

# **Alliances, State Preferences, and Trade Networks: The Impact of United States Sanctions on Dual-use Trade**

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# **Alliances, State Preferences, and Trade Networks: The Impact of United States Sanctions on Dual-use Trade**

## **Abstract**

Export controls on dual-use commodities are crucial to United States foreign policy goals. Research finds that US sanctions motivate third-party compliance with export controls. However, the sanctions-busting literature suggests that allies are more likely than non-allies to sabotage US sanctioning efforts. We argue that US allies export more controlled dual-use goods (CDU) when the importer is not facing US sanctions. However, US allies will not export more CDU than non-allies to US-sanctioned states. We also argue that US sanctions condition the impact of economic and political determinants of CDU trade. We find support in models spanning 1997–2015.

# 1 Introduction

Russia's invasion of Ukraine in February of 2022 shocked the world with a flagrant violation of the post-World War II norm against territorial conquest. Similarly shocking, the aftermath of this unprecedented act of aggression witnessed swift coordination to impose devastating sanctions on Russia. These sanctions include stricter controls on the export of dual-use goods—those with both civilian and military applications—to Russia. These prohibitions on the export of sensitive materials and technology are intended directly to degrade Russian military strength, reducing its capacity for aggression.

Dual-use export controls have also become increasingly relevant as US-China competition intensifies and both states vie for the technological cutting edge. Mearsheimer (2019), for instance, argues that the US should work with its allies to limit dual-use exports to China. This recommendation to strengthen dual-use export controls has not gone unheeded. In 2019, the Trump administration blacklisted China's largest chipmaker Semiconductor Manufacturing International Corp (SMIC) and urged US allies to refrain from selling SMIC advanced equipment. Dutch officials, for instance, were pressured to cancel the sale of an extreme ultraviolet lithography (EUV) machine to SMIC. The Biden administration appears to be following a similar strategy toward China. In March 2021, the US National Security Commission on Artificial Intelligence (NSCAI) recommended that the US should coordinate with the Netherlands and Japan to deny China key chipmaking equipment. The US has also made dual-use export controls central to its strategy of “de-risking” its economic engagement with China.<sup>1</sup>

As these cases illustrate, dual-use export controls are crucial not only for non-proliferation purposes (their original intent), but broadly for the preservation of globalized production chains, holding implications for major power competition and the prospects for global peace (Kim 2019; Mearsheimer 2019). To be clear, export controls and economic sanctions are distinct,

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<sup>1</sup>Notably, the term de-risk is used here differently than in the academic literature, where it generally refers to firm decisions to “over-comply” with sanctions by cutting business ties with target states.

but related concepts. We side with Pape (1997) and Weber and Schneider (2020) and choose to define economic sanctions as economic restrictions aimed at changing a target's political behavior.<sup>2</sup> Export controls, i.e., economic restrictions of the exports of certain goods and services, can be applied as part of a sanctions regime.<sup>3</sup> But they can also be imposed without a clear aim of changing targets' political behavior and without (formal) imposition of economic sanctions. That said, export controls are restrictions on commerce in practice. And at least in principle, a state facing export controls could change policy in a manner that leads to a reduction or removal of export controls. Given these parallels, the broader sanctions literature can offer insights on export controls.

In particular, for the US to succeed in dual-use export controls, it must obtain the cooperation of third-party exporters. Cooperation on export controls to counter Russian aggression has been broad, including European states dependent on Russian oil and gas such as Germany as well as Asian states geographically distant from the war such as Japan and South Korea. Nonetheless, success here faces resistance from China, which has affirmed a continuation of friendship with Russia. But while China's support for Russia reflects a similar authoritarian ideology and a mutual desire to counter US leadership, non-compliance with export controls by US allies also poses a challenge to US foreign policy. Returning to the SMIC example, two days after the NSCAI recommendation, ASML, the world's largest supplier of lithography equipment based in the Netherlands, announced that it would extend the sale of chip manufacturing equipment to SMIC until the end of the year. A US semiconductor industry executive claimed

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<sup>2</sup>Economic sanctions can be conceptualized broadly or narrowly. Drezner (2024) argues that economic sanctions should be conceptualized broadly, including efforts aimed at containment, denial, and political symbolism. Kim (2019), by contrast, argues that economic sanctions should be conceptualized as part of a bargaining process and clearly convey the potential of removal should the target state modify its policy. Policies of containment and denial, including via export controls, do not always follow a target's failure to satisfy some explicit demand, and thus occur even beyond what we define as explicit sanctions cases.

<sup>3</sup>For instance, according to our data spanning 1997–2015, India was sanctioned by the US only from 1998 to 2001. By contrast, it was under very restrictive US export control from 1997 to 2005: across the 15 categories of reasons for export control listed in the US commerce country chart, 12 categories applied to India during this period.

that “This [sale] is a slap in the face to the NSCAI recommendations and shows how big the gap with allies is on these issue” (Nellis 2021).

At first glance, a state like the Netherlands engaging in this behavior appears puzzling given the deep economic, political, and military relationship between the US and Europe, and because of common interests in maintaining a liberal international system characterized by democracy, the rule of law, and institutionalized cooperation against an illiberal rising challenger. Existing studies, however, suggest that this counter-intuitive behavior by allies is to be expected. Just as US allies are the most likely states to engage in sanctions busting (Clarke and Johnston 1999; Early 2015; Meijer 2016), we can expect them to sabotage US export control efforts because they have better access to the restricted items, enjoy political cover for their busting behavior, and therefore expect to reap strong economic benefits in a distorted market without facing severe penalties. This ally-busting<sup>4</sup> behavior thus deserves further scrutiny particularly with respect to controlled dual-use (CDU) trade.

We argue there are two important issues that need to be accounted for simultaneously. First, US commitment to export control varies. We contend that US commitment to restrict CDU trade is strongest when it imposes sanctions that relate to export controls on a target state. These types of sanctions are often imposed for violations of prohibitions against armed aggression, weapons of mass destruction (WMD) proliferation, human rights abuse, and similar proscribed behaviors. While US allies might benefit from political cover when exporting CDU goods to non-sanctioned states, we argue that they lose this benefit when an importer faces sanctions for engaging in behavior that is facilitated by dual-used commodities.

Second, US allies look very different from non-allies on a variety of dimensions. They tend to be more capable of producing CDU goods and are also more trusted and relied upon by the US. They could have more opportunities to export CDU goods, but that fact does not necessarily imply a greater willingness to intentionally undermine US export control efforts. Specifically,

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<sup>4</sup>Throughout the paper, we use the term “ally-busting” to refer to export control circumvention behavior by US allies. For ease of reference, we will refer to dual-use goods that are under export control as “controlled dual-use” goods or “CDU” goods.

we argue that four key factors affect states' opportunity and willingness to engage in dual-use exports: the exporter's ideological proximity (i.e., foreign policy preference similarity) to the US, the exporter's ideological proximity to the importer, and the exporter's and importer's economic integration in dual-use trade networks. When accounting for these determinants, we find that US allies do not export more CDU to US-sanctioned states. Yet, even accounting for economic and political factors underlying CDU trade, US allies export more CDU to states not sanctioned by the US. This result follows, we argue, from the fact that such importers have not been stigmatized by US sanctions, and because US allies do not fear major US reprisal for engaging in this behavior even if it risks subverting international export control agreements.

