Arms, Allies, and Chokepoints*

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Abstract

We compile HS6 product codes from international export-control agreements, harmonize them across HS revisions, match product-level trade elasticities, and construct bilateral measures of dual-use and arms power for all country pairs from 1995 to 2024. Five facts emerge. First, dual-use goods are more substitutable than typical manufactures yet more concentrated in supplier structure, so power operates through supplier concentration rather than product irreplaceability. Second, China's dual-use power gain since 1995 roughly equals the combined losses of Japan, the United States, and the United Kingdom. Third, the two great powers project power through different channels. For China, 82% of military-linked power flows through commercial dual-use supply chains. For the United States, 61% flows through direct arms trade. Fourth, coercive leverage flows from large economies to dependent partners, not between the great powers themselves. Fifth, China's dual-use power over Russia grew 163-fold since 1995, while U.S. power over Saudi Arabia and Israel halved.

Keywords: geoeconomic power, dual-use goods, arms trade, export controls, strategic trade, supplier concentration
JEL codes: F14, F51, F52, H56

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1 Introduction

International trade creates mutual gains but also asymmetric vulnerability. Hirschman (1945) showed that when a country accounts for a large share of a trading partner's imports but the partner accounts for only a small share of its own, the resulting asymmetry generates political leverage. The key variables in his analysis are the concentration of trade on a single supplier and the availability of alternatives. These insights have gained renewed importance as governments increasingly use trade restrictions, export controls, and sanctions as instruments of foreign policy. A central question for the economics of geoeconomic competition is which goods generate the most coercive leverage, and how the answer depends on the scale at which we measure substitutability and concentration.

Clayton et al. (2026) and Clayton et al. (2025) make substantial progress on this question by formalizing geoeconomic power as the welfare cost a target country would suffer from losing access to a hegemon's inputs. In their two-sector implementation, they show that U.S. power relies heavily on financial services, where substitutability is low, while Chinese power is concentrated in manufacturing, where trade volumes are large. This framework provides a rigorous foundation for measuring coercive capacity. However, treating all manufactured goods as a single sector pools strategically important dual-use goods (machinery, electronics, chemicals subject to export controls) with ordinary consumer products. The military dimension of geoeconomic competition remains unmeasured.

We compile HS6 product-code lists from multiple international export-control agreements, including the Wassenaar Arrangement, the Missile Technology Control Regime, the Nuclear Suppliers Group, the Australia Group, and the Chemical Weapons Convention, as well as the WCO Strategic Trade Atlas, the WCO Strategic Trade Control Enforcement Guide, and the EU TARIC dual-use database. These lists are originally reported in different HS vintages and require concordance across revisions, with careful handling of codes that split or merged between editions. We match product-level trade elasticities from Fontagné et al. (2022), reported in HS 2007, to our product classification data. Using BACI bilateral trade data, we construct a 30-year panel (1995–2024) covering approximately 30,000 directed country pairs per year. We extend the Clayton et al. (2025) power measure to the product level, decomposing goods power into three non-overlapping channels (dual-use, arms, and non-strategic manufacturing), and verify robustness across three nested classifications spanning 6% to 35% of global trade. The data reveal five facts.

First, dual-use goods are more substitutable than the average manufactured good (median elasticity 10.0 versus 6.0), yet 62% more concentrated in supplier structure. This finding suggests that power in dual-use goods comes from supplier concentration rather than product irreplaceability. A dual-use good can in principle be sourced from many countries, but in practice a single supplier often dominates. As Hirschman (1945) argued, what matters for coercive leverage is the concentration and asymmetry of the trade relationship, not the total volume or the underlying characteristics of goods. Our product-level data formalize that insight. Whether a dual-use good generates leverage depends on how concentrated its supply is, not on how differentiated the

product is.

Second, China gained 16.9 points of dual-use power between 1995 and 2024. Japan lost 7.6, the United States lost 7.1, and the United Kingdom lost 5.6. China's gain roughly equals the combined losses of these three countries. This reallocation of strategic supply-chain influence is not apparent in aggregate trade data that pool strategic and non-strategic goods.

Third, the two great powers project power through different channels. For China, 82% of military-linked power flows through commercial dual-use supply chains. For the United States, 61% flows through direct arms trade. China overtook the United States in dual-use power around 2015 and projects nearly twice the U.S. level by 2024 (18.6 versus 9.7). The United States retains clear dominance in arms power, with no Chinese overtaking in that dimension.

