in the first year and the effect peaks after nine or more years (−11.4%).

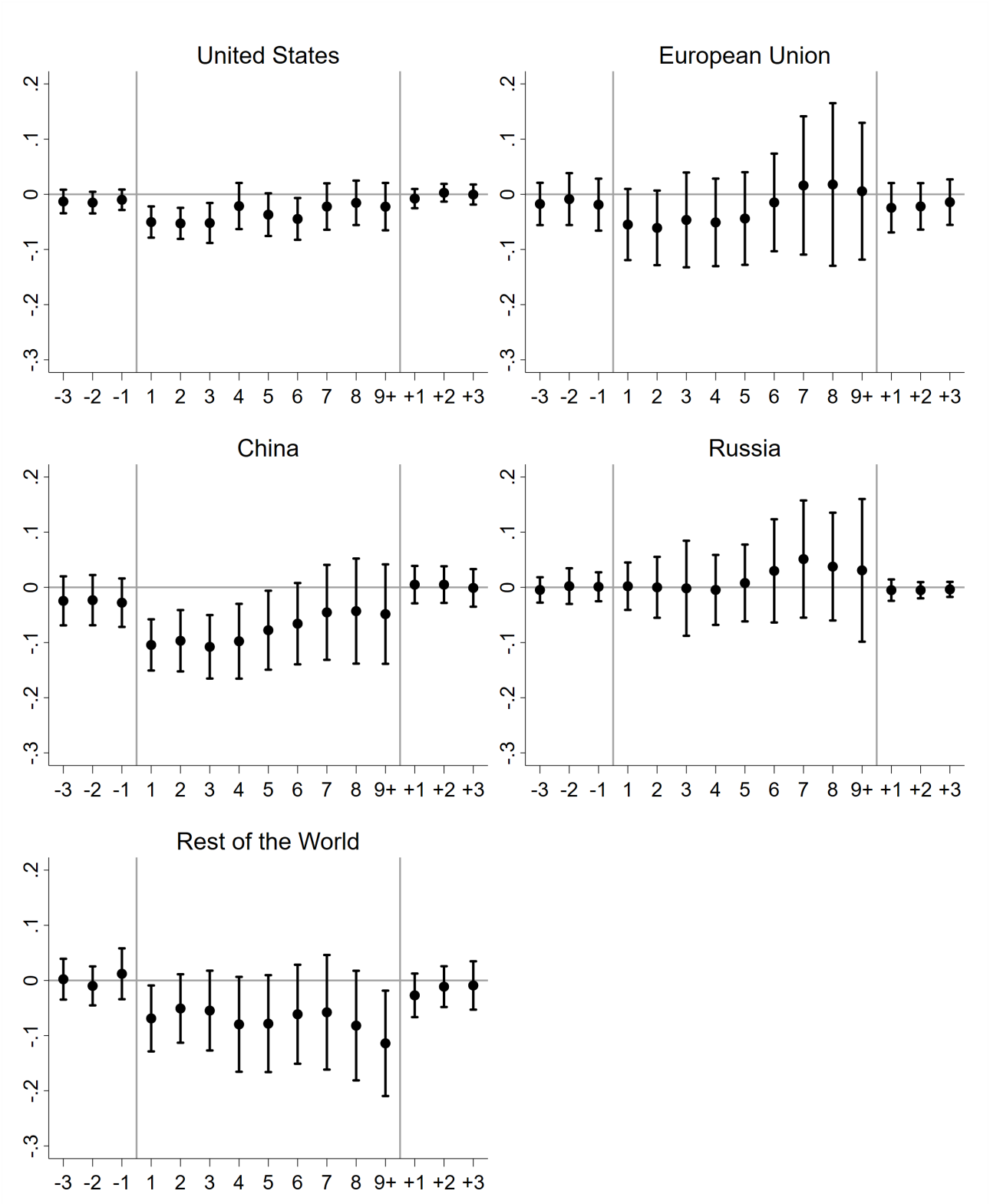
[5] We choose the more conservative 95% confidence intervals since we are not testing for the average effect of sanctions (as, e.g., in Table 1) but their varying impact over the course of a sanction episode.

Figure 1: Event Study of the Effect of US Export Sanctions on Exports



Note: Coefficient estimates for US 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 Eq. (2). The dependent variable is the natural logarithm of exports to the US, the EU, China, Russia, and the rest of the world. 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 (including US non-export sanctions, EU unilateral sanctions, and UN sanctions). **, *, and (*) indicate significance at the 1%, 5%, and 10% level. Number of observations: 4,425.