This paper makes a number of contributions. First, it offers a cautious note toward the existing ally-busting theory. Our study shows that US allies are not more likely to undermine US sanctions by exporting CDU to targets once we account for the above-mentioned confounders. Second, our study connects recent work on sanctions busting with recent advancements in trade networks' effect on economic coercion (Farrell and Newman 2019; Peterson 2020; Zeng 2020). Our results suggest that states' economic integration in the global CDU trade networks is a critical determinant of CDU trade even in the presence of US sanctions. Third, this paper holds several policy implications. The effectiveness of dual-use export controls will vary across different target countries. Echoing Kim's (2019) argument, economic containment of China is less likely to be a viable and effective option given its growing economic integration in global trade networks. Deep cooperation through international organizations could be necessary to coordinate broad export controls against China. This, however, may not be the case for countries that are less integrated (e.g., Russia and Iran). As their policy preferences further diverge from those of the US and (many of) its allies, less integrated states will be constrained from importing CDU goods; and we can identify from whom—i.e., highly-integrated CDU exporters—they are most likely to obtain CDU goods.

## 2 Sanctions busting and dual-use export control

US promotion of export controls is an important aspect of its broader global leadership. The US and its allies established and maintained a rather effective control regime during the Cold War era: the Coordinating Committee for Multilateral Export Controls (CoCom). Though they continue to perceive numerous benefits of a multilateral export control regime, their ability to coordinate on such a large-scale apparently declined since the end of the Cold War. Post-CoCom agreements have been narrower in scope as the world's economies become increasingly integrated while states' security interests further diversify. For example, the Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies largely involves information-sharing on export licenses denied, as well as such licensees granted in the aftermath of denial by another member. The focus of contemporary export control regimes primarily on transparency raises the question of whether and under what conditions export controls of dual-use goods remain effective.

Though in some cases defined by the commodity traded rather than the recipient thereof, export controls are restrictions on commerce in practice, especially from the perspective of firms considering foreign business partners.<sup>5</sup> As such, the sanctions literature can offer insights into the factors that would promote successful export controls. This literature suggests that international institutions and the number of states cooperating to impose sanctions are two critical determinants of effectiveness.<sup>6</sup> Sanctions are more likely to succeed if senders are supported by international organizations (Drezner 2000; Allen 2008; Bapat and Morgan 2009). Meanwhile, sanctions that count on multilateral coalitions can also be more effective than uni-

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<sup>5</sup>Indeed, prospective exporters in the US have to navigate lists of sanctions through the Office of Foreign Assets Control (OFAC) along with the Commerce Control List through the Bureau of Industry and Security (BIS), facing an increasingly complex administrative burden (Stępień and Weber 2019). Further, some sanctions specifically incorporate enhanced export controls as provisions.

<sup>6</sup>See Bapat et al. (2013) for a literature review on a comprehensive list of determinants of sanctions effectiveness.

lateral ones (Bapat and Morgan 2009; McLean and Whang 2010; cf. Martin 1994; Drezner 2000). The effectiveness can be further enhanced if senders can win over the support of targets' major trade partners (McLean and Whang 2010).

The conundrum for dual-use export control after the Cold War, however, is that international institutions weakened substantially after the dissolution of the Soviet Union. As mentioned above, the Wassenaar Arrangement, for instance, is a much weaker regime than its predecessor CoCom (Jaffer 2002). As a result, the success of dual-use export control relies increasingly on willing coordination across countries and private actors (Mineiro 2011). Without a common enemy and constant threats from a rival coalition, enforcing cooperation among multiple actors can be particularly challenging as the security interests of different allies further diversify.

In this regard, the export control practices of US allies are a particularly important factor to understand the effectiveness of US export control efforts. Again, the sanctions literature offers guidance, as Early (2015) argues that US closest military allies are in the best position to exploit the profits from busted sanctions. The distorted market in sanctioned targets can generate significant lucrative profits for third-party states. Given that US allies do not necessarily share the same specific security interests as the US in all cases, the economic interests can overwhelm the policy concerns (Early 2012). Additionally, ally status provides political cover for the respective governments to protect their constituents' busting behavior (Early 2012, 2015). Accordingly, US firms that seek to do business with sanctioned states will be incentivized to shift their operation to US allies (Early 2012; Barry and Kleinberg 2015). Sanctions targets will also adjust their strategies to forge closer ties with countries that can provide the "most cost-effective means of adjusting to the sanctions" (Early 2015, 11).<sup>7</sup> This can potentially help explain why scholars do not find systematic efforts by either Russia or China in busting US and EU sanctions (Gutmann, Neuenkirch and Neumeier 2024) or why some Western firms do not need to circumvent

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<sup>7</sup>It is not fully clear whether these countries should necessarily be US allies. But the theory implies allies are less likely to be targets of US secondary sanctions, therefore trading with them would be a safer and more stable strategy.



sanctions by establishing local affiliates in Russia after the latter was sanctioned in 2014 (Kohl, van den Berg and Franssen 2024).

Anecdotes of CDU ally-busting are available. Clarke and Johnston (1999), for instance, show that Israel was China's primary source of advanced defense technology over a period during which China faced US sanctions and targeted export controls. The "systematic and growing pattern" of illicit Israeli reexports led to subsequent US rebuke of the Israeli government, but little change in Israeli behavior (Clarke and Johnston 1999, 207). Meijer (2016, 127) shows that China's acquisition of Israeli technology was further increased when relations were normalized in 1992. And "since Israel was not a member of CoCom, it was under no obligation to restrict its exports of telecommunications equipment to the PRC" (Meijer 2016, 189).<sup>8</sup> More recently, after Russia's invasion of Ukraine, Turkey has become a main transit center that reexports restricted goods to Russia. Among them, computer numerical control (CNC) machine tools including machining centers, lathes, and electric discharge machines are a key cog that helps sustain Russia's war machine. Notably, 44.8% of the machine centers Russia imported from Turkey between March and September 2023 were imported from Taiwan, a de facto ally of the US (Zayakin and Lee 2024).

However, the degree to which US allies systematically engage in CDU busting activities remains unclear. The existing literature suggests that we need to be attentive to three potential limitations. First, although US allies on average tend to have more opportunities to bust US sanctions, it is still not clear whether they would be more willing to do so (Starr 1978). In particular, US allies represent a distinctly different set of states than non-allies. They benefit from opportunities to export CDU because they tend to be wealthier and more capable of producing or acquiring dual-use products. Given the economic strength of US allies, it would actually be more surprising if we do not find at least some anecdotal stories of US allies selling CDU products to sanctioned countries.

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<sup>8</sup>Even EU allies, with France acting as a key driver, "came quite close to removing the ban on arms sales to China" in 2003-2005 (Meijer 2016, 249). Notably, arms are distinct from dual-use commodities in that their sole use is for military purposes.

Second, further research needs to account for the variation across different dyads and over time. Why wouldn't all allies resort to the sanctions-busting strategy? Why would some allies toe the line in some cases despite the potential for economic benefits associated with busting? For instance, Israel's willingness to engage in sanctions busting can be contrasted with US allies in the EU that did not remove their sanctions on China—even despite France's efforts. For another example, Turkey's rising status as a transit for busting Western export controls happened against the backdrop that most other NATO allies' CDU exports to Russia dropped sharply immediately after the invasion (Zayakin and Lee 2024). Taken together, it is more likely that the US alliance in part motivated compliance with export controls, at least for some states.