Fourth, coercive leverage flows primarily from large diversified economies to dependent partners, not between the great powers themselves. Neither the United States nor China depends on the other as a near-monopoly supplier for any of the 165 strategic dual-use goods. By contrast, China holds near-monopoly positions in 79 strategic goods imported by Russia and 36 by Pakistan.

Fifth, strategic supply-chain influence is realigning along geopolitical lines. China's dual-use power over Russia grew 163-fold between 1995 and 2024. Over Iran, the increase was fourfold. Over Pakistan, eightfold. In the opposite direction, U.S. dual-use power over Saudi Arabia and Israel approximately halved. Sanctions and political alignment are channeling trade toward China in the product categories that matter most for coercive leverage.

This paper contributes to three literatures. Most directly, we extend the geoeconomic power framework of Clayton et al. (2026) and Clayton et al. (2025). Mohr and Trebesch (2025) survey the emerging field of geoeconomics and identify the measurement of coercive power as a first-order open question. By disaggregating to the product level, we reveal that dual-use power operates through a qualitatively different mechanism than financial power, with market structure rather than product differentiation as the relevant margin. The finding connects to Farrell and Newman (2019), who theorize that "weaponized interdependence" arises from network chokepoints. Our measure gives empirical content to that concept at the product level.

Second, we contribute to a literature on the relationship between military ties and commercial trade. Berger et al. (2013) show that CIA interventions during the Cold War increased bilateral trade between the United States and target countries. Bove et al. (2018) demonstrate that oil dependence drives arms transfers, and Long and Leeds (2006) find that alliances increase trade only when they contain explicit economic cooperation provisions. Beppu (2023) studies how arms trade networks propagate conflict. Barteska et al. (2025) document that Vietnam War procurement generated export miracles in allied countries. Moretti et al. (2025) show that defense R&D spending generates productivity spillovers across countries. These papers establish that military and political relationships have real economic consequences. Our contribution is to measure the bilateral structure of strategic trade dependence at the product level, providing a systematic account of how military-linked supply chains generate asymmetric vulnerability across country pairs and

over time.

Third, we contribute to the growing literature on geopolitical fragmentation. Gopinath et al. (2025) document that trade between geopolitically distant countries has declined since 2022. Fan et al. (2026) show that geopolitical deterioration explains 6.8 percentage points of trade growth stagnation since 2012. Caldara and Iacoviello (2022) develop a text-based index of geopolitical risk. Liu et al. (2025) find that U.S. export controls on China spurred Chinese innovation in controlled product categories. These papers document fragmentation at the macro level or through specific policy instruments. We complement this work by identifying the product-level structure of strategic trade dependence and showing how concentration in dual-use goods has shifted across countries and geopolitical blocs over three decades.

The paper proceeds as follows. Section 2 presents the theoretical framework. Section 3 describes the data and measurement. Section 4 reports the main findings. Section 5 discusses what the measure captures and misses. Section 6 concludes and outlines next steps.

2 Framework

2.1 The Power Measure

We build on the geoeconomic power framework of Clayton et al. (2026) and Clayton et al. (2025). In their model, a hegemon (or hegemonic coalition) m can threaten to cut off target country n from all inputs controlled by m's coalition. Power is defined as the welfare loss the target would suffer under exclusion. In a multi-sector CES economy, the power of coalition m over country n takes the form

$$\text{Power}_n^m = -\frac{\beta}{1-\beta}\sum_G \Omega_{nG}\log\left[(1-\Omega_{nG}^R)+\Omega_{nG}^R\left(1-\omega_{nG}^{mR}\right)^{\frac{\varsigma_G-1}{\sigma_G-1}}\right]^{\frac{1}{\varsigma_G-1}}, \tag{1}$$

where the sum runs over sectors G, β is a returns-to-scale parameter, Ω_{nG} is country n's expenditure share on sector G, Ω_{nG}^R is the foreign-input share within sector G, ω_{nG}^{mR} is coalition m's share of n's foreign sourcing in sector G, σ_G is the elasticity of substitution across foreign varieties within sector G, and ς_G is the elasticity of substitution between domestic and foreign inputs.

Two properties of this measure are central to our analysis. First, power is decreasing in σ_G. When foreign varieties are easy to substitute, the target can replace coalition inputs with alternatives, reducing the cost of exclusion. Second, power is convex in controlled shares near monopoly. When ω_{nG}^{mR} is close to one, even small changes in market share produce large changes in power. This convexity means that sectors where a single supplier dominates generate outsized contributions to total power, even if those sectors are small in expenditure terms.