Figure 2: Event Study of the Effect of US Import Sanctions on Imports



Note: Coefficient estimates for US 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 Eq. (2). The dependent variable is the natural logarithm of imports from the US, the EU, China, Russia, and the rest of the world. 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 (including US non-import sanctions, EU unilateral sanctions, and UN sanctions). **, *, and (*) indicate significance at the 1%, 5%, and 10% level. Number of observations: 4,425.

4.2 Sanctions and Trade in Different Types of Commodities

To gain a better understanding of why trade flows change under US 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. Table 2 shows the results of estimating Eq. (1) with dependent variables based on trade in the five categories of goods. Again, we distinguish exports and imports with respect to five (groups of) countries under US export or import sanctions.

As in the case of total trade, there is no significant effect on trade with Russia across all categories of goods. And again, the effect on trade with China and the rest of the world is the largest and broadest, as almost all categories of goods are affected. Concerning trade with the US, only imports and exports of machines and "other goods" as well as imports of materials are significantly reduced. With respect to the EU, we now find some significant effects, as exports of machines and other goods to the EU are significantly reduced, as are imports of agricultural products from the EU. Interestingly, the only category of goods unaffected by import sanctions across all models is critical goods. The category of goods most reliably affected by trade sanctions is machines.

With respect to trade substitution, our analysis underlines again that both China and Russia do not conduct systematic sanctions busting against US trade sanctions. Russia's trade in different types of commodities remains unaffected and China's trade with sanctioned countries even drops across all categories except imports of agricultural and critical goods.

Table 2: Average Treatment Effects of US Sanctions on Exports and Imports of Different Commodities

	Exports					Imports				
	Agricult.	Materials	Machines	Critical	Other	Agricult.	Materials	Machines	Critical	Other
to/from the **US**	–0.007	–0.005	–0.009(*)	–0.002	–0.027**	–0.005	–0.027*	–0.010(*)	–0.003	–0.023**
	(0.005)	(0.013)	(0.005)	(0.003)	(0.010)	(0.006)	(0.012)	(0.006)	(0.004)	(0.009)
R^2 (overall)	0.895	0.854	0.927	0.880	0.838	0.899	0.759	0.885	0.900	0.927
Trade pc $Sanc_{t-1}$	25.3	51.0	28.8	16.9	46.0	24.6	33.6	52.6	33.1	47.1
to/from the **EU**	–0.012	–0.011	–0.036*	–0.014	–0.027(*)	–0.028*	–0.008	–0.027	–0.007	–0.024
	(0.014)	(0.038)	(0.016)	(0.009)	(0.016)	(0.012)	(0.022)	(0.022)	(0.012)	(0.016)
R^2 (overall)	0.921	0.907	0.876	0.908	0.922	0.916	0.902	0.889	0.921	0.931
Trade pc $Sanc_{t-1}$	61.8	79.1	58.6	32.9	70.9	42.6	61.3	105.7	55.9	89.5
to/from **China**	–0.010*	–0.057**	–0.018**	–0.005*	–0.017*	–0.002	–0.029**	–0.048**	–0.013	–0.028**
	(0.005)	(0.018)	(0.006)	(0.002)	(0.007)	(0.001)	(0.010)	(0.018)	(0.010)	(0.009)
R^2 (overall)	0.517	0.692	0.724	0.837	0.626	0.741	0.601	0.625	0.664	0.771
Trade pc $Sanc_{t-1}$	2.1	25.3	2.0	1.4	7.0	2.8	14.7	21.6	10.7	34.4
to/from **Russia**	0.009	0.003	0.003	0.000	0.005	0.003	0.010	0.005	0.003	0.008
	(0.015)	(0.006)	(0.009)	(0.005)	(0.010)	(0.003)	(0.038)	(0.005)	(0.003)	(0.007)
R^2 (overall)	0.637	0.735	0.673	0.663	0.741	0.642	0.670	0.523	0.686	0.739
Trade pc $Sanc_{t-1}$	5.0	4.0	3.3	2.1	4.9	3.1	29.5	2.3	1.2	3.0
to/from the **RoW**	–0.027*	–0.052	–0.059**	–0.022*	–0.051**	–0.026**	–0.066*	–0.034(*)	–0.005	–0.038**
	(0.014)	(0.034)	(0.018)	(0.009)	(0.019)	(0.007)	(0.030)	(0.019)	(0.006)	(0.011)
R^2 (overall)	0.790	0.914	0.845	0.915	0.881	0.867	0.810	0.891	0.927	0.902
Trade pc $Sanc_{t-1}$	63.7	115.5	48.5	26.1	95.3	68.3	163.6	88.1	43.9	107.8

