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Economic Insecurity: Trade Dependencies and Their Weaponization in History

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ABSTRACT

ECONOMIC INSECURITY: TRADE DEPENDENCIES AND THEIR WEAPONIZATION IN HISTORY

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Do trade dependencies leave countries vulnerable to geopolitical coercion? We study the economic costs of trade and financial sanctions, from 1920 to the present. We first develop a continuous measure of sanction intensity, using bilateral commodity-level data to calculate the importance of specific flows that fall under sanctions. We find that sanctions inflict relatively small costs on average: sanctioning 1% of GDP worth of imports or exports leads to approximately 0.3 percentage points of lost GDP over a 5-year period and a 0.1 percentage point increase in unemployment. However, we show that sanctions are far more costly for countries whose trade is highly concentrated, and for countries that rely heavily on exporting primary commodities. Low income and developing countries appear most vulnerable to trade sanctions, while high income financial centers and some EU countries are among the most exposed to financial sanctions.

Keywords: F13, F14, F41, F51

JEL classification: Trade sanctions, Trade dependencies, Vulnerability to sanctions, Financial sanctions, Economic coercion, Effects of sanctions

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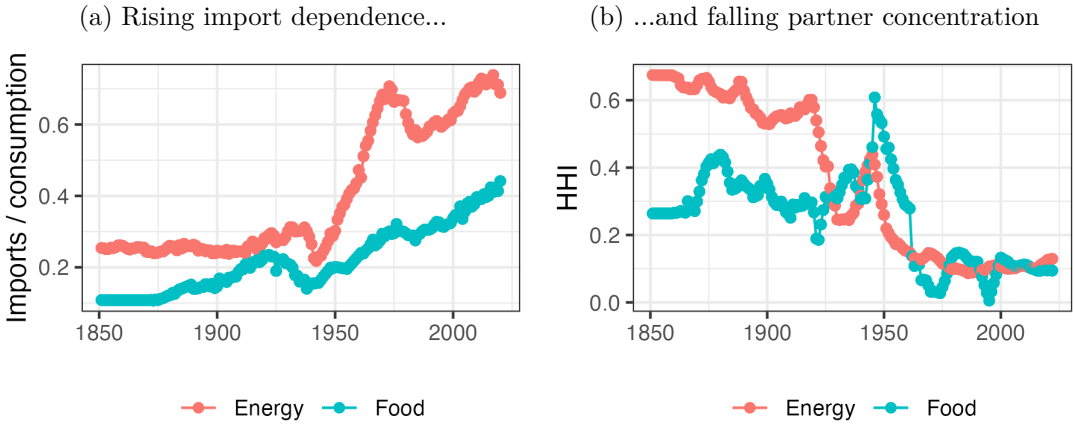
1 Introduction

Trade dependencies are a fact of the 21st century. As Figure 1a suggests, developed economies rely on imports to cover an increasing share of crucial energy and food supplies. Does this leave them vulnerable to geopolitical aggression? These countries also source their crucial imports from an increasingly diversified portfolio of trading partners (panel 1b). Does this provide meaningful insurance? Since Russia's invasion of Ukraine in 2022, policymakers have been especially concerned with these questions. This paper attempts to quantify the extent to which their concerns are justified, using bilateral trade data and covering a century of trade and financial sanctions.

Figure 1: Trends in import dependence



Note: Figures show long-run averages across six countries (USA, UK, France, Germany, Italy, Japan). Panel 1a is the share of imported quantities in total consumed quantities of energy (megajoules) and food (kilocalories). Panel 1b shows a "Herfindahl-Hirschman index" measure of trading-partner concentration for these same goods. While developed countries are increasingly reliant on imports of essential goods, they're sourcing these goods from an increasingly diversified portfolio of trading partners. For more on the calculation of HHI, see section 4.1; data sources are described in the appendix.

Existing evidence for the effect of sanctions relies largely on general equilibrium trade models (Bachmann et al., 2022; Itskhoki and Ribakova, 2024). These complex models have a rich structure, but depend crucially on assumptions about deep economic parameters that are empirically uncertain. Our approach is complementary. We aim to use the historical record to provide empirical evidence.

Existing empirical analyses of sanctions have so far been somewhat limited by measurement. These analyses usually measure sanctions as binary events, or else examine specific case studies (Eichengreen et al., 2024; Bianchi and Sosa-Padilla, 2023; Ghomi, 2022; Gutmann et al., 2023). In this paper we leverage bilateral trade data to develop a more precise measure: we calculate

the share that a sanctioned trade flow comprises of the sanctioned country's GDP. In addition to measuring bilateral trade flows, where possible we collect data on the specific commodity-level flows that fall under sanction. We are then able to build a continuous measure of the severity of sanction policies, depending on the share of sanctioned trade.[1]

Overall, we find that trade sanctions inflict only small costs on average, but that certain countries are far more vulnerable. On average, sanctioning 1% of GDP worth of imports or exports appears to cause around 0.3 percentage points of lost GDP over 5 years, and a 0.1 percentage point increase in unemployment. Causing significant damage would thus require sanctioning something like 10% of GDP. Imports or exports in developed countries usually account for about 30% of GDP, so a sufficiently strong sanction would mean cutting off at least one third of a country's trade. Our results thus suggest that sanctions do hurt, but that only very drastic sanctions can inflict meaningful economic damage – at least on average.

However, we also find that trade vulnerabilities can render sanctions significantly more costly, and that inversely, diversification seems to provide insurance. Sanctions appear far more potent against 1) countries that are dependent on exporting primary commodities and 2) countries whose trade is highly concentrated with a small number of partners. As a rough benchmark, countries seem to escape economic harm when their "HHI" score of trading partner concentration is below 0.25. The reduction in trading partner concentration that developed countries have experienced since 1950 - panel 1b – thus renders them far less vulnerable to weaponized dependence. In contrast, countries that are dependent on exporting primary commodities, and who rely on a small number of trading partners, tend to be lower-income or developing countries. Overall, our evidence thus suggests that developing countries, and not wealthy European or North American economies, have the most to fear from weaponized dependence.[2]

Historians and political scientists have studied the effects of historical sanctions. Their research typically asks whether sanctions are effective in achieving their declared political aims, and most often focuses on case studies (Miller, 2014; Ghomi, 2022; Mulder, 2022; Hufbauer et al., 2009; Gutmann et al., 2020). In contrast, a recent economic literature has focused on the economic cost of sanctions.[3] In this research, one issue has been the potential endogeneity of economic sanctions: countries are sanctioned for reasons that may be related to their economic conditions. Recent efforts to address this issue include reducing the control sample (Neuenkirch and Neumeier, 2015) and employing a nearest neighbor matching approach (Neuenkirch and

[1] We construct a similar, but less precise, measure of financial sanctions in section 4.

[2] Figure 13 in the conclusion shows the 15 countries most and least vulnerable to sanctions, based on the estimates in this paper.

[3] For a literature review, see Morgan et al. (2023), Felbermayr et al. (2021), van Bergeijk (2021).

Neumeier, 2016).

Two recent papers are worth discussing in more detail. Kwon et al. (2022) attempt to address the endogeneity of sanctions: they propose an instrument based on the aggressiveness of sanctioning countries, which they then use to study a range of bilateral and unilateral sanction outcomes.[4] Similarly, Gutmann et al. (2023) uses an event-study design to analyze the costs of sanctions. Both of these papers however rely on a binary indicator for sanction events. We contribute a more precise measure of sanctions' intensities. In the appendix, we show that we are able to roughly replicate the more substantial costs found in Gutmann et al. (2023),[5] when using a dummy for sanction events rather than our continuous measure. This suggests that the measurement of sanction intensity does matter to quantify their cost.

The remainder of the paper is structured as follows. Section 2 introduces our sanction data and provides descriptive evidence. Section 3 gives our formal empirical analysis, and section 4 studies the vulnerabilities that render sanctions more potent. We then study financial sanctions in section 5. Section 6 concludes.

2 Sanction selection and measuring sanction intensity

This section introduces the underlying data. We discuss our sample of sanction events and how we measure sanction intensity.

As a starting point, we use the "Global Sanctions Database" (Felbermayr et al., 2020), which has also been used in several recent studies. We make two additions to these data. First, we add sanction events from the interwar period and the late 19th century, which have been discussed in recent research (Mulder, 2022; Eichengreen et al., 2024; Hufbauer et al., 2009). Second, and crucially, we add observations of the specific bilateral trade flows affected, as well as, where possible, the specific commodities sanctioned. This allows us to calculate the intensity of imposed sanctions. To our knowledge, ours is the first paper to measure sanction intensity from disaggregated, bilateral trade data.

Following Felbermayr et al. (2020), we define "trade sanctions" as trade restrictions enacted by sanctioning state(s) specifically in order to punish or compel change in a sanctioned country

[4] One concern is that their results may be contaminated by selection bias, as most of the sanctions they study were nonetheless imposed on countries at war. We exclude all countries that fight a war in the years following a sanction, to avoid contaminating the effects of sanctions with the effects of wars. When we re-include these observations, our estimated effects become larger, suggesting that indeed, the larger estimated effects of sanctions might be capturing the negative effects of war.

[5] Gutmann et al. (2023) found that during a sanction episode, the GDP per capita of an average target country decreases by 2.8 percent within the initial two years. Notably, this decline persists even three years after the sanctions are lifted.

or countries. As such, we do not consider tariffs or other 'conventional' trade policy measures on their own to necessarily constitute sanctions. Defined this way, sanctions are *politically* motivated; this makes it more likely that they are exogenous to domestic economic conditions. We explore whether this is likely to be true in the next section.

In total, we identify 535 unique sanction policies, enacted by one or more countries against one or more countries, for one or more years. The average sanction policy lasts for six years, with a median length of three. Table 1 gives an overview of these policies. In 120 cases, multiple countries agreed to enact a sanction together, and in 24 cases, the sanction was imposed on multiple countries at the same time. Because so many sanction cases involved coalitions, the number of *dyadic* sanction events is much larger: there are 9208 distinct dyadic pairs involved across all of the 545 cases. And because most sanctions lasted multiple years, the total number of dyad-years during which sanctions were enacted is over 70,000.

Table 1: Summary statistics sanction events, 1870-2020

	Total obs.	Dyadic obs	Dyad-by-year obs	Avg. case length	Avg. No. sender per case	Avg. No. target per case
Total sanction cases	535	9,208	71,889	5.9	14	1
Multi-sender only	111	6,666	38,465	6.7	60	1
Multi-target only	15	155	963	3.3	1	10
Both	9	1,987	30,619	11.4	29	9
Neither	400	400	1,842	5.7	1	1

Source: Author calculations from extensions to the data in Felbermayr et al. (2020). See text.

We are interested in the effects of sanctions on their targets; we thus focus our attention on observing sanctioned countries. For this purpose we define sanction "spells" faced by a targeted country. A sanction "spell" is a period of consecutive years in which a country faces one or more sanctions. A "spell" begins when a sanctioned country goes from experiencing no sanction, to experiencing some sanction; it lasts for the duration of the sanction. The 535 policies in our data are distributed across 227 distinct targeted-country sanction spells (see Table 2 for summary statistics). That means, within one sanction spell, the sanctioned countries experience more than two sanctions on average.

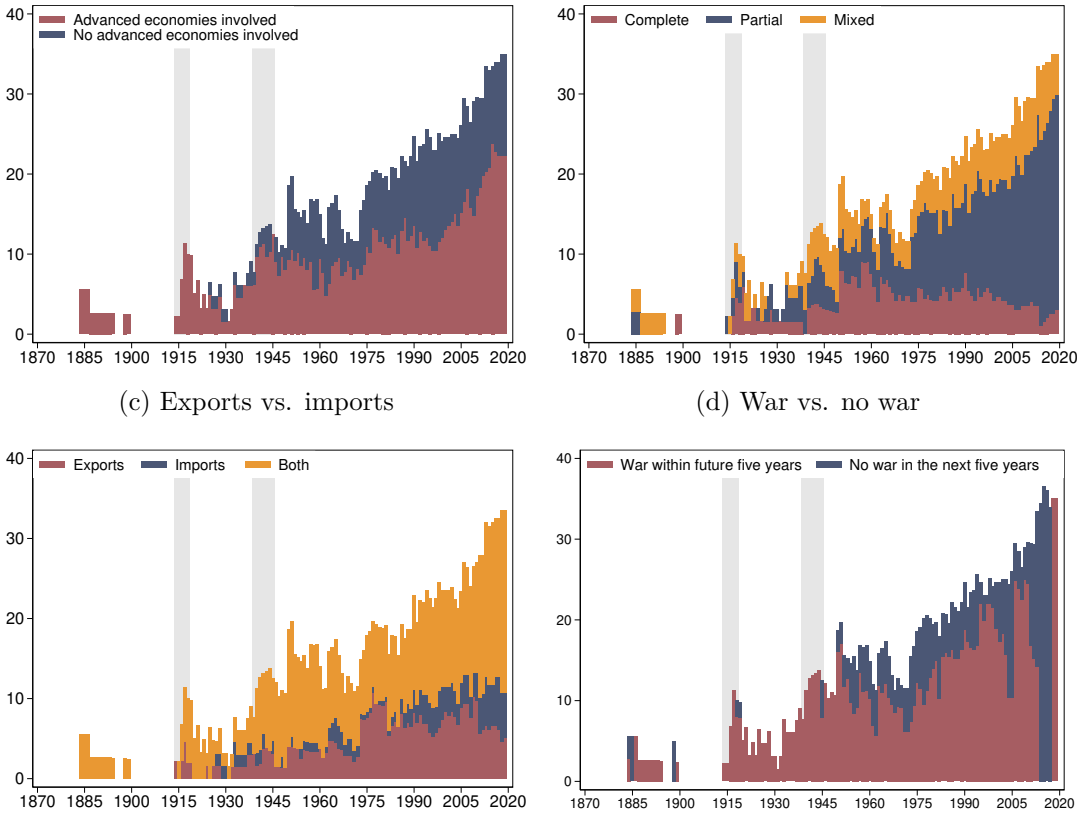
Ultimately however, we are interested both in the effectnacting an initial sanction, and of continuing or intensifying an existing sanction. We thus want to observe each targeted country in each year that they face any active sanction. These 'target-years' will be the basis of our analysis.