Clayton et al. (2025) implement Equation (1) with two sectors, manufacturing (M, with $\sigma_M = 6$) and finance (F, with $\sigma_F = 1.76$). The key finding is that U.S. power relies heavily on finance, while Chinese power is concentrated in manufacturing. This two-sector decomposition treats all manufactured goods identically.

2.2 Extension to Dual-Use and Arms Sectors

We disaggregate the goods sector into three components while preserving the structure of Equation (1). For each product s classified as dual-use, we compute bilateral power at the HS6 level using the product-specific elasticity σ_s from Fontagné et al. (2022). The dual-use power of exporter m over importer n is

$$\text{Power}^{DU}_{mn,t} \equiv \sum_{s \in DU} \Omega_{ns,t} \cdot \frac{1}{\sigma_s - 1} \cdot \log\left(\frac{1}{1 - \omega_{nsm,t}}\right), \tag{2}$$

where $\Omega_{ns,t}$ is the expenditure weight of product s in n's total dual-use imports and $\omega_{nsm,t}$ is exporter m's share of n's imports of product s. This expression follows from Equation (1) under the simplifying assumption that the foreign-input share $\Omega^R_{ns} = 1$ within each narrow HS6 category.[1]

The arms power component, $\text{Power}^{A}_{mn,t}$, is constructed analogously HS codes that capture direct weapons trade. Total bilateral goods power then decomposes as

$$\text{Power}_{mn,t} = \text{Power}^{M\setminus DU}_{mn,t} + \text{Power}^{DU}_{mn,t} + \text{Power}^{A}_{mn,t}, \tag{3}$$

where $\text{Power}^{M\setminus DU}$ captures non-strategic manufacturing. The decomposition allows us to ask how much of measured geoeconomic power flows through military-linked channels, a question that cannot be addressed in the two-sector framework.

3 Data and Measurement

3.1 Trade Data

Bilateral trade flows come from BACI (CEPII, 2024), which reconciles exporter-reported and importer-reported trade data from UN Comtrade into a single consistent dataset at the HS6 product level. We use the HS 1992 classification for consistency across the full time series. The data cover 1995 to 2024 and include approximately 5,000 HS6 product codes, 200 reporting countries, and over 60 million bilateral observations in the dual-use subsample alone.

We exclude small territories, non-sovereign dependencies, and customs-union captured markets from the analysis. Non-sovereign territories (e.g., Christmas Island, Pitcairn) mechanically exhibit near-monopoly supplier shares due to geographic proximity and thin trade volumes. Members of the Southern African Customs Union other than South Africa are excluded because their

[1] Setting $\Omega^R_{ns} = 1$ in Equation (1) eliminates the domestic term $(1 - \Omega^R_{ns})$. The nested exponent simplifies: $\left[(1-\omega)^{(\varsigma-1)/(\sigma_s-1)}\right]^{1/(\varsigma-1)} = (1-\omega)^{1/(\sigma_s-1)}$, so the domestic-foreign elasticity ς drops out. Taking the log and normalizing $\beta/(1-\beta)$ to one yields Equation (2). Clayton et al. (2025) instead estimate Ω^R from OECD Inter-Country Input-Output tables, which is the appropriate approach at broad sector aggregation. At the narrow HS6 level, comparable production data are not yet available. The direction of bias from setting $\Omega^R = 1$ is toward overstating power levels, since the domestic alternative is treated as absent. Rankings and time-series patterns are less affected, since the bias is approximately proportional across country pairs. Incorporating OECD ICIO data to compute proper expenditure shares is a priority for future work.

near-total import dependence on South Africa reflects customs-union geography rather than strategic vulnerability. North Korea is excluded because sanctions render its trade data unreliable. After filtering, the sample contains approximately 30,000 directed country pairs per year.

3.2 Dual-Use Classification

Identifying which traded products are dual-use requires mapping international export-control lists to the HS trade classification. We compile HS-code lists from multiple sources, including the five major multilateral export-control agreements (the Wassenaar Arrangement, the Missile Technology Control Regime, the Nuclear Suppliers Group, the Australia Group, and the Chemical Weapons Convention), the EU TARIC dual-use database, the WCO Strategic Trade Control Enforcement Implementation Guide (STCE), the WCO/JRC Strategic Trade Atlas (STA), the Nuclear Trade Atlas, the Small Arms Survey, and the U.S. Common High Priority List (CHPL). The resulting classification covers a broad range of strategic goods, from narrow arms codes to comprehensive EU dual-use lists that span more than a third of global trade.