Note: Coefficient estimates for Eq. (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. **, *, and (*) indicate significance at the 1%, 5%, and 10% level. Number of observations: 4,425. Trade pc $Sanc_{t-1}$ indicates the level of trade per capita (in USD) in the year before the imposition of sanctions. RoW: rest of the world.

4.3 Sanctions and Trade: Transmission Channels

The final part of our empirical analysis is dedicated to the study of two potential transmission channels through which sanctions could affect trade. First, we re-estimate Eq. (1) with the natural logarithm of the average official exchange rate against the US dollar in price notation or the natural logarithm of real industrial value added per capita (including construction) as the dependent variable. Table 3 sets out the results.[6]

Table 3: Average Treatment Effects of Sanctions on Exchange Rate and Industry Value Added

Dependent variable:	**FX/USD**	**FX/USD**	**Industry VA**	**Industry VA**
US Export	0.436(*)		–0.073*	
	(0.263)		(0.032)	
US Import		0.228		–0.078*
		(0.288)		(0.033)
US Other	0.155	0.237	0.014	0.022
	(0.226)	(0.241)	(0.019)	(0.020)
UN	0.111	0.085	–0.059	–0.051
	(0.405)	(0.398)	(0.056)	(0.055)
EU Unilateral	0.129	0.117	0.008	0.009
	(0.127)	(0.126)	(0.035)	(0.035)
R^2 (overall)	0.908	0.908	0.991	0.992
Observations	4,291	4,291	4,060	4,060

Note: Coefficient estimates for Eq. (1) where the dependent variable is either the natural logarithm of the average official exchange rate against the US dollar in price notation or the natural logarithm of real industrial value added 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. **, *, and (*) indicate significance at the 1%, 5%, and 10% level.

We find that the exchange rate is significantly higher when US export sanctions are in place (43.6%), implying that sanctions lead to a dramatic depreciation or devaluation of the domestic currency.[7] Put differently, lower exports go hand-in-hand with a decrease in the demand for domestic currency (Itskhoki and Mukhin 2022). This significant result, however, is not replicated for US import sanctions. In addition, we document a significant reduction of the industrial value added after both, US export (–7.3%) and import (–7.8%) sanctions. This is not surprising given that trade sanctions can limit access to production inputs and block access to foreign markets for industrial products. Finally, we do not find a significant effect of EU, UN, or non-trade US sanctions on either dependent variable.

[6] Due to missing values, these results are based on a slightly reduced sample.

[7] In our analysis, we do not distinguish between countries with floating and fixed exchange rates, since the latter could be forced to devalue as a consequence of sanctions.