Third, we do not really observe the counterfactuals of what US allies would have done were they not US allies. The fact that some US allies increase their dual-use exports to sanctioned countries is not good enough evidence that allies are more likely to engage in sanctions-busting activities unless we can find evidence (or are willing to assume) that these countries would have exported less were they not US allies. If, for example, the Netherlands were a potential US rival, wouldn't it make more sense to bust US sanctions as a "black knight?" Indeed, the combination of commercial interests and (potential) rivalry can often result in a much stronger incentive to bust sanctions (Early 2011). Enemies of enemies are "three times more likely to become allies" (Maoz et al. 2007, 108). Russia, for instance, acted as a sanctions-buster after the US and EU imposed an arms embargo on China in the early 1990s, becoming the latter's primary supplier of military equipment (Meijer 2016). More recently, China chose to sign the strategic partnership deal with Iran as the former's conflict with the US intensified (Greer and Batmanghelidj 2021). And although events are still unfolding as of this writing, China appears prepared to thwart sanctions and export controls against Russia over the invasion of Ukraine.

### 3 Theory and hypotheses

The limitations discussed above lead us to develop a new theory to explain CDU trade considering the central role of the US. We argue that US sanctions serve as signals that have a particularly pronounced impact on trade in CDU. Without relevant US sanctions that signal US commitment, the ally-busting rationale would often hold. US export control laws “follow the goods” and apply to non-US-made items where US-origin contents exceed a certain value threshold (Hirschhorn, Egan and Krauland 2021, 34–38). However, the lack of US sanctions would signify that (1) the US may not be fully committed to enforcing the restrictions to third-party states; (2) the US does not view the importing state as a particularly notable violator of liberal international norms; and (3) CDU exports of non-US-made items are still allowed so long as the controlled US contents do not exceed the threshold. In addition, export controls alone would not entail the same shaming or stigmatizing impact as explicit economic sanctions (Biersteker 2015).<sup>9</sup> Trusted and relied upon by the US, US allies could remain confident that they benefit from political cover such that CDU exports will not provoke retaliation by the US as long as such exports do not directly undermine US sanctions.

When targets are under relevant US sanctions, however, we contend that US allies are not the most likely exporters of CDU. This is because US sanctions would clearly communicate its policy preferences to third-party states and showcase its willingness to enforce the restrictions (Peterson 2021). Once a target state is under US sanctions, additional layers of laws and agencies will be brought in to actively monitor transactions and take enforcement actions, prohibiting certain foreign transactions even when they meet the US export control regulations. The

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<sup>9</sup>For instance, India’s nuclear tests in 1998 were met with harsh critique in the international community. One day after the tests, the Clinton administration immediately pledged to implement punitive US sanctions laws. This stigmatized India as a violator of the non-proliferation norm. Several other US allies including Canada, Japan, and Germany also followed with condemnation and sanctions. Sanctions can achieve this stigmatizing effect because they can send out a clear and intensive signal (Biersteker 2015). By comparison, the restrictive US export controls on India in other years without sanctions do not entail this kind of stigma.

US can also apply secondary sanctions barring Americans from doing business with sanctions busters (Lew and Nephew 2018), and impose steep civil and criminal penalties on violators (Early and Preble 2020). For instance, the US fined the French bank BNP Paribas nearly \$9 billion in 2014 for sanctions violations. The central status of US financial institutions also renders the threats of financial sanctions a particularly powerful weapon (Drezner 2011, 2015; Farrell and Newman 2019).

In addition, busting allies' sanctioning efforts comes at the price of reducing cooperation and potentially weakening the alliance (Mansfield and Bronson 1997). US allies might see some lucrative opportunities for business dealings with certain states. However, when the US imposes relevant sanctions on a target state intended to cut off its access to strategic goods, the reason is often for behavior such as territorial aggression, sponsorship of terrorism, nuclear proliferation, or human rights abuse (Miller 2014; Peterson 2021). Continuing this severe form of CDU busting would directly enable the proscribed behavior that poses serious challenges to widely-held norms (and US foreign policy preferences) for peace and human rights promotion, and potentially weakens the alliance. Moreover, the US would be hesitant to form or maintain alliances with states that would either not protect the dual-use and advanced military technology they import or intentionally reexport sensitive technology. Fuhrmann (2008, 647) finds that "military allies receive 134% more dual-use exports from the United States than non-allies." In contrast, non-allies are on average less trusted and often have no access to advanced US technology. For instance, the ultra-stealthy fifth-generation F-35 jets are only available to 13 closest US allies. Selling F-35s to other countries such as the UAE (even though they are very close to the US) can raise serious policy concerns and debates in Washington (Schenker 2021). While military equipment is on average more sensitive than CDU, many of the technologies and components that enable the production of military hardware fall under the CDU classification. Given the above economic and security repercussions, we have our first hypothesis as follows:

**Hypothesis 1.** *Compared to non-allies, US allies export more CDU to an importer under the condition that US sanctions are not in force against the importer. The positive association between US alliance and CDU exports is not present (or reverses) under the condition that US sanctions*

*are in force against the importer.*

Related to the above argument on US commitment, we expect that the severity of US export controls against specific importers could influence CDU exporters' incentives. All else equal, stricter US export controls suggest more bureaucratic red tape that would reduce CDU exports from US firms. In the absence of US sanctions against the importer, third parties could perceive an opportunity to step in and fill this gap. However, if the US has sanctioned the importing state, the benefit of filling this gap likely pales in comparison to the possible cost of US retaliation. Further, as discussed above, CDU exporters could interpret US sanctions as stigmatizing the importer. In the case that sanctions are imposed, stricter US export controls on the target might signify the opposite: that a given US sanction target is a particularly risky or undesirable partner for CDU exports. Our second hypothesis follows:

**Hypothesis 2.** *Stricter US export controls on an importer are associated with more third-party CDU exports under the condition that the US sanctions are not in force against the importer. The positive association between US export control strictness and CDU exports is not present (or reverses) under the condition that US sanctions are in force against the importer.*

US influence on trade in CDU does not end with its allies. We further argue that it is important to account for political and economic determinants of CDU trade, which could have heterogeneous effects depending on the presence of US sanctions. First, similar to Fuhrmann (2008), we expect that more CDU trade will be higher among dyads with closer ideological proximity, defined as foreign policy preference similarity. At a minimum, ideological proximity is important to control for given its potential correlation with alliance. However, we also contend that US sanctions condition the impact of ideological proximity on CDU trade.

Controlling the spread of dual-use commodities and technology is an important liberal norm and important goal of US foreign policy. The passage of UN Security Council Resolution 1540 demonstrates broad agreement with this goal in principle. Liberal states more ideologically proximate to the US are particularly likely to ascribe to the norm of dual-use export controls. As such, we expect all else equal that these states will export less CDU in general, but especially when US sanctions against a potential importer have signaled that this state is

violating liberal international norms. On the other hand, ideological distance from the US incentivizes higher CDU exports in general, but particularly to US-sanctioned states, given that ideologically distant exporters should face a greater political desire to undermine US foreign policy efforts—i.e., to play the role of the “black knight” (Early 2011).