Figure 2 reports the share of countries worldwide that have faced an active sanction in a given year. Panel 2a shows the share of countries that faced a sanction imposed by at least one "advanced economy." Overall, most sanctions were imposed at least in part by these advanced economies.

Figure 2: Share of countries sanctioned worldwide (in %), 1870-2020

(a) Sender countries involved

(b) Complete vs. partial



(c) Exports vs. imports

(d) War vs. no war

Note: Advanced economies include Australia, Canada, United Kingdom, United States, Germany, France, Belgium, Netherlands, Switzerland, Portugal, Spain, Italy, Ireland, Norway, Denmark, Finland, Japan, Sweden.

Sources: Felbermayr et al. (2020); Mulder (2022); Eichengreen et al. (2024); Hufbauer et al. (2009)

Following Felbermayr et al. (2020), we track whether enacted sanctions are "import sanctions," in which the sanctioning country stops importing from the sanctioned country, or "export sanctions," which are the reverse (panel 2c). The direction of the flows can be confusing: note that the convention in the literature is to name sanctions from the perspective of the *sanctioning* country. So, an "import sanction," in which the sanctioning country stops importing from the sanctioned country, affects the sanctioned country's *exports*. We will follow this convention, but will often clarify explicitly – for example, by writing "import sanction placed on a country's exports."

We also track whether sanctions are "complete" embargoes, in which all imports or all exports

stop between the sanctioned and sanctioning countries, or only "partial" sanctions (panel 2b).

We next measure the intensity of each imposed sanction. As mentioned, we want to account for the effect of the initial imposition of a sanction, as well as of the intensification or continuation of existing sanctions. As such, we measure the intensity of trade sanctions in each year by calculating the share of sanctioned trade in the sanctioned country's GDP. Equation 1 formalizes this: it describes the total intensity of all sanctions faced by sanctioned country a in time t. We look at the sanctioned country's trade with all other countries (which are indexed by b) in the year before the sanction, $t-1$. At time t, a share $1-n_t^{ab}$ of trade between a and b falls under sanction. We thus relate $(1-n_t^{ab}) * Trade_{t-1}$ to the sanctioned country's GDP in $t-1$:[6]

$$\text{Sanction intensity}_t^a = \frac{\sum_{b=1}^{B}(1-n_t^{ab}) * Trade_{t-1}^{ab}}{GDP_{t-1}^a} \tag{1}$$

In equation 1, we can sum over all trade flows to calculate the intensity of all sanctions, or we can include only imports or exports to respectively measure the intensity of export or import sanctions separately. For "complete" sanctions we assume that all trade is affected, and $n=0$. For "partial" sanctions, when possible, we determine the specific goods on which the sanction was placed by reviewing historical laws, resolutions, and newspaper articles. We then use bilateral trade data from the UN Comtrade database, including commodity-level data where possible, to measure $(1-n_t^{ab}) \times Trade_{t-1}^{ab}$, the share of the specific trade flow in $t-1$ that fell under sanction in time t.[7]

Where commodity-level data is unavailable (either because the goods affected by the sanction cannot be determined, or because the sanctioned country did not report adequately disaggregated data in year $t-1$), we impute the share of sanctioned trade. In Section 3.1, we present results indicating that "partial" sanctions on average cut the relevant bilateral trade flow by 25%. We thus set $1-n_t^{ab} = .25$ in our measure of sanction intensity when the commodities under sanction are unobserved.[8] This is a weakness with our data, but the assumption does not appear hugely important: our results are unchanged by assuming that 75% instead of 25% of trade is affected during unobserved partial sanctions. Additionally, dropping these observations entirely, although it leaves us underpowered, yields similar point estimates.

[6] For example: if country a's imports from country b amounted to 1% of country a's GDP in year $t-1$, and if country b then stopped exporting to country a in year t – meaning that they imposed an "export sanction" – then as a first pass, the intensity of this sanction would be 0.01

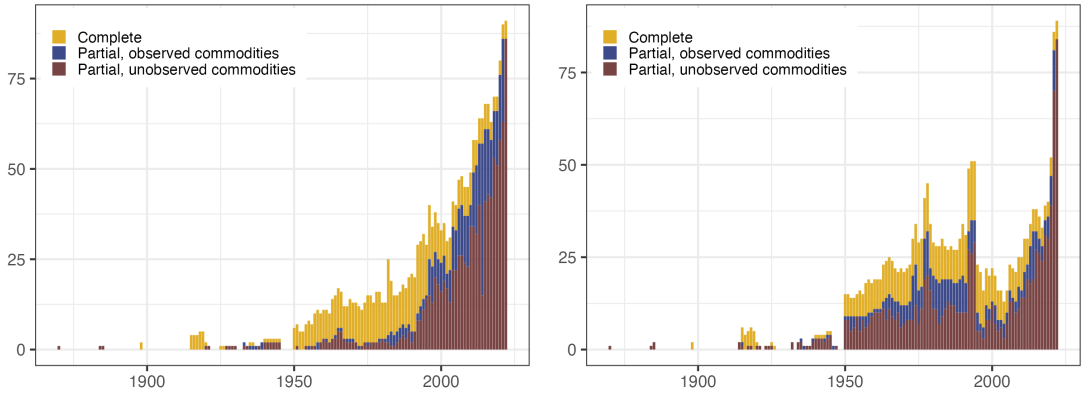
[7] For instance, if country b's sanction was only on wheat exports to country a in year t, and if exports of wheat from b to a in year $t-1$ were 15% of all of a's imports (by value), then the intensity of this sanction would instead be 0.01×0.15.

[8] In the example above, if country b's export sanction on a was partial and the goods involved were unobserved, then we would estimate its intensity instead to be 0.01×0.25.

Figure 3 gives an overview on the import and export sanctions across 150 years. It reports the absolute number of countries facing import and export sanctions each year. The majority of sanctions are "partial," affecting only some goods. However, we cannot observe the affected commodities for most (83%) of these partial sanctions (brown shaded area), and rely instead on observing the total value of the affected bilateral trade flow affected.

Figure 3: Number of target countries by kind of sanction, 1870-2020

(a) Import sanctions (b) Export sanctions



Sources: Felbermayr et al. (2020); Mulder (2022); Eichengreen et al. (2024); Hufbauer et al. (2009)

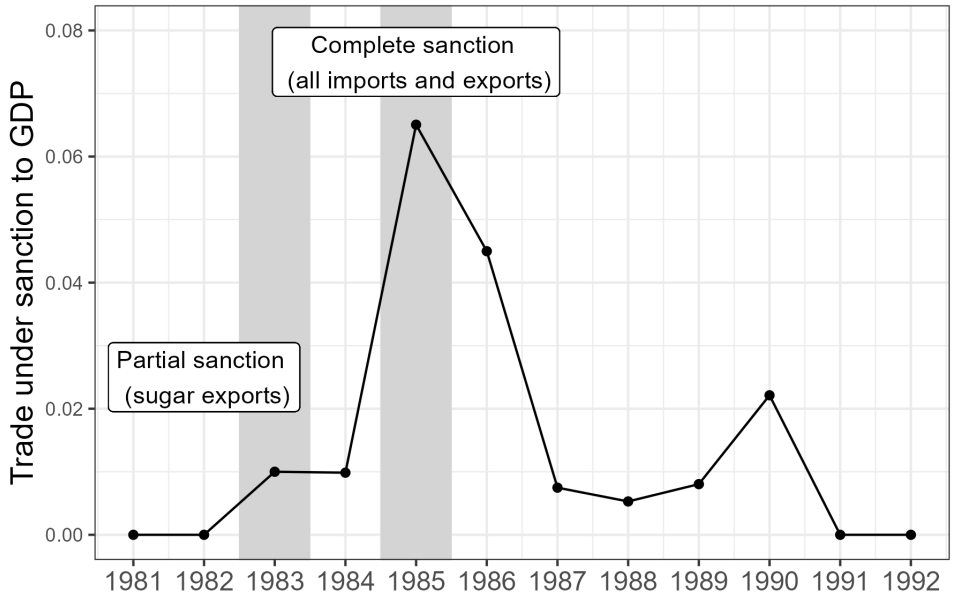
Finally, observe that to account for multilateral sanctions, we consider all sanctions faced by country a in year t by summing over all partner countries b.[9] This measure thus captures the total intensity of *all* sanctions faced by country a in a year t, taking into account sanctions of specific commodities and the combined effect of any multilateral sanctions.

Figure 4 shows an example. It plots the path of sanctions enacted by the US against Nicaragua in the 1980s, as the US government tried to remove the communist Sandinista party from power. After the Sandinistas expelled three US diplomats in 1983, Ronald Reagan's administration retaliated by reducing the quota on imports of sugar from Nicaragua by 90%. Nicaraguan sugar exports to the US totaled $27.4 million before the sanction, amounting to about 1% of Nicaragua's GDP; they fell to $4 million after the sanction. Ignoring a GATT ruling that the sanctions violated free trade, in 1985 the White House invoked emergency national security powers to bypass Congress and enact a full trade embargo against Nicaragua (Leogrande, 1996). As Figure 4 shows, this produces a spike in our sanction intensity measure: gross trade with Nicaragua totalled $178.7 million in 1984 (about 6.5% of Nicaragua's GDP); this fell to $91

[9] So, if country c joined country b in sanctioning country a in year t, we would repeat the above calculation for bilateral trade between country c and a, and add the resulting bilateral intensity to the intensity of a's sanction. That is: if country b's exports to a were 1% of a's GDP, and country c's exports were 0.5% of a's GDP, and if b imposed a partial sanction worth 25% of trade and c imposed a complete sanction, then the total intensity of the sanction faced by a would be $0.01 \times 0.25 + 0.05 \times 1 = 0.075$.

million in 1985 as the sanction began to take effect; and finally fell all the way to $6.1 million in 1986. In Figure 4, this corresponds to the intensities of the sanction in 1985, 1986, and 1987. The US finally lifted sanctions in 1991.

Figure 4: Example sanction path (US sanctions against Nicaragua)



Note: This figure plots the intensity of sanctions imposed by the US against Nicaragua between 1983 and 1990 (see text for historical details). Sanction intensity on the y-axis is the share in GDP of last year's trade that falls under sanction this year. So for instance, the value of 0.01 in 1983 represents the fact that the US stopped importing sugar from Nicaragua in 1983, and in 1982, Nicaraguan exports of sugar to the US were worth about 1% of Nicaraguan GDP. The intensity of 0.065 in 1985 reflects the fact that the US imposed a complete import sanction that year; Nicaragua's exports to the US in 1984 were worth 6.5% of its GDP.

Aside from illustrating our measure of sanction intensity, Figure 4 also shows why we measure sanctions in each year. In this case, we want to avoid attributing the effect of the partial sanction in 1983 to the full embargo enacted in 1985; similarly, we want to avoid attributing the effects of the full embargo to the lower intensity sanctions measured from 1986 to 1990. Our empirical strategy will take care to avoid comparing observations that would produce exactly this sort of contamination (we follow strategies to do so laid out in Dube et al. (2023)). We discuss this in more detail when presenting the design below.

Finally, many sanctions occur during wars. We want to capture the effect of sanctions themselves, without contaminating our results with the potentially large economic costs of wars. As such, we exclude all years when the sanctioned country is involved in a 'militarized interstate dispute' in any of the next five years, as defined and coded by the Correlates of War database (Sarkees and Wayman, 2010). This leaves us with a final sample of 920 target-year observations over 69 sanction spells.

Table 2 reports the average and median intensities of sanctions in our data. The average intensity of a new sanction event – i.e., of the first year that any sanction is imposed on a country – is 3.2% of GDP. This is driven by a few very large sanction events; the median sanction intensity is instead half a percentage point of GDP. When sanctions are observed in every year that they are kept in place, the median intensity is about the same; the average intensity is 2.3% of GDP.[10] Finally, excluding wars does not appear to have large effects on these summary statistics; at first glance, there are minimal obvious differences in the intensities of sanctions that were followed by wars, and those that were not.