Table 4: Exchange Rate and Industrial Value Added as Transmission Channels

	Exports					Imports				
	Table 1	Restr.	FX	VA	FX & VA	Table 1	Restr.	FX	VA	FX & VA
to/from the **US**	–0.036*	–0.030(*)	–0.024	–0.030(*)	–0.023	–0.032*	–0.032*	–0.029*	–0.031*	–0.028*
	(0.016)	(0.016)	(0.015)	(0.017)	(0.015)	(0.014)	(0.015)	(0.015)	(0.014)	(0.014)
R^2 (overall)	0.914	0.920	0.921	0.920	0.921	0.937	0.950	0.951	0.950	0.951
to/from the **EU**	–0.008	0.015	0.031	0.012	0.030	–0.019	–0.012	0.000	–0.018	–0.005
	(0.045)	(0.044)	(0.044)	(0.044)	(0.045)	(0.036)	(0.034)	(0.035)	(0.034)	(0.036)
R^2 (overall)	0.930	0.948	0.950	0.948	0.950	0.940	0.960	0.962	0.960	0.962
to/from **China**	–0.090**	–0.074**	–0.069**	–0.080**	–0.075**	–0.071*	–0.053*	–0.044*	–0.057*	–0.048*
	(0.024)	(0.022)	(0.022)	(0.023)	(0.024)	(0.028)	(0.021)	(0.020)	(0.022)	(0.021)
R^2 (overall)	0.755	0.793	0.795	0.795	0.796	0.742	0.807	0.813	0.807	0.813
to/from **Russia**	0.010	0.014	0.017	0.014	0.018	0.016	0.021	0.024	0.019	0.022
	(0.031)	(0.032)	(0.032)	(0.033)	(0.032)	(0.041)	(0.041)	(0.041)	(0.042)	(0.042)
R^2 (overall)	0.779	0.786	0.788	0.786	0.788	0.719	0.787	0.788	0.787	0.788
to/from the **RoW**	–0.095*	–0.071(*)	–0.065	–0.075(*)	–0.069(*)	–0.073**	–0.056*	–0.048*	–0.056*	–0.047*
	(0.041)	(0.039)	(0.040)	(0.040)	(0.040)	(0.028)	(0.025)	(0.023)	(0.024)	(0.022)
R^2 (overall)	0.930	0.942	0.943	0.942	0.943	0.925	0.941	0.942	0.941	0.942

Note: Estimates of Eq. (1) based on different dependent variables. Standard errors (in parentheses) are clustered at the country level. Models contain control variables, country-fixed effects, and year-fixed effects. **, *, and (*) indicate significance at the 1%, 5%, and 10% level. Number of observations: 4,425 (Table 1) and 3,939 (other columns). Column 'Table 1' replicates the baseline results, column 'Restr.' re-estimates the baseline model with all observations where data for the lagged exchange rate against the US dollar and the lagged real industrial value added per capita (including construction) is available, and columns 'FX', 'VA', and 'FX & VA' test for the different transmission channels. FX: exchange rate; VA: industrial value added; RoW: rest of the world.

In a second step, we test whether including the lagged exchange rate or the lagged industrial value added in our models presented in Table 1 changes our baseline estimates. To account for missing values in both variables, we first re-estimate Eq. (1) using a restricted sample (Restr.) before adding both potential transmission variables individually and jointly (columns FX, VA, and FX & VA). Some patterns become visible in Table 4. Most importantly, the inclusion of industrial value added (columns VA) does not noticeably change the coefficients from the columns 'Restr.' In contrast, the inclusion of the exchange rate (FX and FX & VA) slightly lowers the absolute value of the coefficients, providing further evidence for this variable as being a potential transmission channel for the effect of sanctions on trade.

5 Conclusion

In this study, we analyze the effect of US sanctions on trade flows of 184 countries during the period 1995–2019 using standard panel difference-in-differences estimations and an event study design. Motivated by the claim that China and Russia could purposefully undermine US sanction efforts, we test whether trade with China and Russia increases under US trade sanctions.

We find no evidence for such sanction-busting behavior by the two superpowers. Russia does not change its trade patterns in response to US sanctions. The negative effect of US sanctions on trade with China is even larger than that on trade with the US itself. A similar result emerges for trade with the rest of the world (i.e., countries other than China, the EU, Russia, and the US). These overall patterns are reconfirmed when studying different groups of commodities: agricultural products, (raw) materials, machines, critical goods, and other goods. Hence, our results are consistent with the consistent observation in the empirical literature that sanctions have important adverse effects on a country's economy and society.

Further results indicate that the effect of US sanctions on exports from the sanctioned countries is more persistent than the effect on imports to these countries. We find some evidence for a reduction in industrial value added and, in particular, a devaluation of the domestic currency as potential transmission channels through which US sanctions affect trade. Lastly, our findings can be interpreted as causal, since we do not observe a reduction

in trade flows in the years before the imposition of sanctions, indicating that the deterioration marks a significant deviation from the pre-trend.

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Appendix: Background Information on the Dataset

Table A1: Variable Definitions and Sources

Log-Exports pc; **Log-Imports pc**. Natural logarithm of exports/imports per capita (+1, in 1,000 USD). *Source*: UN Comtrade Database and Gaulier and Zignago (2010). Exports and imports are broken down along two dimensions:

Trade partners

1. US
2. EU
3. China
4. Russia
5. Rest of the world (i.e., excluding US, EU, China, and Russia)

Type of goods

1. Agricultural goods (HS 2-digit categories 1–24)
2. (Raw) materials (HS 2-digit categories 25–29, 31, 38, 68, 72–76, 78–81, and 83)
3. Machines (HS 2-digit categories 82 and 85–90)
4. Critical goods (arms, explosives, and nuclear items; HS 2-digit categories 36, 84, and 93)
5. Other goods (remaining HS 2-digit categories)

Log-GDP pc. Natural logarithm of real GDP per capita (in 1,000 USD). *Source*: World Bank.