As noted above, we also contend that political motivation to export more CDU could stem from the exporter’s ideological proximity to the importing state (Fuhrmann 2008). However, we further expect that this motivation will increase when the US imposes sanctions against the importing state. While previous research suggests that states trade more with friendlier (i.e., more ideologically proximate) states, the presence of US sanctions against the importer implies a greater economic opportunity to reap gains from CDU exports as well as a political opportunity to aid an ideologically similar state. While economic gains are present even amid greater ideological distance between importer and exporter, exporters in this case should be more likely to exercise caution, as CDU exports would potentially strengthen the military of a state that could pose a future threat. Notably, this argument points out how US sanctions reshape patterns of CDU trade, but do not universally reduce such trade. Two hypotheses follow from the discussion above.

**Hypothesis 3.** *States export less CDU when they are more ideologically proximate to the United States; and this relationship is stronger under the condition that US sanctions are in force against the importer.*

**Hypothesis 4.** *States export more CDU when they are more ideologically proximate to the importing state; and this relationship is stronger under the condition that US sanctions are in force against the importer.*

Finally, we expect dyadic CDU trade to be positively related to each state’s preexisting integration in CDU trade networks. Early (2012) notes that US allies often bust US sanctions because they have the opportunity to do so, thus highlighting the importance of controlling for this determinant of CDU trade. Exporters with greater integration in CDU networks—that is, those more closely connected to a larger number of trade partners—should have more opportunities to export CDU all else equal. More integrated exporters should also be more capable

of enduring economic disruption or threats from US secondary sanctions since they can more easily find alternative markets (Peterson 2020).

Similarly, we expect importing states' integration in CDU import networks to be positively related to their CDU imports from any given exporter. This logic follows because importers, even if facing US sanctions, are more capable of purchasing CDU from alternative suppliers as their network integration increases. As such, exporting states would expect the sanctions efforts on more integrated targets to be more likely to fail (Kim 2019), resulting in a more challenging situation to coordinate control efforts across multiple actors and a stronger incentive to defect for each individual state. Taken together, we should expect both exporters' and importers' integration to be positively correlated with dyadic CDU trade. We also expect the effects to be stronger when an importer is under US sanctions because sanctions can create a distorted and arguably more lucrative market. Sanctioned states should also have stronger incentives to purchase and stock CDU while they can. In this situation, more integrated exporters are also more capable of reaping profits from the distorted market. More integrated importers can better exploit other states' incentives to defect. A final hypothesis follows from the discussion above.

**Hypothesis 5.** *Dyadic exports of CDU will be higher when the exporter is more integrated in CDU export networks; and this relationship is stronger under the condition that US sanctions are in force against the importer.*

**Hypothesis 6.** *Dyadic exports of CDU will be higher when the importer is more integrated in CDU import networks; and this relationship is stronger under the condition that US sanctions are in force against the importer.*

## 4 Research design

To test our hypotheses, we use data on directed dyads composed of an exporter and an importer, with yearly observations. Given our focus on how the US influences CDU beyond its borders, we exclude the United States in either role. Following from limitations across all variables, our directed dyad-level observations cover the 1997-2015 period.

## 4.1 Dependent variable

Our dependent variable captures exports of dual-use goods—i.e., those subject to export controls. Ideally, we would like to have a list of dual-use goods under US export control that varies across targets and over time. However, such data are not readily available. As a result, we follow Peterson (2021), choosing to use the export control list provided by the European Commission given the EU’s deep cooperation with the US in several key export control regimes.<sup>10</sup> The main advantage of using the list is that it provides Combined Nomenclature (CN) codes which are a finer taxonomy of the Harmonized System (HS).<sup>11</sup> Using this list of codes, we extract the trade data of dual-use goods under export control from the UN Comtrade data (1962-2018).

Given potentially inconsistent trade reports across countries, we use the Atlas of Economic Complexity’s data on trade flows, which applies the Bustos-Yildirim method to clean the Comtrade’s raw data (The Growth Lab at Harvard University 2019). To alleviate the concerns of inflation over time, we use the trade data in millions of constant 2010 US dollars. To mitigate the impact of outliers, we log-transform these values. The distribution, as shown in Figure 1 panel (a), remains right-skewed and censored at 0. For the plurality of cases, states do not export any CDU.<sup>12</sup>

## 4.2 Primary independent variables

We use the EUSANCT Dataset Weber and Schneider (2020) to identify US sanction targets. While other states and international organizations impose sanctions, we focus on US sanctions

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<sup>10</sup>Correlation list between TARIC and the Dual-use Annex of the Regulation 428/2009, <https://ec.europa.eu/trade/import-and-export-rules/export-from-eu/dual-use-controls/>, accessed 11 April 2021.

<sup>11</sup>The CN code in the list exists at 10 digits. But the first 6 digits follow the HS codes. In compiling the data, we use the HS codes (828 unique values) to identify commodities. See [https://publications.jrc.ec.europa.eu/repository/bitstream/JRC97664/2015.11.19.economicrelevancedualuse\\_online\\_version.pdf](https://publications.jrc.ec.europa.eu/repository/bitstream/JRC97664/2015.11.19.economicrelevancedualuse_online_version.pdf), accessed 11 April 2021.

<sup>12</sup>There are 49,512 zeros relative to 239,893 values above zero. The first bin in the histogram includes other values that are very close to 0.



because the US has been the most prevalent sender particularly in the post-Cold War period, as well as a dominant player in various export control regimes.<sup>13</sup> Though the EUSANCT data is coded similarly to the commonly-used Threat and Imposition of Economic Sanctions (TIES) data (Morgan, Bapat and Kobayashi 2014), EUSANCT is distinguished in part by omitting primarily economic issues such as escalated trade disputes and demands for financial reform. Though one could quibble with the inclusion of every issue in EUSANCT,<sup>14</sup> we contend that any of the issues included therein could plausibly signal pariah status associated with violation of liberal international norms (Biersteker 2015). While all EUSANCT issues are relevant, not all sanction types—i.e., not all types of restrictions—obviously signal that enhanced enforcement of export controls against the target is an aim of the US government. As such, including all sanction types could potentially inflate our sample with many cases where targets are not necessarily under enhanced scrutiny on export controls. To strike a balance, we use the US sanctions imposition type variable in EUSANCT to tease out sanction types that are not likely to be related to export control.<sup>15</sup> We exclude sanctions consisting solely of (a combination of) these types: import restriction, termination of foreign aid, travel ban, suspension of economic agreement and exclusion from regional or international organizations, and diplomatic sanction. The final sanctions variable is a dichotomous indicator of sanctions against the importer in the exporter-importer dyad. The yearly proportion of importers under US sanctions is shown in Figure 1 panel (b). We interact this sanctions variable with political and economic determinants of dual-use trade, as described below.

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<sup>13</sup>EUSANCT codes threats and impositions of sanction by the European Union, the US, and the United Nations from 1989-2015. Adding a variable for EU or UN participation in sanctions does not alter our main results.