Table 2: Summary statistics sanction intensity (in % of GDP), 1870-2020

	Obs	Mean	Median	SD	Min	Max
Intensity per sanction spell						
Full sample	227	3.6	0.5	10.6	0.0	86.5
Without wars	69	2.7	0.2	5.7	0.0	28.0
Intensity per target-year						
Full sample						
All sanctions	2,746	2.3	0.4	6.9	0.0	86.5
Import and export sanctions	1,293	4.1	0.9	9.9	0.0	86.5
Import sanctions only	816	0.7	0.1	3.1	0.0	54.3
Export sanctions only	637	1.6	0.5	3.1	0.0	28.0
Sample without wars						
All sanctions	920	2.3	0.5	6.5	0.0	77.7
Import and export sanctions	365	4.8	1.6	10.2	0.0	77.7
Import sanctions only	307	0.7	0.1	3.3	0.0	54.3
Export sanctions only	248	1.8	0.7	3.2	0.0	28.0

Note: A sanction "spell" is a period of consecutive years in which a country faces one or more sanctions. A spell begins when a country goes from facing no sanctions to some sanctions, and it ends when the country goes from facing some sanctions to no sanctions. In contrast, "target-years" are observed each year that a targeted country is subject to a sanction. See text.

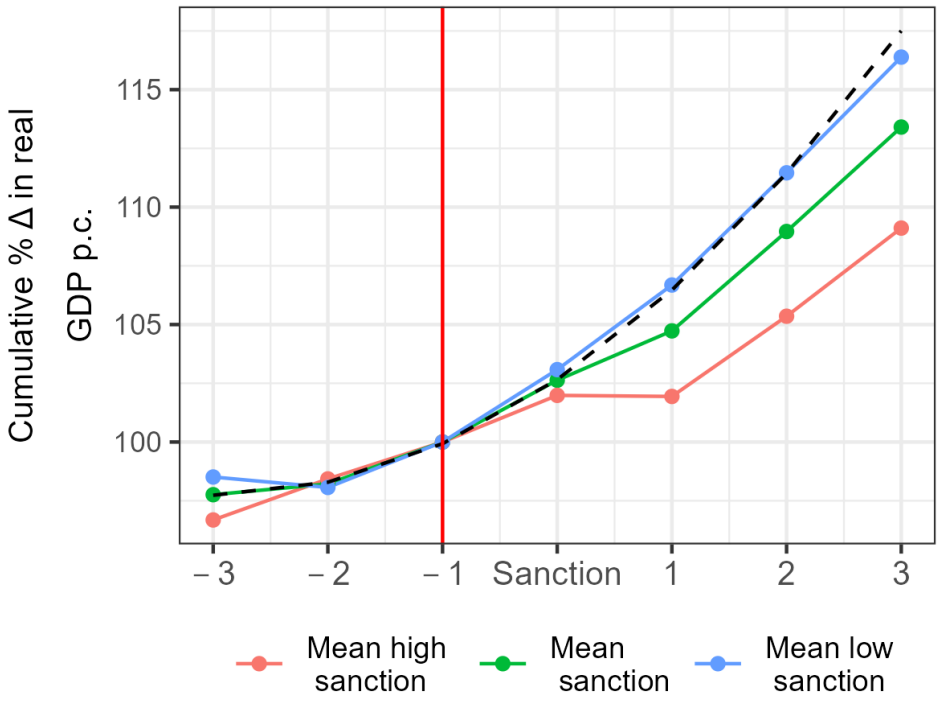
What is the average path of an economy following a (peacetime) sanction? Figure 5 looks at an average across all sanction events in our data. It plots the average cumulative percent change in real GDP per capita from the year before a sanction was imposed to year t (GDP in year $t-1$ is thus normalized to 100). A sanction event here is defined as the first year in which a country went from facing no sanctions to facing some sanction; subsequent years in which the

[10] It is logical that this second mean is lower: after a sanction is imposed, trade of course will fall between the sanctioned and sanctioning country, meaning that the 'intensity' of the sanction during subsequent years will be lower.

sanction was held in place are excluded from the sample in this figure.

Figure 5 groups sanctioned countries into those facing sanction events with below- and above-median intensities. The green line shows the mean path of relative GDP of all countries facing any sanction; the blue line shows the mean path of relative GDP for countries facing a below median intensity sanction, and the red line for those facing an above-median intensity sanction. Even this simple descriptive exercise is suggestive: all groups appear on a similar GDP trend before the imposition of sanctions, growing between 2-3 percentage points between year $t-3$ and $t-1$. Afterwards, countries that faced more intense sanctions began to grow more slowly. The dashed black line extrapolates a quadratic trend from before the imposition of sanctions; countries that faced low-intensity sanctions show essentially no deviation. In contrast, countries that faced high-intensity sanctions seem cumulatively to have lost around 5 percentage points of counterfactual GDP in the four years following the sanction, corresponding to 1.2% lower growth each year. (This is a large loss, but the median *high-intensity* sanction is indeed quite large: it is 3.2% worth of GDP that falls under sanction.)

Figure 5: GDP following sanction events



Note: Lines show the mean paths of the cumulative percent change in real GDP per capita before and after the imposition of a sanction. GDP paths are normalized to 100 in the year before the sanction is imposed. The green lines are the average path for all sanctioned countries; the red and blue lines show the average path for countries facing high and low-intensity sanctions respectively. These are defined as sanctions in which the GDP share of sanctioned trade is above or below that of the median sanction event. Sanctioned countries appear to lose about 1-2 percentage points of cumulative GDP, and highly-sanctioned ones about 5 percentage points.

To verify this descriptive evidence, we next develop a more formal empirical strategy.

3 Empirical strategy and results

To test for the economic costs of sanctions, we use a Local Projections-based difference in differences strategy, designed to capture the causal effect of sanctions on GDP. 'Treatment' in this design is the intensity of a sanction in a given year. After removing all sanctions that are enacted during or prior to wars, we assume that the remaining sanctions are exogenous to the domestic economic conditions in the sanctioned country.

A first piece of evidence in support of this assumption is provided by Figure 5 in Section 2. There are no obvious jumps or dips in the paths of GDP or unemployment prior to the imposition of a sanction. It does not appear to be the case that sanctions systematically occur during either economic booms or busts. To provide further support for this, we attempt to predict the occurrence of sanctions with prior domestic economic conditions. If it were possible to statistically predict sanctions with lagged economic variables, this would indicate that political sanctions were not exogenous to economic conditions: perhaps sanctions are enacted to fight countries experiencing strong and threatening growth; or alternatively, perhaps they are systematically enacted against countries experiencing low growth to take advantage of their vulnerability. We estimate logit regressions, predicting the imposition of a sanction with lagged values of GDP, inflation, and unemployment.

As Table A1 in Appendix A shows, prior domestic economic conditions do not appear meaningfully correlated with the imposition of a sanction in the future. This is at least somewhat reassuring for our ability to identify the causal effect of sanctions. In addition, in our baseline comparison we match countries on pre-sanction levels and trends of GDP growth.[11] This implements a 'conditional parallel trends' assumption, in which we are only comparing sanctioned countries to unsanctioned ones with similar pre-sanction economic conditions.

There are three additional concerns for our ability to identify causal effects. First, other events that take place may be responsible for economic slowdowns. The main concern here is that sanctions are often passed against countries at war; if wars systematically follow sanctions, we would risk attributing the economic damages inflicted by war to the costs of the sanction. As mentioned earlier, we as such remove all observations where the sanctioned country is involved in a war in any of the next 5 years. This cuts our sample by more than half, but the long

[11] While this means controlling for a lagged outcome variable, Nickell bias is unlikely to be a problem because of the very long time dimension of our dataset. See Alvarez and Arellano (2003).

and wide nature of the data nonetheless leaves us with over 900 country-year observations of enacted sanctions.

Second, sanctioned countries may anticipate the imposition of sanctions, and change their behavior. One concern here is that countries may prepare for an impending trade sanction. How would this affect our results? In the appendix, we discuss arguments for why anticipation could render our results biased in either direction. We present a test for bias in our results, by measuring treatment two years before the imposition of a sanction. Overall we find minimal evidence that anticipation has a large effect on our results.

Finally, political conditions may be driving our results. If sanctions are systematically enacted against countries experiencing political instability, it is possible that this instability is responsible for poor economic performance (Funke et al., 2023). First, our matching strategy may partially address this concern. Because we only compare countries on similar growth paths before the sanction, we may already be restricting our comparison to countries in similar political situations as well. We further address this possibility with several robustness checks described below; we include controls for both levels and trends of pre-sanction political conditions, and we also exclude from the sample all countries that experienced a significant worsening of their political conditions. Neither of these experiments change our results.

3.1 Measuring the effect of sanctions on bilateral imports

We study two initial outcomes of interest. First, we test for the direct effect of sanctions on trade, measuring the extent to which bilateral trade flows fall following the imposition of a sanction. Here, we use a local projection specification that is consistent with the estimation of "structural gravity" in trade models. Specifically, we study the effect on imports into country i from country j, after i imposes an import sanction and stops importing from j, via the following equation:

$$\Delta_h \log\left(imports^{ij}_{t+h}\right) = \alpha^h_{it} + \alpha^h_{jt} + \alpha^h_{ij} + \beta^h ISANC_{ijt} + \varepsilon^h_{ijt} \tag{2}$$

The outcome variable is the change in the log nominal value of imports from j to i, between year $t-1$ and year $t+h$. The variable $ISANC_{ijt}$ indicates the start of a sanction spell: it is 1 in the first year that a sanction is imposed, missing during years that the sanction is held in place, and 0 otherwise.

As presented by Head and Mayer (2014), a wide variety of international trade models yield predictions about nominal bilateral flows that can be estimated by 'structural gravity' equations similar to Equation 2. In these models, the nominal value of bilateral trade in each year is a

multiplicative outcome of importer, exporter, and bilateral factors; log bilateral trade in a given year can thus be estimated linearly. Structural gravity gives one equation per year; when working with panel data, structural gravity thus models the importer and exporter fixed effects as time-varying. Since our local projection specification is really the difference of two gravity equations, these time-varying fixed effects are not differenced out and remain in the estimation.[12] Note that they as such capture all time-varying country-specific variables.

The final term in structural gravity is a term capturing bilateral trade frictions. Because we are measuring a difference, any time-invariant bilateral frictions between countries i and j will be differenced out. Sanctions provide a clear source of time-varying frictions. We also include an additional ij fixed effect. The goal of this term is to measure the average h-year change in bilateral trade frictions between countries i and j, separately from trade sanctions. If a given country pair is on a long-run trend of, say, increasing trade frictions, then a reduction in trade observed over the h-year horizon following a sanction may just be the result of this long-run trend. This fixed effect attempts to correct for this (to understand this term in the context of gravity equations, see Equation (3)). Finally, we use Newey-West standard errors to account for serial correlation of the error terms.

$\widehat{\beta}^h$ thus gives an estimate of the causal effect of sanctions on bilateral trade, in a way that is consistent with structural gravity. (The effect of an import sanction imposed by i on exports from j to i is estimated analogously to Equation 2, instead using the relevant flow and sanction indicator.)

Figure 6 plots the coefficients $\widehat{\beta}^h$ from estimating Equation (2). We find the expected direct effect: trade does indeed fall following the imposition of a sanction. This captures the causal effect of a unilateral sanction on bilateral trade: when one country imposes a complete import or export sanction on another, this causes the relevant bilateral trade flow between the two countries to fall by about one log point (left panel). These are estimates for nominal values, as predicted in structural gravity; in our sample, this corresponds on average to a reduction in the nominal value of bilateral flows by a factor of 3.6. When the sanction is only 'partial,' trade in the sanctioned direction falls by 0.25 log points, which corresponds to approximately a

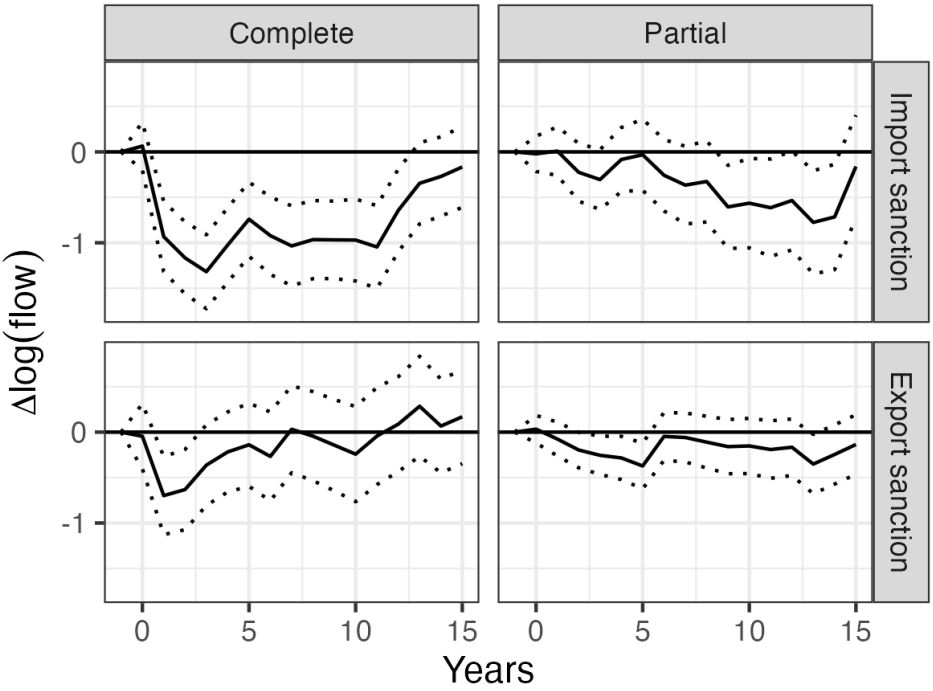
[12] To see this, observe that our equation can be written directly as the difference between two gravity equations:

$$x_{ij,t+h} - x_{ij,t-1} = \underbrace{(\gamma_{it+h} - \gamma_{it-1})}_{\alpha^h_{it}} + \underbrace{(\gamma_{jt+h} - \gamma_{jt-1})}_{\alpha^h_{jt}} + \underbrace{(\beta_1 \tau_{ijt+h} - \beta_2 \tau_{ijt-1})}_{\beta^h ISANC_{ijt} + \alpha^h_{ij}} + \underbrace{(\nu_{ijt+h} - \nu_{ijt-1})}_{\varepsilon^h_{ijt}} \quad (3)$$

Our sanction indicator is clearly an important component of the change in bilateral trade frictions between $t-1$ and $t+h$. Any time-invariant trade frictions are taken out by differencing. We thus use α^h_{ij} to capture any remaining horizon-varying frictions between i and j.