Log-RTA. Natural logarithm of the number of regional trade agreements (plus one). *Source*: Mario Larch's Regional Trade Agreements Database (Egger and Larch 2008).

Human Rights. Latent human rights protection score with higher values indicating better protection. *Source*: Fariss (2019).

Democracy. Binary democracy indicator. *Source*: Bjørnskov and Rode (2020).

Major Conflict; **Minor Conflict**. Armed conflicts resulting in at least 1,000 battle-related deaths in a given year; conflicts resulting in between 25 and 999 battle-related deaths. *Source*: UCDP/PRIO Armed Conflict Dataset (Gleditsch et al. 2002).

Sanctions. Binary indicators for country-years with sanctions by specific senders in place (see Table A3). *Source*: Global Sanctions Data Base, Version 2 (Felbermayr et al. 2020a; Kirikakha et al. 2021).

Log-FX/USD. Natural logarithm of the average official exchange rate against the US dollar in price notation. *Source*: World Bank.

Log-Industrial Value Added pc. Natural logarithm of real industrial value added per capita (including construction). *Source*: World Bank.

Table A2: List of Countries

Afghanistan (17/0), Albania (25/0), Algeria (25/8), Angola (25/1), Antigua and Barbuda (25/3), Argentina (25/0), Armenia (25/0), Australia (25/0), Austria (25/1), Azerbaijan (25/8), Bahamas (25/0), Bahrain (25/0), Bangladesh (25/0), Barbados (25/0), Belarus (25/20), Belgium (25/0), Belize (25/16), Benin (25/3), Bhutan (25/0), Bolivia (25/0), Bosnia and Herzegovina (25/0), Botswana (20/0), Brazil (25/0), Brunei (25/0), Bulgaria (25/0), Burkina Faso (25/2), Burundi (25/10), Cambodia (25/14), Cameroon (25/5), Canada (22/3), Cape Verde (25/0), Central African Republic (25/8), Chad (25/2), Chile (25/0), Colombia (25/13), Comoros (25/0), Congo (25/0), Costa Rica (25/16), Cote d'Ivoire (25/4), Croatia (24/6), Cuba (25/25), Cyprus (25/24), Czech Republic (25/0), Democratic Republic of Congo (25/3), Denmark (25/0), Djibouti (6/0), Dominica (25/2), Dominican Republic (25/9), Ecuador (25/6), Egypt (25/5), El Salvador (25/0), Equatorial Guinea (25/3), Eritrea (17/2), Estonia (24/0), Ethiopia (25/0), Fiji (25/15), Finland (25/0), France (25/22), Gabon (25/0), Gambia (25/12), Georgia (25/0), Germany (25/0), Ghana (25/2), Greece (25/7), Grenada (25/0), Guatemala (25/20), Guinea (25/8), Guinea-Bissau (25/2), Guyana (25/0), Haiti (25/25), Honduras (25/2), Hungary (25/0), Iceland (24/0), India (25/14), Indonesia (25/24), Iran (25/14), Iraq (25/0), Ireland (25/17), Israel (24/0), Italy (25/0), Jamaica (25/9), Japan (25/0), Jordan (25/0), Kazakhstan (25/0), Kenya (25/0), Kiribati (21/0), Kuwait (24/0), Kyrgyz Republic (25/0), Laos (25/3), Latvia (24/0), Lebanon (25/3), Lesotho (20/4), Liberia (19/0), Libya (20/7), Lithuania (24/0), Luxembourg (21/0), Macedonia (25/0), Madagascar (25/0), Malawi (25/3), Malaysia (25/0), Maldives (24/0), Mali (25/2), Malta (25/0), Marshall Islands (25/0), Mauritania (25/2), Mauritius (25/0), Mexico (25/0), Micronesia (25/0), Moldova (24/8), Mongolia (25/0), Montenegro (14/0), Morocco (25/0), Mozambique (25/0), Myanmar (25/24), Namibia (20/0), Nauru (15/0), Nepal (25/1), Netherlands (25/0), New Zealand (25/0), Nicaragua (25/1), Niger (25/8), Nigeria (25/16), Norway (25/0), Oman (25/0), Pakistan (25/11), Palau (19/0), Panama (25/0), Papua New Guinea (25/0), Paraguay (25/0), Peru (25/4), Philippines (25/18), Poland (25/0), Portugal (25/0), Qatar (19/0), Romania (25/2), Rwanda (25/2), Saint Kitts and Nevis (25/0), Saint Lucia (25/0), Saint Vincent and the Grenadines (25/0), Samoa (25/0), Sao Tome and Principe (18/0), Saudi Arabia (25/2), Senegal (25/0), Seychelles (25/0), Sierra Leone (25/3), Singapore (25/0), Slovak Republic (25/0), Slovenia (24/0), Solomon Islands (25/0), Somalia (6/0), South Africa (25/5), South Korea (25/0), South Sudan (5/3), Spain (25/0), Sri Lanka (25/8), Sudan (25/3), Suriname (25/0), Swaziland (20/0), Sweden (25/0), Switzerland (25/0), Syria (25/13), Tajikistan (25/0), Tanzania (25/1), Thailand (25/3), Timor (19/0), Togo (25/25), Tonga (25/0), Trinidad and Tobago (25/0), Tunisia (25/0), Turkey (25/1), Turkmenistan (25/0), Tuvalu (24/0), Uganda (25/0), Ukraine (25/6), United Arab Emirates (25/0), United Kingdom (25/0), Uruguay (25/0), Uzbekistan (25/10), Vanuatu (25/0), Vietnam (25/14), Yemen (25/2), Yugoslavia (23/0), Zambia (25/3), Zimbabwe (25/17).