<sup>14</sup>In particular, the issue of drug trafficking might seem to be more of an economic (i.e., black market) issue. However, research finds that arms trafficking can follow drug trafficking using the infrastructure established by the former (Griffiths and Jenks 2012).

<sup>15</sup>There are 13 different sanctions types identified in the dataset. And a target can be under several types of sanctions simultaneously.

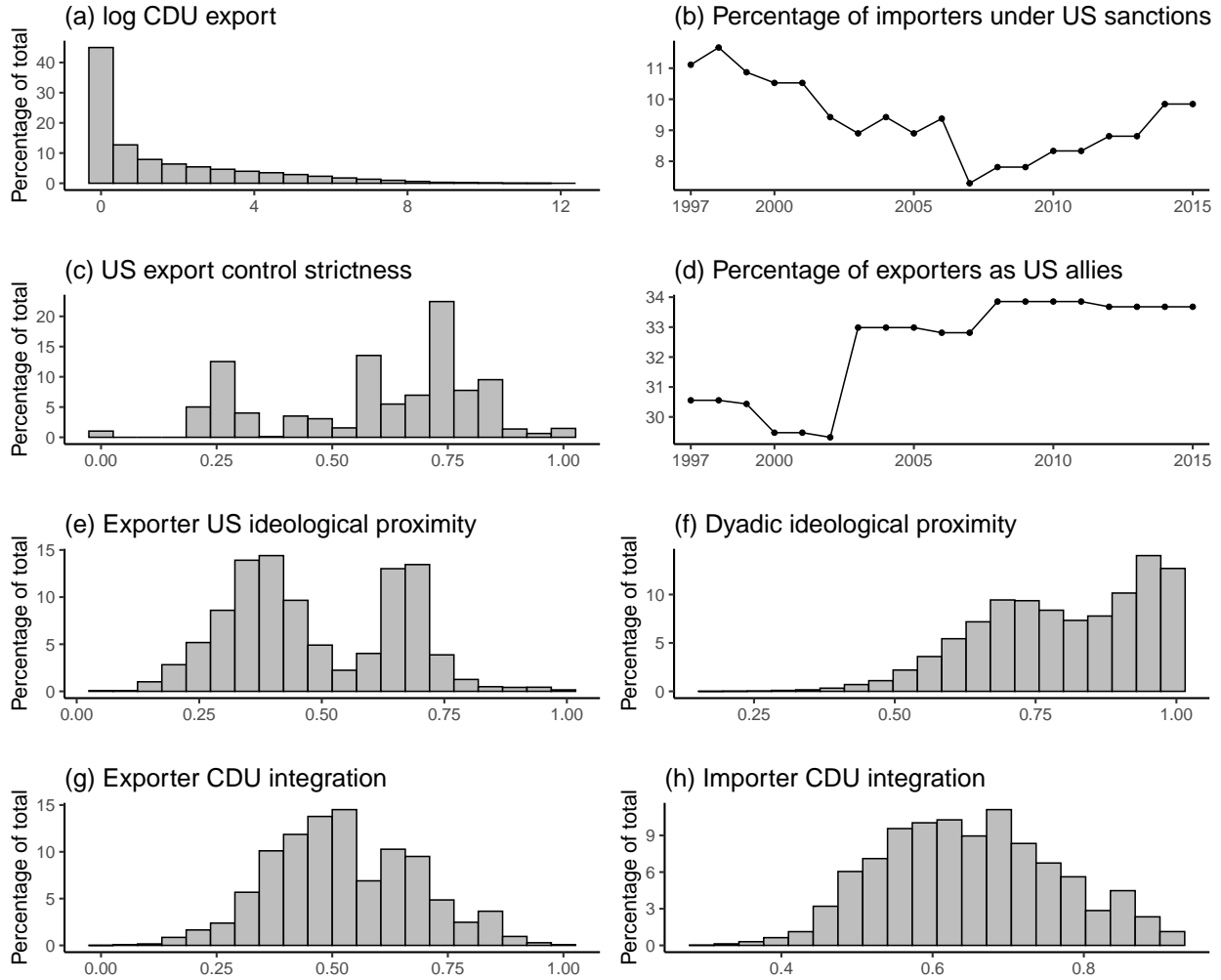


Figure 1: Distributions of the dependent variable and primary explanatory variables.

We measure the strictness<sup>16</sup> of US export controls against the importing state using the United States Commerce Country Chart, available as supplement number 1 to part 738 of the Export Administration Regulations.<sup>17</sup> This chart lists reasons for export controls on each country, including e.g., national security, regional stability, and crime control. The number of cate-

<sup>16</sup>Technically, we are measuring the breadth of applicable export controls. This measure might not perfectly capture severity, but we expect that there is a strong correlation. Notably, the broadest export controls exist against states such as Cuba, Iran, North Korea, Syria, and Venezuela—all states facing comprehensive US sanctions and facing maximal export controls.

<sup>17</sup>Combined with our focus on sanction types, the inclusion of an export control strictness variable allows us to account, albeit indirectly, for the degree to which US sanctions specifically correspond to export controls.

gories for each reason varies from one (e.g., Missile Tech) to three (e.g., Chemical and Biological Weapons). The chart presents Xs to indicate whether each export control category applies to a given state. We use historical charts to code country-year variables for every category over the span from 1997 to 2023. We sum the number of “X” for each country and standardize it by the yearly maximum values to create a country-year US export control strictness index for each importing state as a function of which export control reasons apply.<sup>18</sup> This index is interacted with the dichotomous indicator of US sanctions against the importing state.<sup>19</sup> Figure 1 panel (c) illustrates the distribution of the strictness index.

We measure US alliance status using the Alliance Treaty Obligations and Provisions (ATOP) data (v 5.0) by Leeds et al. (2002), which covers military alliance agreements signed by all countries between 1815 and 2018. Alliances are defined as “written agreements, signed by official representatives of at least two independent states, that include promises to aid a partner in the event of military conflict, to remain neutral in the event of conflict, to refrain from military conflict with one another, or to consult/cooperate in the event of international crises that create a potential for military conflict” (Leeds et al. 2002, 238). Following their recommendation, we choose to exclude the cases of nonaggression pacts and only code two countries as allies if either state has a defense, offense, or neutral obligation toward the other during a given year.<sup>20</sup> Using this coding scheme, we identify exporters that are allies of the United States with a dichotomous variable. Given that this variable is interacted with the presence of US sanctions against the importer, the coefficient for *Exporter US ally* signifies the association between US alliance and CDU exports in the specific instance that US sanctions are not in place against the

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<sup>18</sup>EAR §738.3 notes that “[t]here is a direct correlation between the number of ‘X’s applicable to your transaction and the number of licensing reviews your application will undergo.” In an alternate analysis, we found similar results using item response theory models.

<sup>19</sup>The strictness index has a modest correlation with US sanctions (0.28). Indeed, the most strict export controls fall on states facing comprehensive sanctions, as noted. However, there is variation in strictness across sanctioned and non-sanctioned states.

<sup>20</sup>If we do not exclude nonaggression pacts, then China and Russia (USSR) would be counted as US allies since 2009 and 1975 respectively.

importer. The marginal effect of US alliance in the presence of US sanctions against the importer is equal to this coefficient plus the coefficient for the interaction term. Figure 1 panel (d) illustrates the proportion of exporters that are US allies over time.