23% reduction.[13] Effects are similar for import sanctions, when the sanctioning country stops importing from the sanctioned country (top), and for export sanctions (right). Effects are also comparable in the full sample (shown here) and in the sample that excludes future wars (shown in the appendix, Figure A2).

Figure 6: Gravity-consistent direct effect of sanctions on bilateral trade



Note: Average change in a bilateral trade flow after it falls under sanction. *Note:* This figure plots the estimates of β^h in Equation (2). The y-axis is the log-change in value of the affected flow: that is, of trade from a sanctioned to a sanctioning country, following an import sanction (top); or in trade from a sanctioning to a sanctioned country, following an export sanction (bottom). The average complete sanction spell length is 8.5 years, and the average partial sanction spell length is 5.5 years. These bilateral trade flows, however, seem to take longer to fully recover to pre-sanction levels.

In the appendix (Figure A1), we estimate local projections that simply track the average path of bilateral trade flows following sanctions. While these estimates do not derive from a gravity model, they help build intuition for what the typical sanction event looks like. They also ensure that our estimates are robust to considering the *real* values of trade flows following sanctions. In those results, we find that complete sanctions do indeed correspond to an essentially full cessation of trade (bilateral trade reduces on average to just 3% of its former value following a sanction). We find that partial sanctions correspond to an average reduction of 22%, similar to the estimates in Figure 6.

[13]This is why, when we cannot observe the specific commodities sanctioned, we assume partial sanctions to affect 25% of the relevant bilateral trade flow.

These results also suggest that sanctions may have a persistent 'scarring' effect. The average complete sanction spell lasts 8.5 years; the average partial sanction spell lasts 5.7 years. But Figures 6 and A1 offer some evidence that bilateral trade is depressed for longer, especially after import stops. This suggests that sanctions may continue to affect bilateral relations, even after they have been lifted.

3.2 Effects of sanctions on cumulative changes in log real GDP

We now turn to estimating the effect of sanctions on economic outcomes. Here, we use our measure of sanction intensity: as described in the previous section, the "intensity" of a sanction is a continuous measure equal to the share in GDP of previously-unsanctioned trade that falls under sanction. We want to estimate the effect of imposing harsher sanctions: if a country sanctions one percentage point of a country's GDP worth of trade, how much harm does this inflict? We propose an answer by estimating local projections that are able to make difference-in-differences comparisons between comparable sanctioned and unsanctioned countries. Specifically, we estimate the following equation:

$$\Delta_h y^i_{t+h} = \alpha^h_t + \beta^h \widetilde{SANC}_{i,t-1} + \Gamma'_h \mathbf{X}_{it} + \varepsilon^h_{it} \tag{4}$$

The outcome variable $\Delta_h y^i_{t+h}$ is the cumulative change in log real GDP per capita from year $t-1$ to year $t+h$. We include year fixed effects (time-invariant country effects are removed because the outcome variable is a difference). $\widetilde{SANC}_{i,t-1}$ is the measure of sanction intensity described in the previous section: it gives the share in GDP of the previous period's trade that falls under sanction at time t. To ensure that we implement a clean difference-in-differences comparison, we take the following steps. First, we assume that the effects of a sanction have stabilized after L consecutive years in which no sanction was imposed.[14] Then, for each horizon h, we admit into our sample only 'treated' or 'clean control' countries. In the 'treated' group, we include only countries that experienced no change in sanction intensity between year $t-L$ and year $t-1$, and then a change in sanction intensity in t. Into our 'clean control' group, we admit only countries that experienced no change in sanction intensity between year $t-L$ and $t+h$. This ensures that we are indeed only comparing countries whose sanction intensity changed in year t, to countries whose sanction intensity remained unchanged throughout the entire relevant horizon. This avoids contaminating our results with the type of 'unclean' difference-in-difference comparisons discussed in many recent papers (for a survey see de Chaisemartin

[14] In reported results, we take $L = 10$ years, but results are robust to alternate values.

and D'Haultfœuille (2023)). The ability of a local projection specification like equation (4) to identify a causal effect is discussed in Dube et al. (2023).[15]

β^h thus measures the marginal effect of initiating *or intensifying* a sanction. As always, we exclude observations followed by wars in any of the next five years. We also include two lags of log real GDP per capita as controls. As Dube et al. (2023) discuss, this amounts to implementing a conditional parallel trends assumption, where we match countries on their pre-sanction GDP paths.[16] Results are robust to including lagged inflation and unemployment measures in the controls, as well as to controlling for political conditions (see Figure A6).

Our baseline estimate comes from Equation (4). This equation takes into account sanctions of different intensities, and also accounts for the effect of continuing or intensifying sanctions. Figure 7 plots estimates of β^h. Because our explanatory variable measures the percent of GDP under sanction, these coefficients can be thought of as elasticities: they measure the cumulative percentage-point change in GDP per capita in response to a one percent increase in GDP under sanction. For all sanctions (left), sanctions of a country's exports (middle), or sanctions of a country's imports (right), the elasticity is about 0.3: sanctioning 1% of GDP is associated with a cumulative 0.3 percentage-point loss over 5 years. There appears to be a modest but incomplete catch-up, in which growth only partially makes up for lost GDP (at least in the horizon we study).

This suggests that sanctions can indeed inflict economic damage, but that their ability to do so is rather minor: a country would need to sanction a large amount of GDP to induce anything more than a mild slowdown. The share of imports or exports in GDP for most developed countries ranges from 15% to 40%. Inflicting serious economic costs would probably require sanctioning at least 10% of GDP, or somewhere between one- and two-thirds of a country's total imports or exports.

This result is relevant for both unilateral and multilateral sanctions. Because we measure sanction intensity as the share in GDP of *all* trade that falls under sanction, our result captures the combined effect of a coalition's sanction. What is relevant in our estimate is the total amount of trade that falls under sanction; it applies equally whether the sanctioned trade is all from one partner (as in a unilateral sanction), or if it comes from multiple partners all imposing

[15] Our estimator is not robust to 'treatment heterogeneity' in the sense that it will not pick up nonlinearities in treatment (this is the case with any linear regression). To address this, we could define different treatment bins (e.g., low, medium, and high intensity) and estimate a clean discrete LP-DID for each bin, to test for any nonlinearities in the treatment effect.

[16] As mentioned, this approach is unlikely to introduce problematic Nickell bias because of the long time dimension of our data (Alvarez and Arellano, 2003).

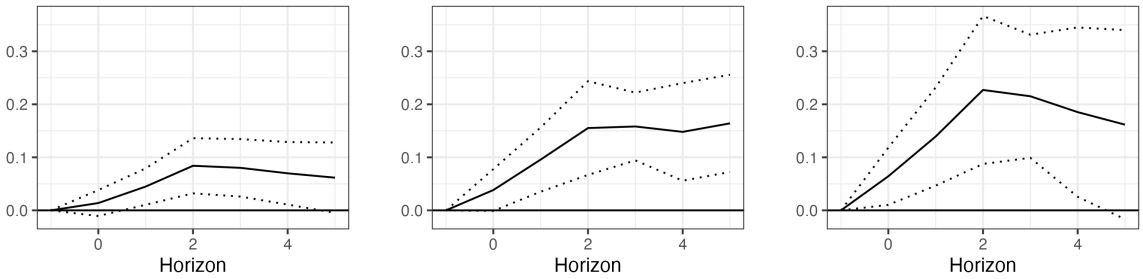
sanctions (as in a multilateral one). The estimate is that, if multiple countries together sanction 1% of GDP worth of trade, this will cost 0.3 percentage points of GDP over five years.

Figure 7: "Elasticity" of per capita GDP to sanctioned trade

Note: Results from Equation (4). Sanctioning one percent of GDP in trade is associated with 0.2-0.4 percentage points of lost GDP. LP-DID specification matching on two previous years of log real GDP per capita, comparing "switchers" to "stayers." See text. Left: any sanction event. Middle: import sanction placed on a country's exports. Right: export sanction on imports.

As discussed above, one concern is that political conditions could be driving these results. Although sanctions are arguably exogenous to domestic economic conditions, they are usually imposed for political reasons. One might be worried that countries are sanctioned because of worsening domestic political conditions, and that these conditions are responsible for worsening economic outcomes. To address these concerns, we first include lags of measures of the quality of a country's governance, taken from the Polity5 database. We also try excluding all countries from the sample whose governance significantly worsened following the imposition of a sanction. Neither exercise changes the results (these checks are described and presented in Figure A6).

Figure 8: "Elasticity" of unemployment to sanctioned trade



Note: Percentage-point change in unemployment in response to each 1% increase in the share of GDP under sanction. Left: any sanction; middle: import sanction placed on a country's exports; right: export sanction placed on imports.

Finally, Figure 8 reestimates Equation 4, using instead the cumulative percentage-point change in unemployment as the outcome variable. It shows that sanctions may come with slightly

worsening unemployment, but that again, the effect is rather modest: unemployment rises only about one- or two-tenths of a percentage point for each percent of GDP that falls under sanction.

4 Interaction of sanction intensity and trade vulnerabilities

Are there certain trade vulnerabilities that render sanctions more potent? We consider three possibilities. First, sanctions may be especially costly for countries that rely on a small number of trading partners for most of their trade: these countries may have fewer opportunities to substitute away from sanctioned trade. Second, sanctions may be especially costly for countries that rely on importing primary commodities: sanctions can deprive these countries of crucial inputs to production. Finally, sanctions may be especially costly for countries that rely on *exporting* primary commodities: sanctions can cut these countries off from the markets on which they rely for income. We test each of these three possibilities in turn. Ultimately, we find that relying on a small number of partners does indeed render sanctions more costly; and interestingly, high dependence on primary commodity *exports*, rather than imports, appears to be the vulnerability that makes sanctions worse.

4.1 Partner concentration

A standard measure of trade concentration is a version of the Herfindahl-Hirschman index: for a given direction (imports or exports), let $HHI_{it} \equiv \sum_j \left(\frac{x_{ijt}}{X_{it}}\right)^2$ be the sum of the squared import (or export) shares of all of i's trading partners. HHI is thus measured on a scale from 0 to 1, where higher HHI means that country i relies on a smaller number of partners for a larger share of its trade. We interact this index with our sanction intensity measure:

$$\Delta^h y^i_{t+h} = \alpha^h_t + \alpha^h_i + \beta^h \left(\widetilde{SANC}_{i,t-1} \times HHI_{i,t-1}\right) + \gamma^h_1 \widetilde{SANC}_{i,t-1} + \gamma^h_2 HHI_{i,t-1} + \Gamma'_h \mathbf{X}_{it} + \varepsilon^h_{it} \quad (5)$$

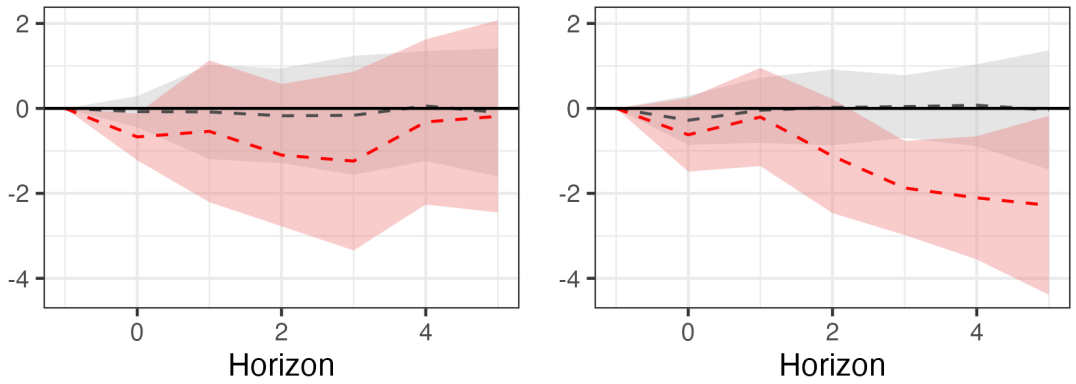
β^h now measures the additional cost of sanctions when a country's trade is highly concentrated. Figure 9 plots $\beta^h \times HHI_{i,t-1} + \gamma^h_1$ for a country whose HHI is one standard deviation above (red) and below (gray) the mean. The y-axis thus measures the percentage-point loss in GDP from sanctioning an additional percentage-point worth of GDP in trade, for countries with high or low partner concentration. It suggests that high concentration may indeed make sanctions more costly: a one standard deviation increase in HHI increases the elasticity by one entire point relative to figure 7.[17] This would mean making a sanction six times as effective, increasing the elasticity of GDP to sanctioned GDP from 0.3 to almost 2. These estimates are imprecise

[17] The estimates of γ^h_2 are not significantly different from 0.