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 US sanctions against that country. Sanctions enacted by the UNSC are not counted as US sanctions.

Table A3: Frequency of Sanctions

Sanction senders		**US sanctions over time**	
US (without UN)	653	Pre-Trend –3 Years	68
... US Unilateral	438	Pre-Trend –2 Years	72
... US & EU	215	Pre-Trend –1 Year	80
UN	244		
EU (without UN & US)	129		Export / Import
		Sanctions Year 1	24 / 27
US sanction types		Sanctions Year 2	19 / 21
Non-Trade	399	Sanctions Year 3	16 / 16
Trade	254	Sanctions Year 4	14 / 16
... Export	190	Sanctions Year 5	13 / 15
... Import	230	Sanctions Year 6	13 / 15
		Sanctions Year 7	12 / 15
		Sanctions Year 8	10 / 13
		Sanctions Year 9+	69 / 92
		Post-Trend +1 Year	75
		Post-Trend +2 Years	67
		Post-Trend +3 Years	64

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: 4,425.

Table A4: Descriptive Statistics (Mean Values)

Continuous variables	**(1)** **Full Sample**	**(2)** **No US Sanctions**	**(3)** **US Sanctions**
Log-Exports to US	0.219	0.231	0.153
Log-Exports to EU	0.518	0.554	0.309
Log-Exports to China	0.120	0.133	0.044
Log-Exports to Russia	0.046	0.048	0.036
Log-Exports to RoW	0.580	0.626	0.316
Log-Imports from US	0.245	0.261	0.148
Log-Imports from EU	0.584	0.627	0.337
Log-Imports from China	0.214	0.231	0.116
Log-Imports from Russia	0.089	0.091	0.077
Log-Imports from RoW	0.679	0.728	0.394
Lag(Log-GDP pc)	1.471	1.560	0.959
Log-RTA	3.227	3.209	3.331
Human Rights	0.713	0.870	-0.193
Binary indicators			
Major Conflict	0.038	0.036	0.052
Minor Conflict	0.111	0.091	0.224
Demoracy	0.603	0.627	0.469
Transmission channels			
Log-FX/USD	2.948	2.802	3.838
	(4,291)	(3,686)	(605)
Log-Indust. Value Added pc	0.089	0.171	-0.382
	(4,060)	(3,461)	(599)

Note: Mean values for all dependent variables, control variables, and both transmission channels. Full sample (Column 1; 4,425 obs.) is split into country-years without (Column 2; 3,772 obs.) and with US sanctions in place (Column 3; 653 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. Sanctions enacted by the UNSC are not considered US sanctions.