We capture political proximity for two pairs of states: specifically, *exporter-US proximity*, and the *exporter-importer proximity*. While it may be attractive to use sentiment polls to proxy citizens' attitudes, one could be concerned about the mismatch between popular will and actual government policies (Kim 2021). As such, we code proximity using the ideal point data by Bailey, Strezhnev and Voeten (2017) which uses roll-call voting data in the UN General Assembly to estimate states' foreign policy preferences (i.e. ideal points). We use the version updated in April 2021 which covers data from 1946 to 2019. We first calculate political distance as the absolute values of the differences between two countries' ideal points. We divide this distance measure by the maximum value in our data to create a 0-1 scale. We then subtract this value from 1 such that the values closer to 1 indicate greater proximity rather than distance. The distribution of these variables is shown in Figure 1 panels (e) and (f). As with the variables for exporter US alliance and importer US export control strictness, these variables are interacted with the dichotomous variable for US sanctions against the importing state.

We apply network analysis to capture integration in a respective trade network. Following Zeng (2020), we use the closeness centrality measure, which examines weighted shortest paths to capture how close a state is to the rest of other countries in the CDU networks—including those that are not direct CDU trade partners. The higher the value of closeness, the more central and integrated a state is in a trade network. Using the controlled dual-use trade data, we apply this method to both the network of CDU exports (where network edges are outward flows) and CDU imports (where network edges are CDU in-flows). We calculate the values across the 10 broad categories in the BIS's Commerce Control List<sup>21</sup> separately and select the highest one for each country year.

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<sup>21</sup>See <https://www.bis.doc.gov/index.php/regulations/commerce-control-list-ccl>, accessed 11 April 2022.

This way, we obtain two measurements: (1) exporter integration in the CDU export network, capturing the extent to which its controlled exports diffuse through the international system; and (2) importer integration in the CDU import network, capturing its ability to obtain controlled products, including via indirect sources. Once again, we divide each value by the maximum to create final variables that span from 0 to 1. The distributions of these two variables are shown in Figure 1 panels (g) and (h). Once again, these variables are interacted with the indicator of imposed US sanctions against the importer.

### **4.3 Control variables**

We control for gravity covariates—exporter and importer (logged) GDP in constant dollars as well as the (logged) weighted average distance between states—using data from CEPII (Mayer and Zignago 2011). We also code a variable identifying the exporter’s and importer’s membership in at least one of the most notable multilateral export control regimes (MECR): the Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies, the Nuclear Suppliers Group, the Australia Group, or the Missile Technology Control Regime. Finally, given our focus on liberal international norms and US leadership with respect to these norms, we code variables for the exporter’s and importer’s liberal democracy score as coded by the Varieties of Democracy project (Coppedge et al. 2022). The liberal democracy index incorporates information on limits on government, checks on the executive, civil liberties, and electoral institutions. In a separate model, we also interact the presence of US sanctions with all of our control variables.

The summary statistics of our explanatory variables are shown in Table 1. Given our contention that US allies differ from non-allies with respect to these variables, we present statistics by exporter US alliance status. We can see that US allies tend to export more CDU in general. They are also more integrated in the export trade networks. Taken together, these provide at least some *prima facie* evidence that US allies have more access to and are more capable of exporting CDU. Additionally, their respective targets are under tighter US export controls and

Table 1: Summary statistics: 1997-2015

Characteristic	Exporter US ally		p-value <sup>2</sup>
	No, N = 171,686 <sup>1</sup>	Yes, N = 117,719 <sup>1</sup>	
log CDU export	1.16 (1.80)	2.18 (2.34)	<0.001
US export controls	0.58 (0.23)	0.61 (0.21)	<0.001
Exporter integration	0.47 (0.15)	0.60 (0.14)	<0.001
Importer integration	0.66 (0.12)	0.64 (0.11)	<0.001
Exporter US proximity	0.42 (0.16)	0.58 (0.15)	<0.001
Dyadic proximity	0.80 (0.15)	0.79 (0.14)	<0.001
Exporter log GDP	17.35 (1.93)	19.03 (1.85)	<0.001
Importer log GDP	18.22 (2.05)	17.81 (2.05)	<0.001
Exporter liberal democracy	0.34 (0.25)	0.66 (0.20)	<0.001
Importer liberal democracy	0.48 (0.28)	0.46 (0.28)	<0.001
Distance	8.45 (0.84)	8.62 (0.89)	<0.001
Importer US sanction			0.6
No	156,786 (91%)	107,433 (91%)	
Yes	14,900 (8.7%)	10,286 (8.7%)	
Exporter MECR			<0.001
No	130,569 (76%)	39,563 (34%)	
Yes	41,117 (24%)	78,156 (66%)	
Importer MECR			<0.001
No	94,654 (55%)	74,858 (64%)	
Yes	77,032 (45%)	42,861 (36%)	

<sup>1</sup>Mean (SD); n (%)

<sup>2</sup>Wilcoxon rank sum test; Pearson's Chi-squared test

are less integrated in CDU import networks. Also notable is that exporters that are US allies are considerably more likely to be members of multilateral export control regimes. Finally, we find no statistically significant difference in the likelihood that an importer is facing US sanctions across dyads in which exports vary in their alliance status with the US.

#### 4.4 Estimation

In order to address potential serial correlation common when using panel data, we estimate generalized least squares models with an autoregressive moving average (ARMA) residual struc-

ture grouped by dyad.<sup>22</sup> We also include year fixed effects in order to address time-specific factors that we do not model with our explanatory variables. Finally, to further prevent spurious correlation, we take the first difference of the DV.<sup>23</sup> We estimate the models presented below using the GLS command through the nlme package version 3.1-157 in R version 4.2.0.

## 5 Analysis

Table 2 presents coefficients and 95% confidence intervals. Model 1 presents a non-interacted baseline model in which we can see the average associations between each of our explanatory variables and CDU exports. Model 2 interacts our variable for US sanctions against the importer with each of our primary explanatory variables (exporter is a US ally, exporter-US ideological proximity, exporter-importer ideological proximity, exporter CDU network integration, and importer CDU network integration). Model 3 interacts the variable for US sanctions against the importer with all other explanatory variables, effectively duplicating the results we would obtain with a sub-sampling rather than an interactive approach to estimation. Coefficients for year fixed effects are not shown.

The results of Table 2 broadly support our hypotheses. First, the coefficient for exporter US alliance is positive and significant in all models. In Model 1 (in which no variables are interacted), this result suggests that US allies do on average export more CDU than non-US allies. However, the positive and significant results in Models 2 and 3 imply that this association holds specifically for importers that do not face US sanctions. Substantively, US allies export approximately 0.5 percentage points (Models 2 and 3) more CDU than non-allies, under the condition

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<sup>22</sup>Specifically, we specify an AR(1), MA(1) process. In the supplemental appendix, we present a variety of additional models, for example, auto-regressive models where we added lags of the dependent variable until AR(1) serial correlation was eliminated, and also produced robust standard errors clustered on the dyad. Results are consistent.

<sup>23</sup>The results of models in which we use the level rather than one-year change in CDU export, or where we include a lagged DV to account for preexisting CDU trade, look very similar. We present these alternate specifications in the appendix.