– but they nonetheless suggest that countries with a small number of trading partners may be significantly more vulnerable to trade sanctions.

Figure 9: Interaction of sanction intensity with trading partner concentration

(a) Concentration of export market (b) Concentration of import market



Note: This figure shows the response of GDP to sanctions when a sanctioned country's trading partners are more or less concentrated. The red lines plot $\beta^h \times HHI_{i,t-1} + \gamma_1^h$ for a country whose HHI is one standard deviation above the mean, and the gray lines for a country whose HHI is one standard deviation below the mean. The y-axis thus measures the percentage-point loss in GDP from sanctioning an additional percentage point worth of GDP in trade, for countries with high or low partner concentration. The confidence intervals are constructed from the joint test of the null hypothesis $\beta^h \times HHI_{i,t-1} + \gamma_1^h = 0$. The estimates are imprecise, but the interaction appears important: sanctioning one percent of GDP in trade leads to a 2% loss of GDP for countries whose partners are highly concentrated, compared to a minimal effect on countries with more diversified partners.

4.2 Primary commodity export vs import dependence

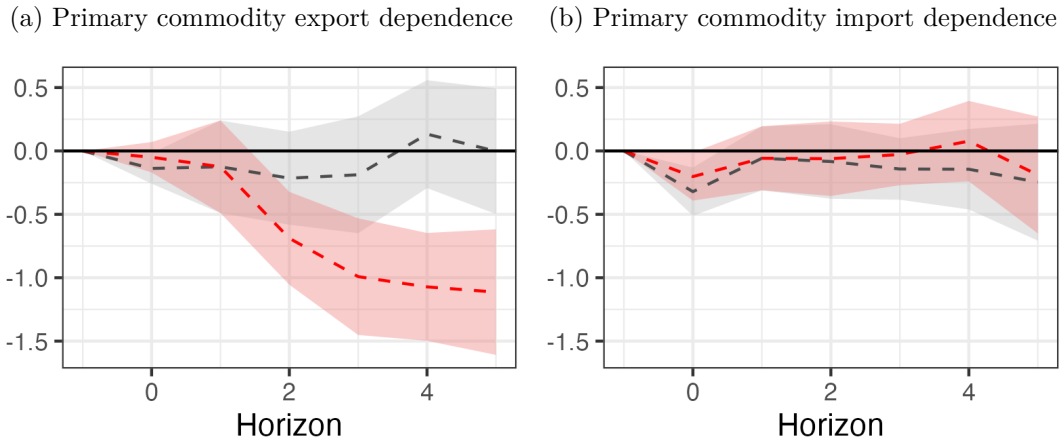
We next test whether primary commodity import or export dependence makes sanctions more costly. To measure primary commodity dependence, we follow the United Nations Conference on Trade and Development's simple approach (UNCTAD, 2023) and examine X_f^c/X_f^{total}, the share of imports or exports of primary commodities in total imports or exports (f denotes the relevant flow). Countries for whom this value is higher are considered to be more dependent on trade in primary commodities. Again following UNCTAD, we define "primary commodities" to be those whose SITC code's first digit is 5 or lower.[18] We use three-digit commodity-level trade data from UN Comtrade to compute the ratio X^c/X^{total} for both exports and imports. As above, we then interact this ratio with our measure of sanction intensity, separately for export and import sanctions:

$$\Delta^h y_{t+h}^i = \alpha_t^h + \alpha_i^h + \beta^h \left(\widetilde{SANC}_{i,t-1} \times \frac{X_{i,t-1}^c}{X_{i,t-1}^{total}} \right) + \gamma_1^h \left(\widetilde{SANC}_{i,t-1} \right) + \gamma_2^h \left(\frac{X_{i,t-1}^c}{X_{i,t-1}^{total}} \right) + \Gamma_h' \mathbf{X}_{it} + \varepsilon_{it}^h \tag{6}$$

[18] This corresponds to food, beverages, crude materials, mineral fuels, animal fats and oils, and chemicals.

Figure 10 plots the estimates of $\beta^h \times \frac{X^c_{i,t-1}}{X^{total}_{i,t-1}} + \gamma^h_1$, for countries with high and low dependencies. Specifically, the red lines plot these values for countries whose commodity export or import dependence is one standard deviation (0.1) above (red) and below (gray) the mean. The left panel shows results for sanctions on a country's exports: sanctioning one percent of a highly export-dependent country's exports yields a GDP loss of about 1%. This would make sanctions 3-4 times as effective as the baseline result in figure 7. The right panel shows results for sanctions on a country's imports. In contrast, high dependence on importing primary commodities does not appear to come with heightened vulnerability.

Figure 10: Interaction of sanction intensity with dependence on primary commodity trade



Note: This figure shows the response of GDP to sanctions when a sanctioned country is more or less dependent on primary commodity exports (left) or imports (right). The red lines plot $\beta^H \times X^c_{i,t-1}/X^{total}_{i,t-1} + \gamma^h_1$ for a country whose trade dependence is one standard deviation above (red) or below (gray) the mean. Countries that are more dependent on exporting primary commodities appear susceptible to more costly sanctions: a one standard-deviation increase in average export dependence (an increase of about 0.1) face an elasticity of GDP to sanctioned GDP of about 1.

5 Costs of financial sanctions

A related question is whether financial sanctions come with similar costs. The "Global Sanctions Database" (Felbermayr et al., 2020) codes whether sanctions are "financial" in nature, during 1950-2022. Financial sanctions involve freezes on the exchange of assets and investments, and often include the cessation of aid. More recently, they have included prohibitions on a wider range of financial transactions involving the sanctioned country, for example via exclusion from SWIFT. In this section, we consider only financial sanctions imposed when *no* trade sanctions were simultaneously imposed.

US financial sanctions against Iran over the past decade are illustrative. In February 2012, an executive order effectively blocked all lending and borrowing by any Iranian financial agent to/from the United States. The order stated that any capital lent into the US by Iranian indi-

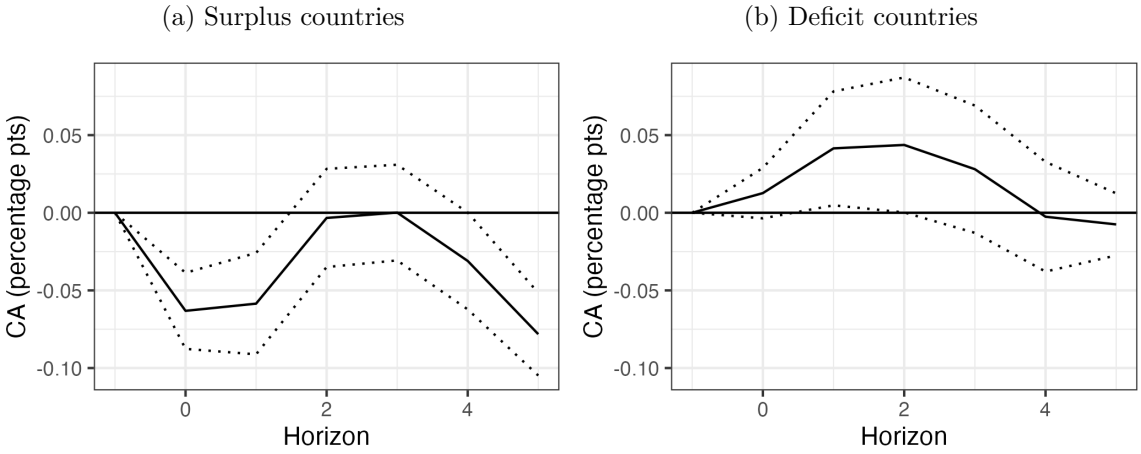
viduals or banks would be frozen and could not be withdrawn; the order also forbad American individuals and banks from lending to Iran.

The sanctions appeared to have had a clear direct effect. Iran had been a net lender prior to 2012: it's current account was 9.3% of GDP in 2011. When sanctions were imposed, borrowing and lending stopped: the current account fell to 0.3% in 2015, as Iran could no longer lend to the US. After the US signed a treaty with Iran in 2015 and lifted sanctions, Iran's current account rose back to its former level, reaching a 10% surplus in 2018 as lending resumed. In 2018, Donald Trump withdrew from the 2015 treaty, reimposing sanctions; Iran's current account quickly fell to -0.4% by 2020.

Existing estimates are that the sanctions against Iran imposed significant costs: one recent paper uses synthetic controls to estimate a 20% counterfactual loss of Iranian real GDP between 2012 and 2015; it also uses panel income data to estimate that the cost of sanctions fell primarily on younger, illiterate, rural households rather than on more educated households or those working in government (Ghomi, 2022).

Does the experience of Iranian sanctions generalize to other cases? To answer this question, this section looks at a sample of country-year observations when financial sanctions, but *no* trade sanctions, were imposed in year t.

Figure 11: Effect of financial sanctions on the current account



We first test whether financial sanctions have a direct effect on the current account. Figure 11 re-estimates Equation (8), using a dummy for a new financial sanction as the explanatory variable and the percentage-point change in the current account / GDP ratio as the outcome variable. We split the sample into countries with a preexisting surplus (left) and those with a preexisting deficit (right). Following a financial sanction, the current account in surplus

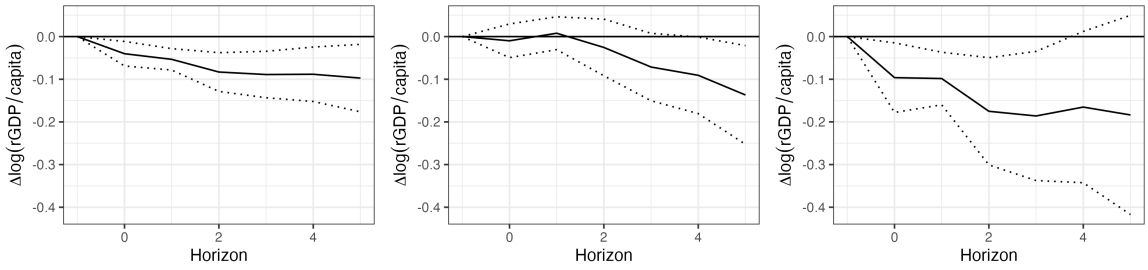
countries falls, while the current account in deficit countries rises. In both cases, the magnitude of the change is somewhere between 2 and 5 percentage points over 2-3 years.

This makes sense as a direct effect of financial sanctions. These sanctions seek to restrict a country's ability to borrow and lend abroad. If the restrictions have bite, then sanctioned countries' current accounts should move towards zero: those with a current account surplus, (who lend more than they borrow abroad, like Iran in the 2010s), would see their current account fall as their lending activity is restricted. Countries with a current account deficit, in contrast, would see it rise as sanctions restrict foreign borrowing. Notably, Figure 11 restricts the sample to countries with a *sizable* preexisting deficit (above 5% of GDP). For countries with deficits closer to 0, the current account does not change (or falls slightly) following a financial sanction.

Are these sanctions economically costly? The left panel of Figure 12 re-estimates Equation (8), using a dummy for a new financial sanction as the explanatory variable and now using the change in log-GDP per capita as the outcome variable. It shows that financial sanctions are costly – they appear to be followed by 5-10 percentage points of lost GDP cumulatively over 5 years.

Measuring the 'intensity' of a financial sanction is more difficult. We ask whether countries that are more financially open face higher costs: these countries arguably have a higher share of wealth that would be affected by a sanction. The middle and right panels of Figure 12 interact two measures of financial openness (taken from Quinn et al. (2011) and Haelg (2020) respectively, and normalized to a continuous scale from 0 to 1) with a financial sanction dummy. More financially open countries do seem to suffer more: 10% more financial openness comes with about an additional percentage point of lost GDP over the entire horizon.

Figure 12: GDP after financial sanctions



Note: Left: path of GDP after a peacetime financial sanction. Middle: interaction between financial sanction dummy and financial openness, measured by Quinn et al. (2011); Right: interaction with financial openness measured by Haelg (2020). These measures are originally on a scale from 0 to 100, and are here normalized to be between 0 and 1. The average financial sanction is associated with a subsequent 5-10% cumulative GDP loss over 5 years (or about 1-2pp of lost growth per year). More financially open countries seem to suffer more: 10% more financial 'openness' is associated with an additional percentage point of lost GDP over the entire horizon.