Our baseline uses the Strategic Trade Atlas (STA) list compiled by the Joint Research Centre of the European Commission in collaboration with the World Customs Organization. The STA identifies 179 HS6 codes of strategic importance, covering approximately 5.9% of global merchandise trade. We select the STA because it represents a focused, internationally recognized set of genuinely strategic goods, rather than the broader EU TARIC classification (876 codes, 34% of trade) which includes many products with limited strategic significance. Of the 179 STA codes, 13 overlap with the 26 direct arms codes. We exclude these overlapping codes from the dual-use set to ensure a clean decomposition. After concordance matching with trade elasticities, 159 pure dual-use codes and 26 arms codes remain with complete elasticity coverage and no double-counting.[2]

The arms classification, "Arms (HS)," contains 26 codes capturing conventional weapons, concentrated in HS chapters 87 (military vehicles), 88 (aircraft), 89 (warships), and 93 (arms and ammunition). The dual-use codes span a range of industries, with the largest concentrations in machinery (chapter 84), electrical equipment (chapter 85), iron and steel (chapter 72), and inorganic chemicals (chapter 28). We verify robustness to two broader classifications. The WCO Strategic Trade Control Enforcement Guide (STCE) identifies 256 pure dual-use codes (after excluding arms and unmatched codes). The EU TARIC Annex I identifies 774 pure dual-use codes. Results are qualitatively unchanged across all three classifications (Appendix A).

3.3 Trade Elasticities

Computing Power_{mn}^{DU} in Equation (2) requires product-level elasticities of substitution σ_s. We use estimates from Fontagné et al. (2022), who identify trade elasticities at the HS6 level for over

[2]Seven STA codes and one arms code lack a concordance match in the HS07-to-HS92 table and are excluded from the analysis. These are primarily codes that split or merged between HS revisions.

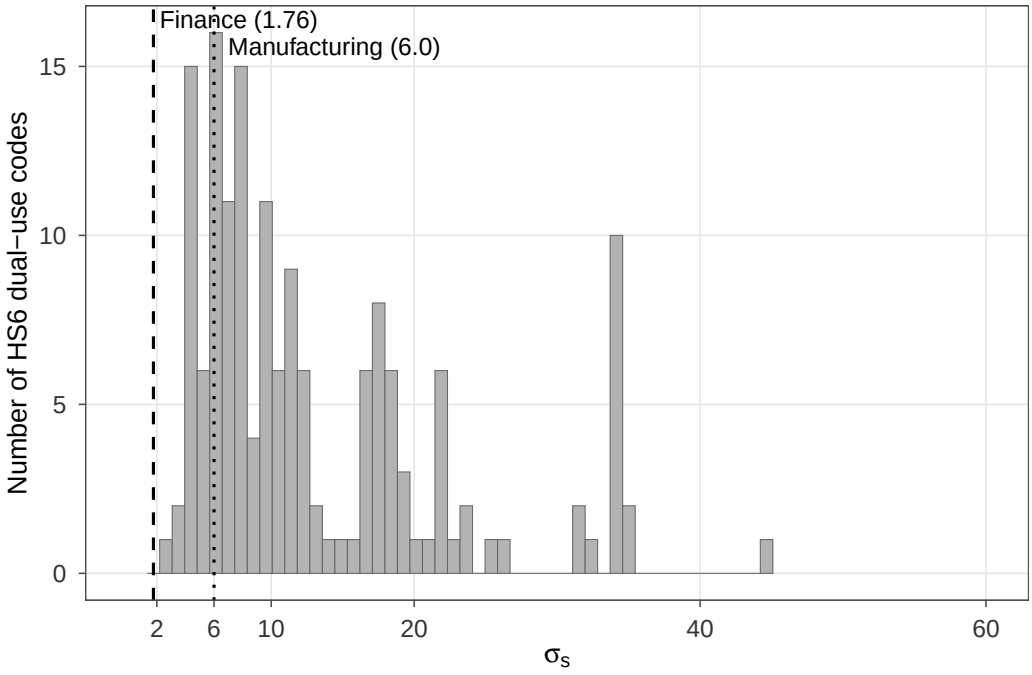


Figure 1: Distribution of trade elasticities (σ_s) across 165 STA dual-use HS6 product codes. Elasticities from Fontagné et al. (2022), matched via HS92-to-HS07 concordance. Dashed and dotted lines mark the Clayton et al. (2025) calibration values for finance ($\sigma_F = 1.76$) and manufacturing ($\sigma_M = 6$). Most dual-use products have higher elasticities than the manufacturing benchmark.