Table 2: Coefficients and 95 percent confidence intervals for GLS models with ARMA residual structure grouped by dyad.

	DV = $\Delta \log \text{CDU}$		
	Model 1	Model 2	Model 3
Importer US sanction	-0.014*** (-0.019, -0.010)	-0.113*** (-0.170, -0.056)	0.007 (-0.102, 0.116)
Exporter US ally	0.005*** (0.003, 0.008)	0.005*** (0.002, 0.008)	0.005*** (0.003, 0.008)
US export controls	0.034*** (0.025, 0.043)	0.032*** (0.023, 0.042)	0.038*** (0.029, 0.047)
Exporter integration	0.162*** (0.147, 0.178)	0.158*** (0.142, 0.174)	0.159*** (0.143, 0.175)
Importer integration	0.162*** (0.126, 0.198)	0.149*** (0.113, 0.185)	0.135*** (0.099, 0.172)
Exporter US proximity	-0.028*** (-0.040, -0.017)	-0.027*** (-0.039, -0.016)	-0.025*** (-0.036, -0.013)
Dyadic proximity	0.041*** (0.034, 0.049)	0.036*** (0.028, 0.044)	0.037*** (0.028, 0.045)
Exporter log GDP	-0.001 (-0.002, 0.000)	-0.001 (-0.002, 0.000)	-0.001 (-0.002, 0.000)
Importer log GDP	-0.002 (-0.004, 0.000)	-0.001 (-0.003, 0.001)	-0.001 (-0.003, 0.001)
Exporter MECR	0.023*** (0.020, 0.027)	0.024*** (0.020, 0.027)	0.023*** (0.019, 0.027)
Importer MECR	0.009*** (0.005, 0.013)	0.007*** (0.003, 0.011)	0.013*** (0.008, 0.017)
Exporter liberal democracy	-0.049*** (-0.055, -0.042)	-0.049*** (-0.055, -0.042)	-0.050*** (-0.057, -0.043)
Importer liberal democracy	-0.027*** (-0.033, -0.021)	-0.024*** (-0.030, -0.017)	-0.026*** (-0.033, -0.020)
log Distance	-0.007*** (-0.008, -0.006)	-0.008*** (-0.009, -0.006)	-0.007*** (-0.009, -0.006)
Importer sanct X Exporter ally		0.003 (-0.006, 0.013)	0.002 (-0.009, 0.012)
Importer sanct X Exp int		-0.036* (-0.066, -0.006)	-0.058** (-0.097, -0.020)
Importer sanct X Exp int		0.052** (0.021, 0.084)	0.037 (-0.022, 0.095)
Importer sanct X Imp cent		0.114*** (0.076, 0.151)	0.483*** (0.319, 0.648)
Importer sanct X Exp prox		-0.007 (-0.040, 0.027)	-0.035 (-0.081, 0.011)
Importer sanct X Dyad prox		0.033 (-0.002, 0.068)	0.046* (0.010, 0.082)
Importer sanct X Exp GDP			0.000 (-0.004, 0.005)
Importer sanct X Imp GDP			-0.016*** (-0.025, -0.007)
Importer sanct X Exp MECR			0.009 (-0.005, 0.023)
Importer sanct X Imp MECR			-0.040*** (-0.052, -0.027)
Importer sanct X Exp libdem			0.021 (-0.004, 0.047)
Importer sanct X Imp libdem			0.008 (-0.015, 0.031)
Importer sanct X Dist			-0.004 (-0.010, 0.001)
Constant	-0.054*** (-0.084, -0.024)	-0.040** (-0.070, -0.010)	-0.047** (-0.078, -0.016)
Observations	265,447	265,447	265,447
Log Likelihood	-199,882.300	-199,875.400	-199,874.300
Akaike Inf. Crit.	399,836.700	399,834.800	399,846.700
Bayesian Inf. Crit.	400,214.300	400,275.400	400,360.600

Note: all models include year fixed effects. \* p less than 0.05, \*\* p less than 0.01, \*\*\* p less than 0.001



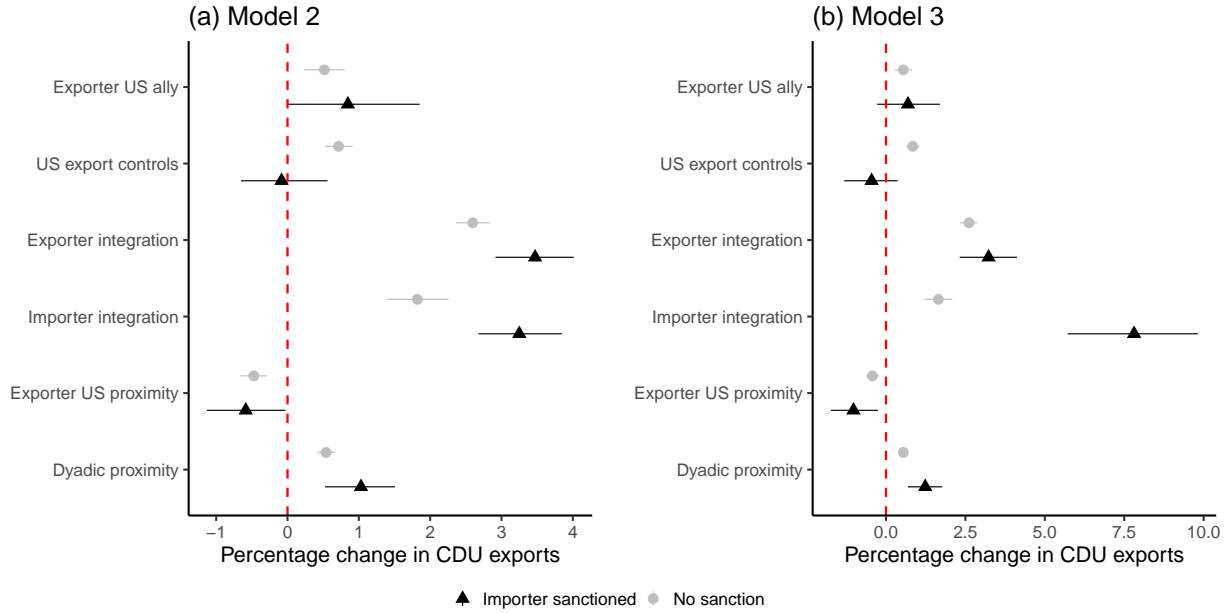


Figure 2: Marginal effects of the main variables with 95 percent confidence intervals. For the four continuous variables, we plot the effects when increasing the respective variable by 1 standard deviation.

of no US sanctions against the importer. We can interpret other coefficient estimates in a similar manner, though it not often clear about the uncertainty of the conditional effects.

To showcase the effects more clearly, we calculate the conditional marginal effect and present them in Figure 2.<sup>24</sup> The figure shows that the impact of exporter US alliance is positive and significant when the importer is not sanctioned by the US. This impact becomes statistically insignificant for US-sanctioned importers in either Models 2 or 3, thereby lending support to Hypothesis 1. We also see that stricter US export controls on the importing state are associated with more CDU exports to that state under the condition that it is not under US sanctions. When US sanctions are in force against the importer, the association reverses signs, though the negative estimate is not statistically significant, as expected by Hypothesis 2.