6 Ranking countries by the vulnerability to sanctions

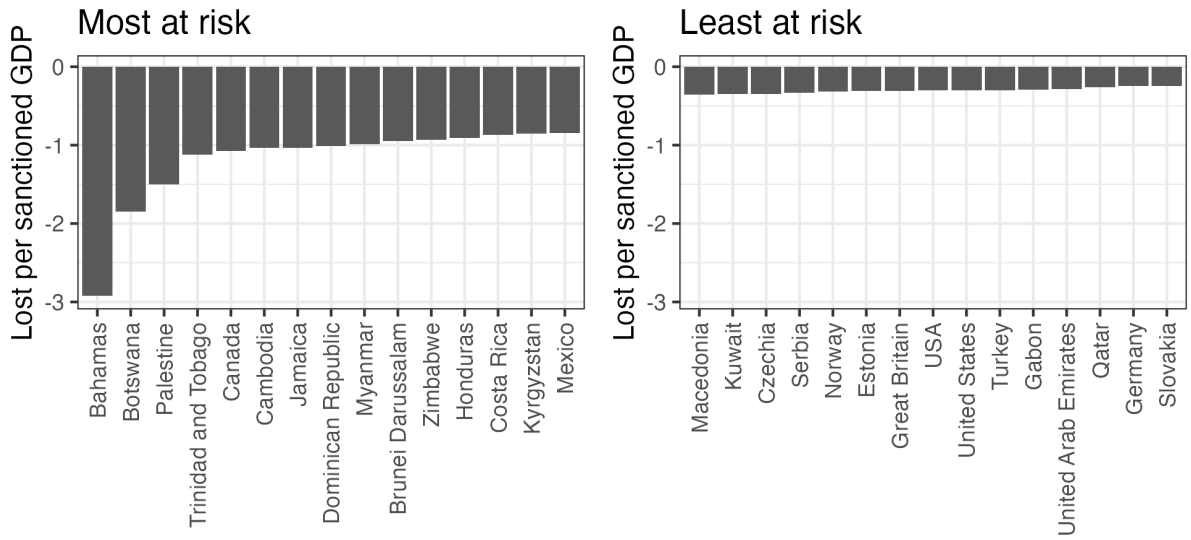
In a last step we apply our results to rank countries' vulnerability to export sanctions, import sanctions, and financial sanctions. Figure 13 summarizes our results by looking at the 15 most and least vulnerable countries, based on trade data from 2023 (restricting the sample to only countries with GDP greater than 10 billion USD).[19] We take the coefficients from a LP-DID specification that includes an interaction between sanctions and partner concentration, as well as between sanctions and primary commodity import/export dependence. We then show the estimated response of each country's GDP (in percentage points, cumulatively over three years) to a sanction worth 1 pp of GDP. Indeed, the most vulnerable countries tend to be small lower-income countries and islands – a sanction worth 1% of GDP can cost these countries up to 5 percentage-points of lost GDP. Developed countries tend to be the least vulnerable.

An interesting exceptions arises: Canada and Mexico show up on the list of most at-risk for a sanction placed on their exports. This is because their exports are highly concentrated to the US. Indeed, Canada and Mexico may be vulnerable to US trade actions. On the import side, small open and island economies with substantial reliance on foreign imports dominate the picture.

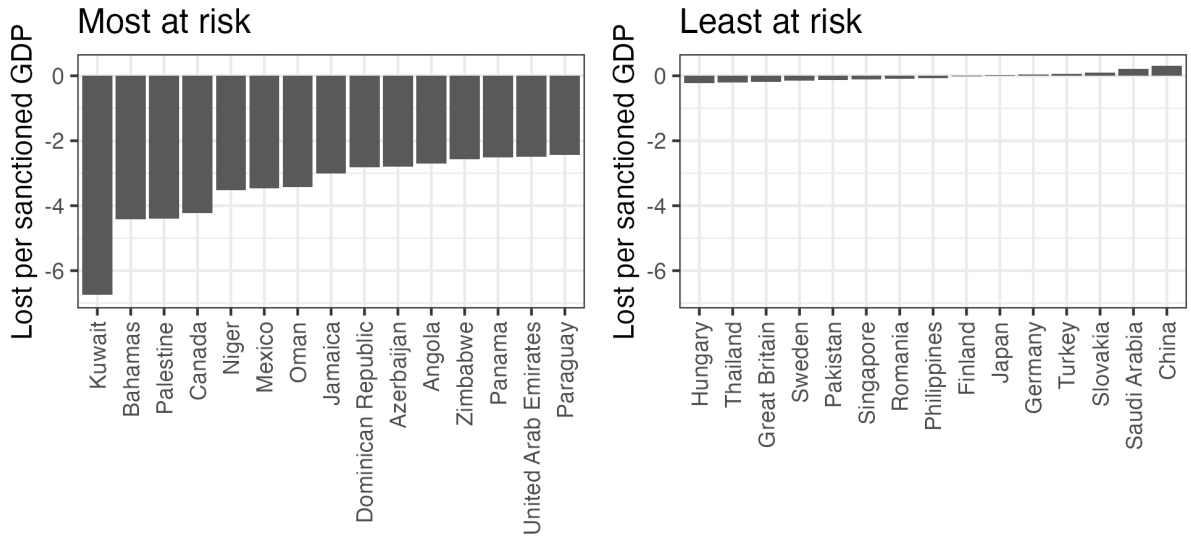
[19] Figure A9 in the appendix shows this for the full sample of countries - indeed, the most at risk countries are often small countries with GDP below this threshold.

Figure 13: Most and least vulnerable countries

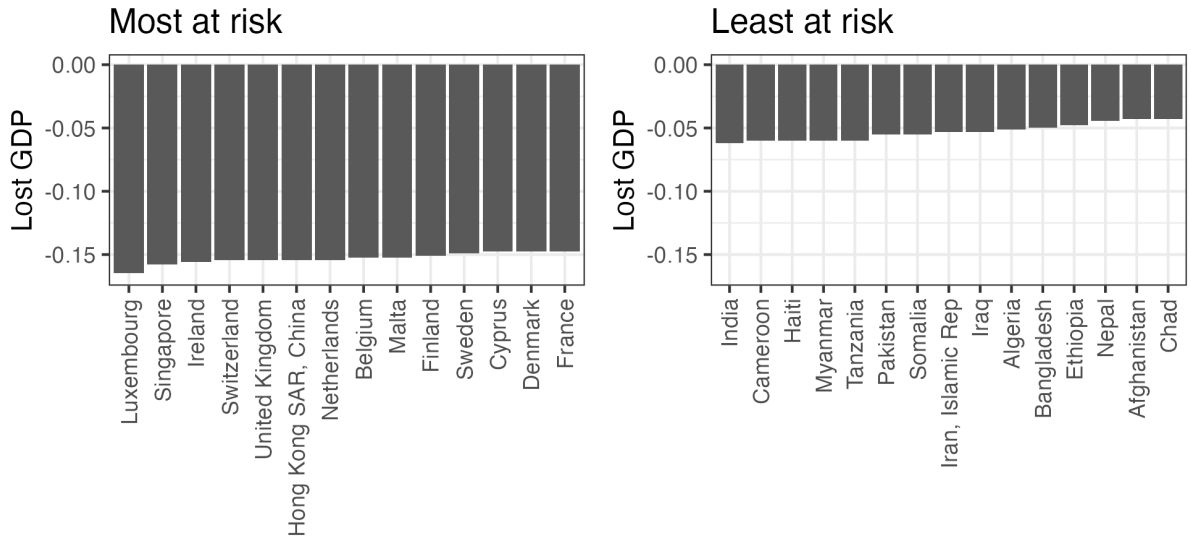
(a) Vulnerabilities to sanctions on imports



(b) Vulnerabilities to sanctions on exports



(c) Vulnerabilities to financial sanctions



With respect to financial sanctions, the picture changes. The countries most exposed to financial sanctions are financial centers like Singapore and Luxembourg – owing to the size of their financial industries in the economy – but also many European countries like Ireland, Switzerland, the UK, the Netherlands and Belgium. Concentration and specialization of economies on particular industries come with the risk of lumpy exposure to specific sanctions.

7 Conclusion

Economic sanctions do inflict costs. Measuring the intensity of sanctions and the concentration of trade leads to a clearer sense of how big these costs are, as well as who has the most to fear from them. We find that in general, trade sanctions need to be large to inflict meaningful economic damage: somewhere around 10% of GDP (one-third of total trade for a developed country) would need to be sanctioned to cause a 2-3% loss of GDP. However, countries with undiversified trading partners, or who are highly dependent on exporting primary commodities, are significantly more at risk: the effects of sanctions can be 3-4 times larger.

Since Russia's invasion of Ukraine, politicians in developed countries have begun worrying about their countries' vulnerabilities to economic sanctions. Our results suggest however that, if we are indeed beginning a 'New Cold War,' it is developing countries that have the most to lose.

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A Appendix

Sanction exogeneity

Table A1 shows the exogeneity test described in the text: we attempt to predict the occurrence of a new sanction with lagged domestic economic variables. There is no correlation between the occurrence of a sanction and the prior state of a country's economy. When adding country and year fixed effects, two of the coefficients do become significant in a non-obvious way – although with 27 coefficients estimated in table A1, only one is significant at the 5% level, and only 2 are significant at the 10% level. The two significant coefficients may as such just be type-I errors.

Additional LP specifications

A.0.1 Direct effects on bilateral imports

In addition to the gravity-consistent specification (2), we also estimate a simpler local projection. We study the effect on imports into country i from country j, after i imposes an import sanction and stops importing from j, via the following equation:

$$\Delta_h \log\left(imports^{ij}_{t+h}\right) = \alpha^h_{ij} + \beta^h ISANC_{ijt}\Gamma'_{1h}\mathbf{X}_{it} + \Gamma'_{2h}\mathbf{X}_{jt} + \Gamma'_{3h}\mathbf{X}_{ijt} + \varepsilon^h_{ijt} \tag{7}$$

The outcome variable is now the change in the log *real* value of imports from j to i, between year $t-1$ and year $t+h$. $\mathbf{X}_{ijt}$ includes lagged values of the bilateral trade flows between countries i and j, in order to ensure that results are not driven by pre-existing trends in bilateral trade between the two countries. We also include controls for each country's log real GDP. We use Newey-West standard errors to account for serial correlation of the error terms.

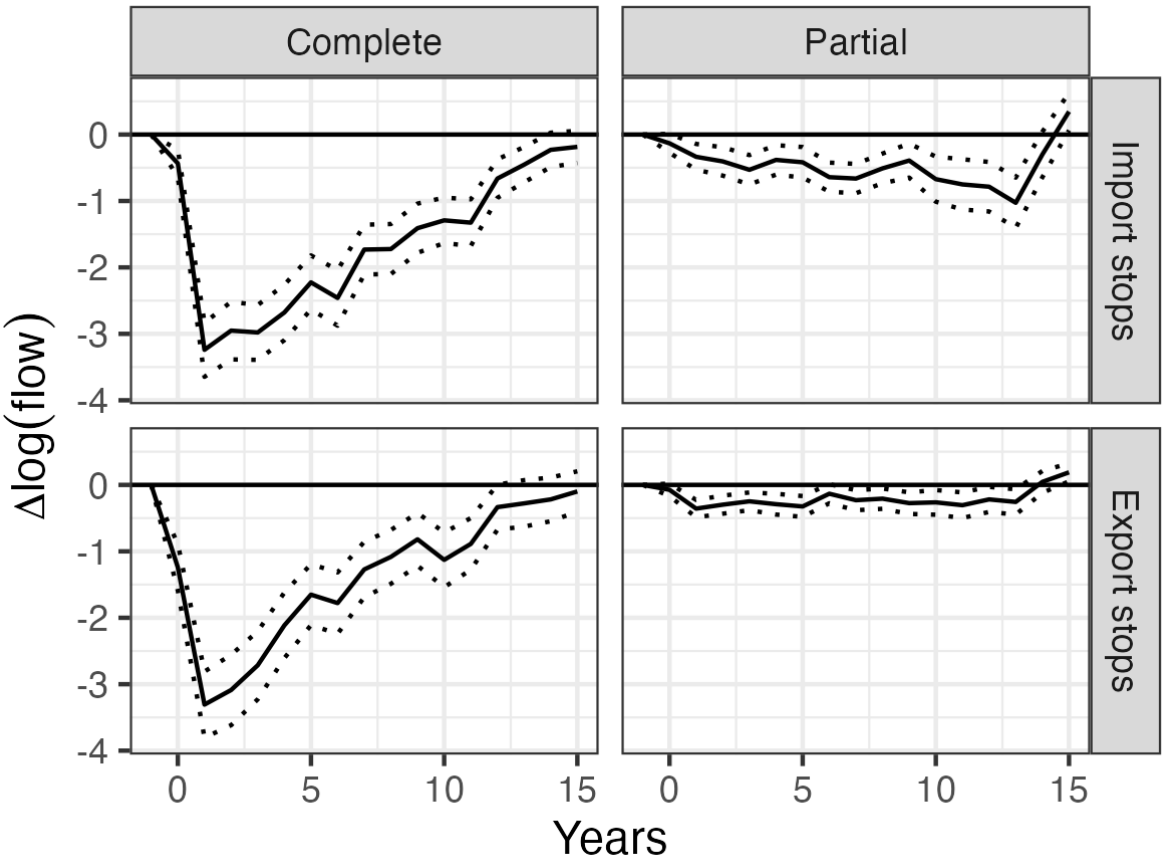
$\widehat{\beta}^h$ now gives an estimate for the average path of bilateral trade following a sanction. Here, bilateral trade on average drops by 3-4 log points following a complete sanction, which corresponds to an average 97% reduction in trade. It falls between 0.25 and 0.5 log points following a partial sanction, consistent with the estimates in the text. Notably, bilateral trade flows appear to take up to 15 years to recover.