5,000 products using bilateral tariff variation across 152 importing countries.[3] Since our trade data use the HS 1992 classification while Fontagné et al. (2022) report estimates in HS 2007, we concord between revisions using the HS07-to-HS92 concordance table from UN Comtrade. Where one HS92 code maps to multiple HS07 codes, we average the elasticity estimates. Coverage is complete. All 165 STA dual-use codes have a matched elasticity.

Figure 1 and Table 1 report the distribution of matched elasticities. The median σ_s across STA dual-use products is 10.0, with the 10th percentile at 4.8 and the 90th at 24.6. These values are higher than the Clayton et al. (2025) manufacturing benchmark of $\sigma_M = 6$. Only 19% of dual-use codes fall below the manufacturing benchmark. None falls below the finance benchmark of $\sigma_F = 1.76$.

The finding that dual-use goods are more substitutable than the manufacturing average may seem counterintuitive. The explanation lies in the distinction between tariff-based substitutability and effective substitutability under export controls. The Fontagné et al. (2022) estimates capture how easily importers switch between suppliers when relative prices change due to tariff varia-

[3]The Fontagné et al. (2022) elasticity data are available at `https://sites.google.com/view/product-level-trade-elasticity`. The variable `epsilon` is the estimated trade elasticity (negative). Non-significant estimates at the 1% level are replaced with the HS4-digit average. We compute $\sigma_s = 1 - \epsilon$. For 10% of STA dual-use codes, this replacement applies. Restricting to the 149 codes with significant HS6 estimates yields a median σ_s of 10.6, slightly above the full-sample median of 10.0 and well above the manufacturing benchmark. Rankings and time-series patterns are unchanged.

Table 1: Trade elasticities for STA dual-use products by HS chapter

	N	Median	Mean	P25	P75	% below $\sigma_M = 6$
Machinery (84)	54	7.5	11.7	5.8	10.6	28%
Electrical equipment (85)	22	5.9	6.4	4.7	8.2	50%
Iron and steel (72)	21	18.6	18.4	16.4	19.5	0%
Inorganic chemicals (28)	11	17.2	17.1	17.2	17.2	0%
Other base metals (81)	10	21.8	23.2	18.5	21.8	0%
Instruments (90)	10	10.0	10.6	5.9	12.7	40%
Organic chemicals (29)	9	13.2	14.5	10.7	16.5	0%
Glass (70)	8	10.4	10.2	8.6	11.5	0%
All other chapters	20	9.4	13.9	5.6	21.8	25%
All STA dual-use codes	165	10.0	13.3	6.6	18.6	18%
Clayton et al. finance	–	1.76	–	–	–	–
Clayton et al. manufacturing	–	6.0	–	–	–	–

Notes. Elasticities of substitution σ_s from Fontagné et al. (2022), matched to 165 STA dual-use HS92 codes via HS92-to-HS07 concordance. Arms codes (27) excluded from the dual-use set. The last column reports the share of codes with σ_s below the Clayton et al. (2025) manufacturing calibration ($\sigma_M = 6$).

tion. For most dual-use goods, there are indeed many alternative suppliers in normal times. The strategic bottleneck emerges not from inherent product differentiation but from export controls that remove suppliers from the choice set entirely. An importer facing a tariff increase on U.S. semiconductors can substitute toward Japanese or European alternatives. An importer facing a U.S. export ban cannot substitute toward suppliers who are bound by the same multilateral control regime. The tariff-based σ_s values therefore provide a conservative estimate of geoeconomic power.

Despite high substitutability, dual-use goods are more concentrated in supplier structure than ordinary manufactures. Figure 2 documents this directly. Across all importer-year observations, the supplier Herfindahl-Hirschman Index for dual-use goods (median 0.18) exceeds the HHI for all goods combined (median 0.11) by 62%. The top supplier's market share is 22% higher in dual-use goods than in aggregate trade.

Figure 3 visualizes this divergence at the product level. Each point represents one of the 165 STA dual-use HS6 codes, plotted by its trade elasticity (horizontal axis) and its average global supplier HHI (vertical axis). The majority of codes lie to the right of the manufacturing benchmark $\sigma_M = 6$, confirming high substitutability. If concentration simply reflected product differentiation, we would expect a negative relationship between elasticity and HHI. The scatter shows no such pattern. Chemicals (HS chapters 28–29) are among the most concentrated product groups despite having among the highest elasticities.