We also find supporting evidence for Hypothesis 3 and Hypothesis 4. Figure 2 shows that

<sup>24</sup>Because the DV is logged, we calculate percentage estimates by exponentiating the coefficient, subtracting 1, and then multiplying by 100. This gives us the percentage changes in CDU export (compared to previous year's). We draw 1000 samples using the respective models' variance and covariance matrix to account for the uncertainty of estimation.

for both models, but particularly Model 3, the impact of ideological proximity appears stronger when the importing state is sanctioned by the US. In Model 3, for instance, the average impact of dyadic proximity approximately doubles, from 0.55% to 1.23%, while the impact of exporter US proximity more than doubles, from -0.43% to -1.02%. Similarly, the marginal effects for exporter's and importer's integration are both positive and significant.<sup>25</sup> The effects also become stronger as the importer is sanctioned by the US. This again adds support to our Hypothesis 5 and Hypothesis 6. It is worth noting that the figure for Model 3 shows that, in the largest substantive magnitude we find among determinants of CDU trade, a standard deviation increase in importer CDU integration is associated with 1.65% higher exports on average when the importer is not sanctioned, and with 7.81% higher CDU exports to states that are sanctioned by the US.

We now return to one of the examples discussed at the beginning of the paper, the exports of CNC machine tools to Russia. Our theory and empirical evidence suggest that most, if not all, of the US allies should align closely with the US dual-use export control policy once clear sanctions measures have been taken by the White House. Additionally, we should expect to see some busting activities by US allies that hold central positions in the CNC machine tools market as well as non-allies that are in a position to exploit the market distortion. According to a recent report by the Financial Times, before 2022 Russia imported the majority of its CNC machine tools from the EU (Leahy et al. 2024). In December 2021, for instance, Russia imported \$31.86 million of CNC machine tools from the EU, more than the aggregate of South Korea, Taiwan, Japan, and China. After the sanctions were imposed, most US allies have worked very closely with the US in implementing the stringent export control regimes on Russia. For instance, the EU, Japan, and the United Kingdom have worked with the BIS in developing the Common High Priority List (CHPL), which includes 50 items that are relevant for Russia's weapons program (Bureau of Industry and Security 2024). According to the above Financial Times' report, in July

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<sup>25</sup>This finding also aligns with recent research that showcases sanctioned states tend to cooperate with non-sanctioned countries (Early 2021). One reason could be that non-sanctioned countries tend to be more integrated in the global market.

2023 the exports of CNC machine tools by the EU had dropped to \$4.15 million.

That said, one should not expect the export control regime to be airtight. First, non-US-allies would have a strong incentive to rake in the profits. For instance, Chinese-origin devices rose to 57% of Russian imports (\$68.39 million), close to a five-fold increase before the war (Leahy et al. 2024). A senior executive of a multinational machine tool group pointed out that “China couldn’t penetrate the market before, but now they’re seeing average gross profit margins of 30-50% on orders from Russia” (Wu 2024).

Second, at least some US allies that are in a central position in the CNC machine tools will seek or be sought to provide the restricted goods. The exports of CNC machine tools from South Korea and Taiwan to Russia in July 2023 rose to \$17.4 million and \$21.16 million (Leahy et al. 2024). It should be noted that the market of high-precision CNC machine tools is still dominated by non-Chinese companies. Compared to Chinese products, Taiwanese CNC machine tools are more precise and of a higher quality, which can be a critical difference for weapon production (Leahy et al. 2024; Zayakin and Lee 2024). It is therefore not surprising that Russian companies would look for Taiwanese suppliers once the European market was cut off.

Finally, US allies that are not in a central position but have closer ideological proximity to Russia would also actively seek to circumvent the control measures. Turkey is a prime example here, despite its common membership with the US in NATO. Its ideological distance with the US is relatively large while its distance with Russia is much smaller.<sup>26</sup> Although Turkey is not in the same position as Taiwan, it has acted so far as a prominent transition center for Russia’s CNC machine tools imports. From January to October 2023, Turkey suddenly became the top importer of Taiwan’s machining centers (surpassing China). Indeed, close to 80% of Taiwan’s machining centers sold to Russia from January to July 2023 were transited by a third country, with China taking up 38.8% and Turkey taking up 39.19% (Zayakin and Lee 2024).

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<sup>26</sup>According to the latest data (V32, published on 21 March 2024) provided by Bailey, Strezhnev and Voeten (2017), the ideal point distance between the US and Turkey was around 2.01 in 2019, 2.09 in 2020, and 1.92 in 2021. By contrast, its distance with Russia was 0.50, 0.55, and 0.58 respectively.

## 6 Conclusion

This study suggests that US international leadership, and particularly US sanctions, affect global patterns of dual-use trade. Importantly, we argue that US allies are not US sanctions' worst enemies with regard to CDU trade, at least within the post-Cold War period we have examined. Though one can point out prominent examples of US allies engaging in CDU sanctions busting as well as—at least at first glance—a positive correlation between exporter US alliance and CDU exports, these patterns can be explained as a function of confounders: US allies' integration in CDU export networks and their ideological proximity to the US, along with importing states' integration in CDU import networks and exporter-import dyadic ideological proximity.

Beyond reconsidering the ally-busting mechanism with respect to CDU exports, this study also emphasizes the wide-ranging impact of US foreign policy on behavior throughout the international system. US sanctions, at least in some instances, serve as important signals that states have violated widely-shared international norms. When witnesses of this proscribed behavior share US interests, US sanctions can lead them to reduce their exports of CDU to target countries. Importantly, however, economic determinants of CDU, notably network centrality, have an even stronger role in CDU trade in the presence of US sanctions. US international leadership in dual-use export control appears, at least to some extent, to *reshape* patterns of dual-use trade rather than universally *reduce* it.

One limitation of our analyses is that they make use of publicly available data on international trade. Importantly, illicit trade likely rises in the aftermath of sanctions imposition (Early and Peksen 2019).<sup>27</sup> Future research, potentially utilizing a mixed-methods approach, would benefit from identifying specific cases of illicit dual use trade as well as attempting to estimate large-scale patterns of such behavior. Sanctions enforcement by OFAC in the United States could identify cases in which such behavior has occurred, though OFAC has evolved towards

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<sup>27</sup>The authors' study uses an estimate of shadow economies but cannot distinguish dual-use trade therein. Thus, we cannot use their data.

pursuing larger violators, or “whales” (Early and Preble 2020) and as such might not provide a representative set of cases where illicit dual-use trade has occurred.<sup>28</sup> Recent research suggests that OFAC enforcement can reduce trade to US-sanctioned states as firms de-risk or else hazard severe penalties (Early and Peterson 2022, 2024). This process might also apply specifically to dual-use trade.<sup>29</sup> However, more research is needed in order to improve our understanding of dual-use trade to prolific violators of international norms.

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<sup>28</sup>For example, individuals in former Soviet states bordering Russia could smuggle microchips necessary for missile guidance systems in the trunks of their cars, rendering detection difficult. This behavior could also fly under the radar of OFAC, whose attention is directed towards large firms.

<sup>29</sup>While these studies also used official international trade data and thus might not capture all illicit trade, they do examine US response to illicit trade, finding that civil penalties affect trade patterns throughout the international system.

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