Table A1: Predicting sanctions with domestic economic conditions

	Dependent variable:			
	New sanction			
	(1)	(2)	(3)	(4)
l_logrgdppc1	−3.002	−0.056	−4.911	−17.925**
	(5.085)	(5.251)	(4.798)	(8.706)
l_logrgdppc2	7.016	−4.012	3.312	19.480*
	(8.387)	(7.374)	(9.396)	(11.623)
l_logrgdppc3	−3.904	5.584	1.916	−9.390
	(4.541)	(6.802)	(6.593)	(6.536)
l_inf1	−2.514	−0.177	−0.151	−0.130
	(4.483)	(0.477)	(1.533)	(0.779)
l_inf2	−8.362	−0.509	−0.662	0.878
	(5.238)	(1.617)	(3.141)	(3.860)
l_inf3	0.097	−0.228	0.097	−0.390
	(0.494)	(0.601)	(0.678)	(2.007)
l_ue1	−7.504			
	(18.970)			
l_ue2	6.465			
	(30.011)			
l_ue3	0.309			
	(18.392)			
Fixed effects		Country	Year	Country year
Observations	1110	831	723	290

*p<0.1; **p<0.05; ***p<0.01

Figure A1: Direct effect of import (left) and export (right) sanctions on bilateral trade



This figure plots the estimates of β^h in equation (7). The y-axis is the log-change in real value of imports from sanctioned to sanctioning following an import sanction (left) or in exports from sanctioning to sanctioned following an export sanction (right). Top: full sample. Bottom: excluding sanction events in which the sanctioned country fought a war in the following two years.

A.0.2 Effect on GDP

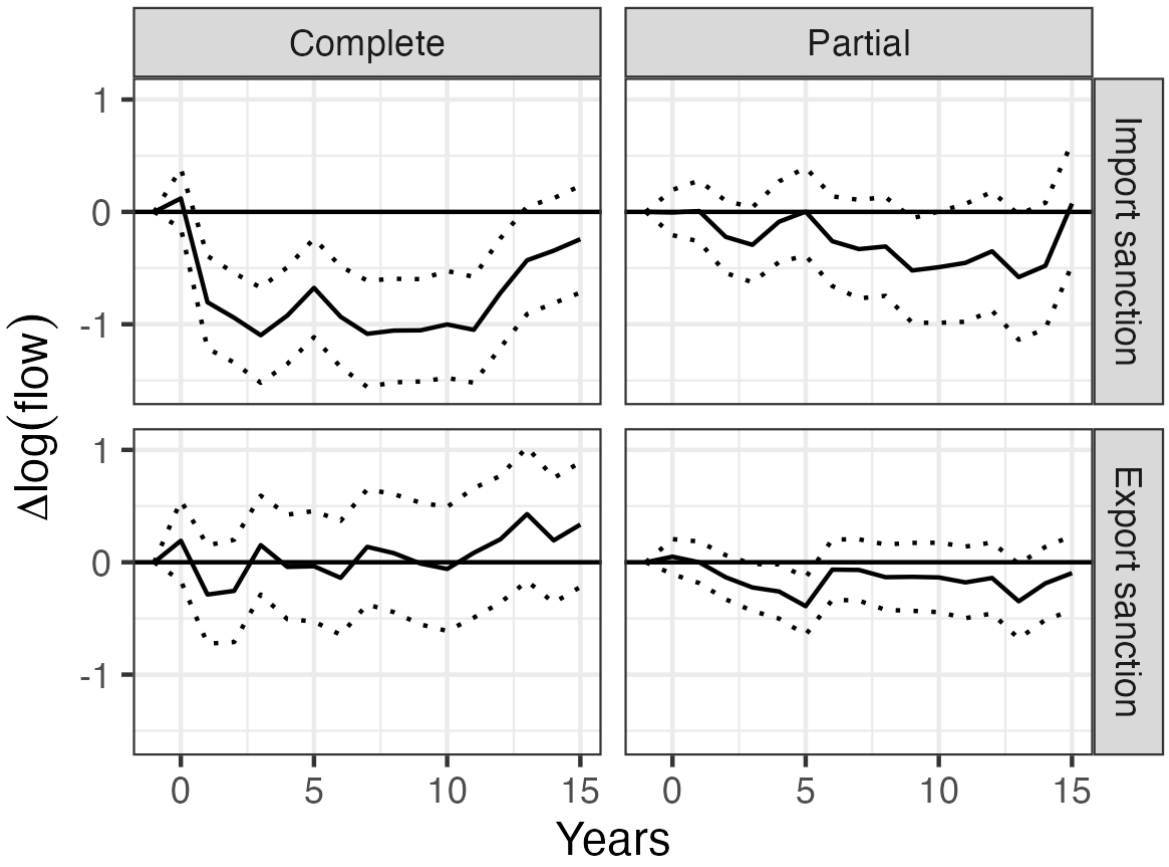
In addition to the estimates from equation (4), shown in figure A5, we also estimate the average path of GDP following the imposition of any sanction for the first time. That is, we estimate:

$$\Delta^h y^i_{t+h} = \alpha^h_t + \beta^h SANC_{it} + \Gamma'_h \mathbf{X}_{it} + \varepsilon^h_{it} \tag{8}$$

Variables are identical to equation (4) in the text, except that now $SANC_{it}$ is simply an indicator variable for whether country i experienced a new sanction in year t. It is equal to zero if country i experienced no sanction; and observations in which country i experienced the continuation or intensification of an existing sanction are excluded. We adopt the analogous 'clean control' criteria for inclusion in the sample at each horizon as described in the text.

Equation (8) is thus equivalent to the estimates in the existing literature. The top row of figure

Figure A2: Gravity consistent effect of import and export sanctions on bilateral trade, excluding wars

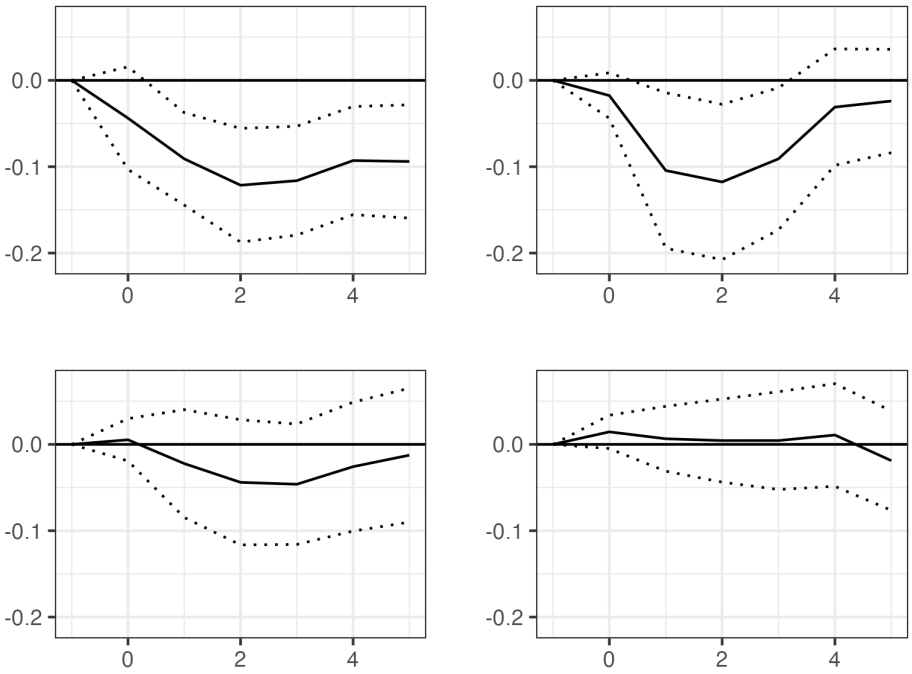


This figure plots the coefficients on β^h in equation (2), on a subsample that excludes all observations where the sanctioned and sanctioning countries are involved in a war in the two years following the sanction.

A3 plots the estimates of β^h. This specification measures the response of GDP to the beginning of any new sanction "spell" (as defined in section 2). On average, a new sanction event is followed by a cumulative loss of about 5 percentage points of GDP over 5 years. This agrees with the estimates in Gutmann et al. (2023), discussed in section 2. The estimate is imprecise, due in part to the wide variety of sanction intensities included: the average cost appears to be somewhere between 1 and 10 percentage points of per capita GDP. The costs of import and export sanctions appear comparable. Figure A3 is thus the formal equivalent to figure 5: it gives the average lost GDP after we net out country, year, country-year variables from the evidence shown in that figure. Observe that the estimates are comparable: in both cases, sanctioned countries appear to lose somewhere between 2-10 percentage points of per capita GDP over 5 years.

However, the bottom row of figure A3 provides one explanation for the discrepancy with the rest of our results. There, we exclude the 10% most intense sanctions, based on our intensity measure. When we do this, the estimates become both smaller and insignificant. This suggests that the estimates in the top panel, and perhaps those in existing literature, do indeed suffer from considering all sanctions equally.

Figure A3: Effect of a new sanction on GDP

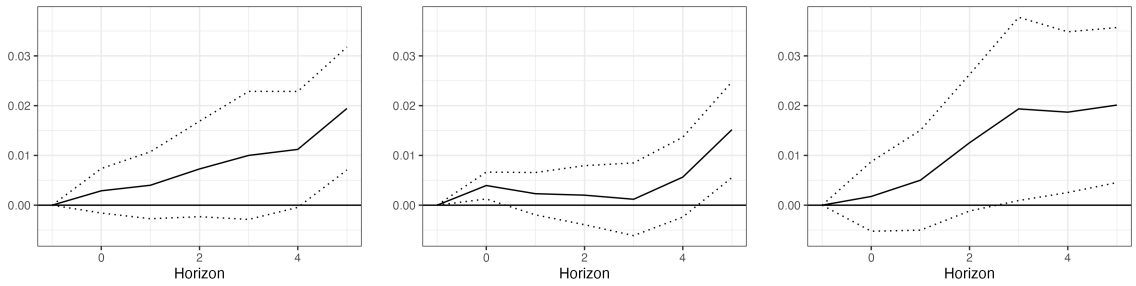


Results from equation (8). Top row includes all sanctions; bottom row excludes the top 10% of sanctions by intensity. Left: import sanction placed on a country's exports. Right: export sanction on imports.

Figure A4 repeats the exercise in figure A3, instead studying the cumulative change in un-

employment following a new sanction event. The estimate is that on average, sanctions have caused somewhere between a one- and three-percentage-point increase in unemployment.

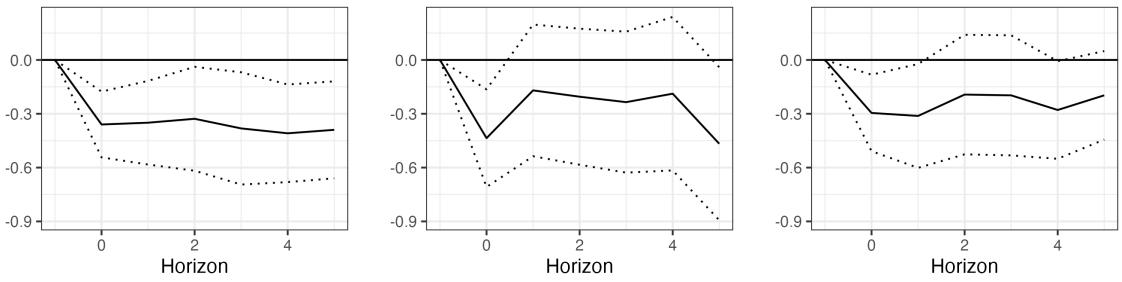
Figure A4: Path of unemployment after a sanction event



Percentage-point change in unemployment in response to a new sanction event. Left: any sanction; middle: import sanction placed on a country's exports; right: export sanction placed on imports.

Finally, Figure A5 estimates a local projection specification more familiar to empirical macroeconomics. As described in the caption to that figure, this specification allows for a larger sample size, at the cost of potentially contaminating the difference-in-differences results. The estimates are comparable, more precise, and slightly larger than those in the text; we retain our preferred specification because of its ability to identify an uncontaminated causal effect, at the cost of some precision. The ability of the estimator in Figure A5 to robustly identify a causal effect is to our knowledge unknown – it is not addressed in Dube et al. (2023).

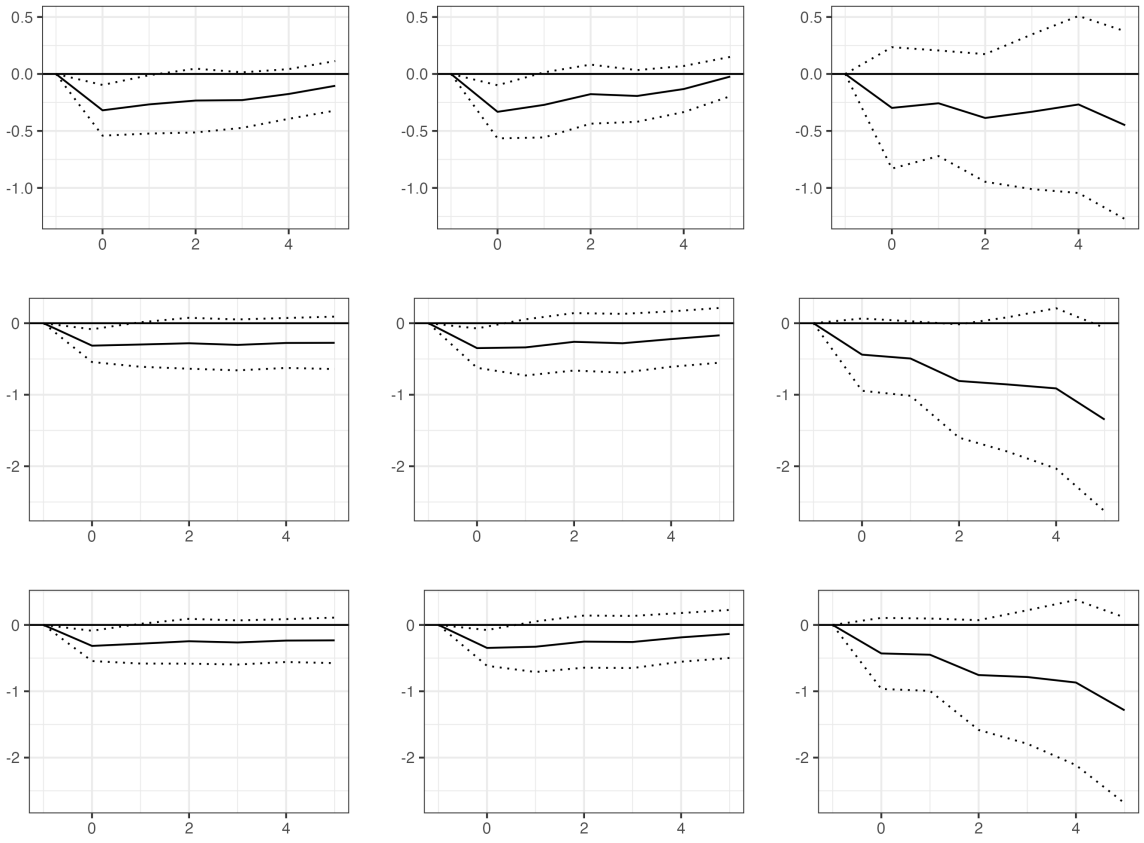
Figure A5: "Elasticity" of per capita GDP to sanctioned trade



This estimates a local projection specification that is more standard to empirical macroeconomics, but which is less careful about making difference-in-differences comparisons. Instead of cleaning the sample to include only 'treated' and 'clean control' observations as described in the text, this estimate now includes two lags of the sanction intensity measure instead. This results in a larger sample size, but introduces potential contamination. The true econometric properties of this estimator and its ability to identify a treatment effect have not to our knowledge been studied; this estimator is however commonly used in empirical macroeconomics. Here, sanctioning one percent of GDP in trade is associated with 0.2-0.5 percentage points of lost GDP. Regression includes country and year fixed effects, two lags of previous sanction intensities, and two lags of real GDP per capita. Left: any sanction event. Middle: import sanction placed on a country's exports. Right: export sanction on imports.

Robustness Figure A6 gives the robustness checks of figure A5. The top row includes controls for two lags of inflation and unemployment. The middle row includes controls for two lags of governance quality, measured by the "polity score" in the Polity5 database. The bottom row

Figure A6: "Elasticity" of per capita GDP to sanctioned trade: Robustness checks

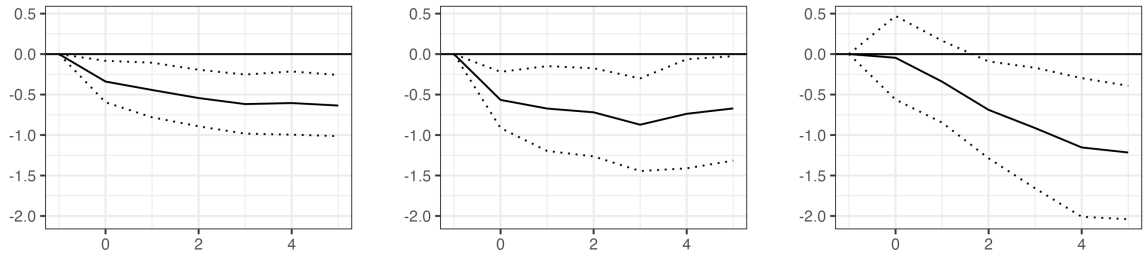


Robustness checks of figure A5: including controls for two lags of inflation and unemployment (top); including controls for two lags of governance quality, measured by the Polity5 database's "polity score" (middle); excluding all observations where the 'polity score' declined by more than 3 points cumulatively in the subsequent five years (the polity score is given on a scale from -10 to 10).

excludes all observations where the 'polity score' declined by more than 3 points cumulatively in the five years following a sanction. The purpose of this last check is to ensure that results are not driven by severely worsening political conditions in sanctioned countries. All of these checks leave the results largely unchanged.

One concern with our design is that countries may anticipate the onset of sanctions, and change their behavior. In the text, we argued that if anything, such anticipation would render countries more resilient, decreasing the observed effect of sanctions. Our results would as such be conservative. However, it could be argued that anticipation would bias our results in the other direction (we present this argument below). As a simple test for bias in either direction, we redefine treatment as follows. In the text, 'treatment' is the share in GDP of $t-1$ trade that falls under sanction in year t. Instead, we now consider the share in GDP of trade at $t-2$. The logic is that if a country anticipates the sanction in year t, then they may deliberately change their trading patterns in year $t-1$. Using $t-1$ trade and GDP would count these changes as

Figure A7: Test for anticipation effects



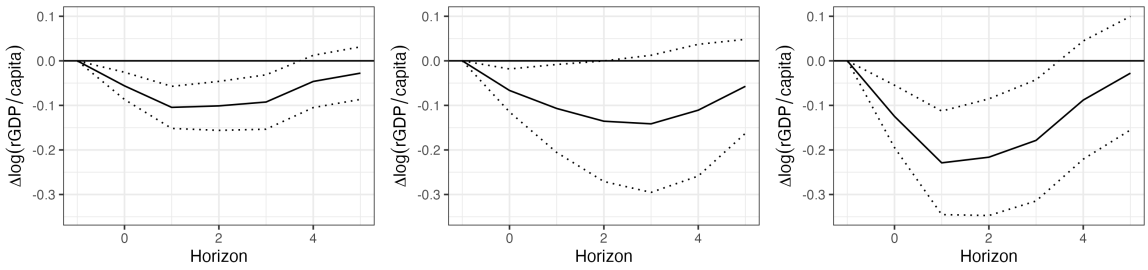
This figure reestimates figure A5, redefining treatment to be the share in GDP of trade two years before the sanction. The goal of this exercise is to account for anticipation by the sanctioned country of the impending sanction (see text). The estimates are mostly unchanged; they are slightly larger, supporting the hypothesis that anticipation allows countries to slightly mitigate the effect of sanctions. Left: effect due to sanctioning all trade; middle: import sanction on exports; right: export sanction on imports.

exogenous. In contrast, if we use the share of trade in $t-2$ that falls under sanction at time t, we might be able to mitigate some of the anticipation effects.

This clarifies why the bias can run in either direction. If a country anticipates a sanction, it may decrease its trade with countries it fears will impose the sanction. This would mean that the sanction intensity would in fact be higher than we measure it, since a country's trade with sanctioning partners in $t-1$ would already be lower than it would be in the absence of the (anticipated) sanction. This could lead us to overestimate the effect of the sanction: we would be attributing the cost of an effectively *larger* sanction (i.e., the effect of the sanction on the trade that remained at $t-1$, as well as the need to reduce trade from $t-2$ to $t-1$ due to the anticipation of the sanction) to a smaller measured sanction intensity. This would lead us to overestimate the magnitude of the response. Again, using $t-2$ trade as the measure of intensity would correct for this.

Figure A7 shows the results of this check. Our results do not appear to overestimate the elasticity – indeed, if anything the figures suggest that they are downwardly biased. The point estimate for the elasticity in this check is around 0.6-0.8, larger than the point estimate of 0.4-0.5 that we present in the text. But both estimates are relatively imprecise, and we reject that the two coefficients are significantly different from one another.

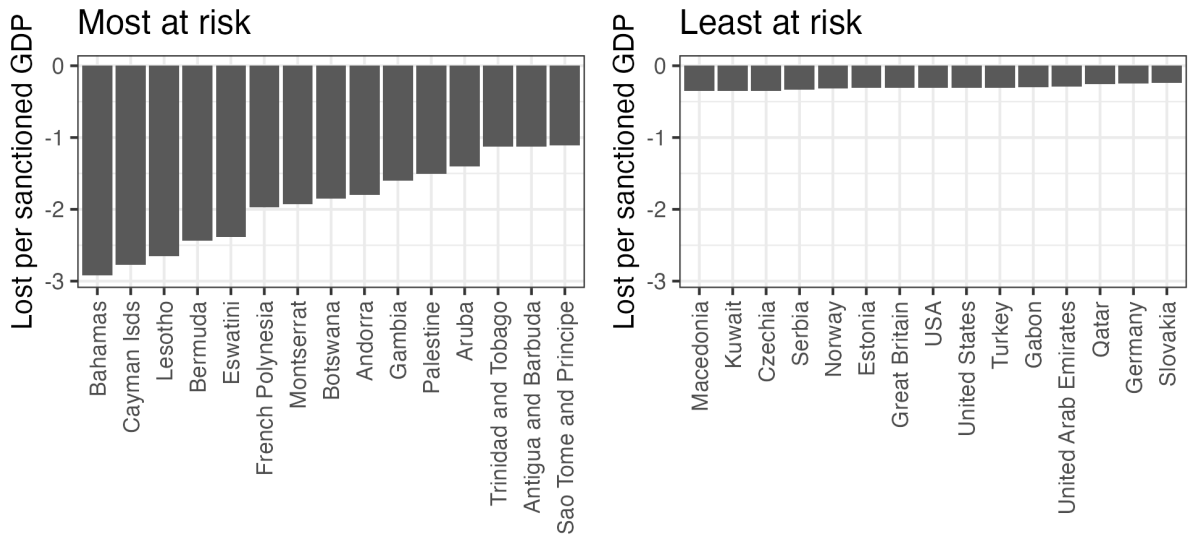
Figure A8: GDP after financial sanctions



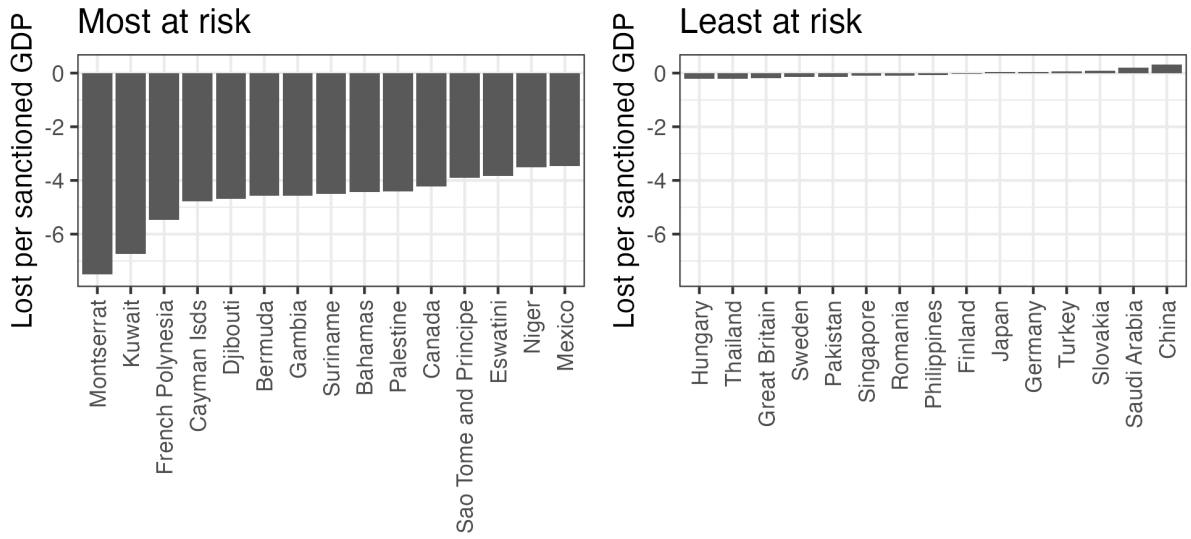
Sample of financial and trade sanctions imposed simultaneously. Left: path of GDP after a peacetime imposition of financial and trade sanctions. Middle: interaction between financial sanction dummy and financial openness, measured by Quinn et al. (2011); Right: interaction with financial openness measured by Haelg (2020). These measures are originally on a scale from 0 to 100, and are here normalized to be between 0 and 1. The average financial sanction is associated with a subsequent 5-10% cumulative GDP loss over 5 years (or about 1-2pp of lost growth per year). More financially open countries seem to suffer more: 10% more financial 'openness' is associated with an additional percentage point of lost GDP over the entire horizon.

Figure A9: Most and least vulnerable countries (full sample)

(a) Vulnerabilities to sanctions on imports



(b) Vulnerabilities to sanctions on exports



(c) Vulnerabilities to financial sanctions