The implication for the power measure is that the elasticity channel ($1/(\sigma_s - 1)$) contributes little. The implied power weight for a typical dual-use product is 0.11, compared to 0.20 for manufacturing and 1.32 for finance. Power in dual-use goods operates primarily through supplier concentration, the $\log(1/(1-\omega))$ term, which is large when a single supplier dominates. The tariff-based elasticities suggest that importers can readily switch across country suppliers in re-

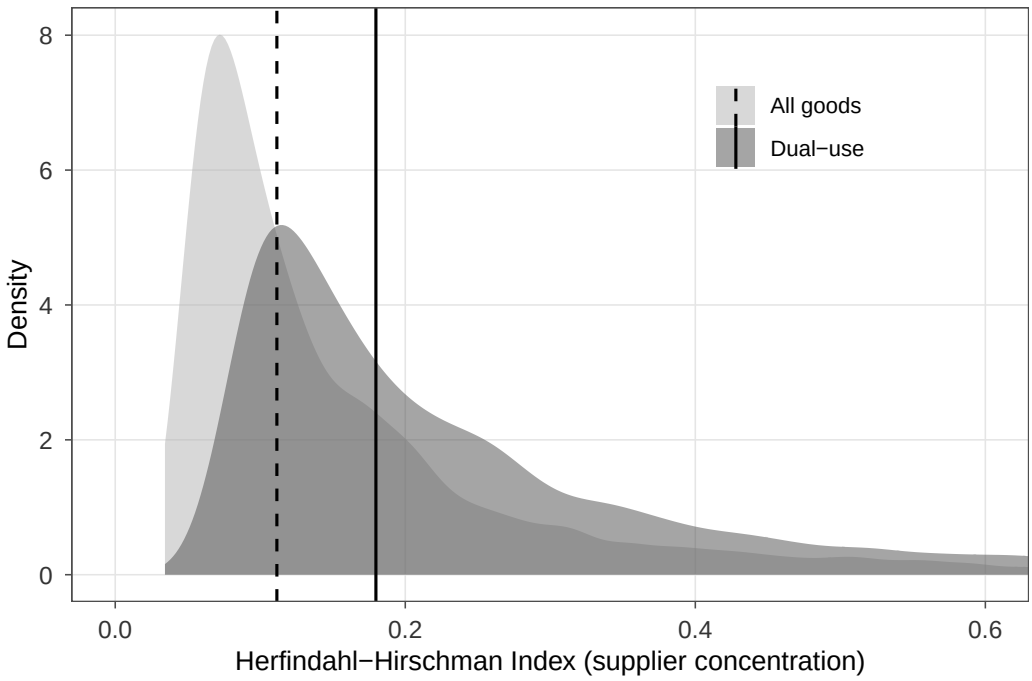


Figure 2: Supplier concentration for dual-use goods versus all goods. Distributions of the Herfindahl-Hirschman Index across importer-year observations, 1995–2024. Vertical lines mark medians. Dual-use goods exhibit higher supplier concentration despite higher measured substitutability.

sponse to relative price changes. Yet in practice, supplier concentration persists, suggesting that non-price barriers, such as export-control regimes and political alignment, sustain dominant supplier positions in dual-use trade.

3.4 Power Construction

We construct the bilateral power measure in three steps. First, for each product s, we compute how important that product is in importer n's total dual-use import basket. The expenditure weight $\Omega_{ns,t}$ is the share of product s in n's total dual-use imports. A product that accounts for a large share of the import basket contributes more to the power measure. Second, for each product s, we compute how dominant exporter m is as a supplier. The market share $\omega_{nsm,t}$ is exporter m's share of n's total imports of product s. When ω is close to one, exporter m is a near-monopoly supplier and the $\log(1/(1-\omega))$ term in Equation (2) becomes large. Third, we weight each product by its matched elasticity from Section 3.3 and sum across all 165 STA dual-use products to obtain $\text{Power}^{DU}_{mn,t}$ for each directed country pair and year.

Two caveats apply. First, our expenditure weights $\Omega_{ns,t}$ are computed from import data alone, because we do not yet incorporate domestic production. The direction of bias is toward overstating power levels, though rankings and time-series patterns are less affected since the bias is approximately proportional across country pairs. Second, the power formula treats each HS6

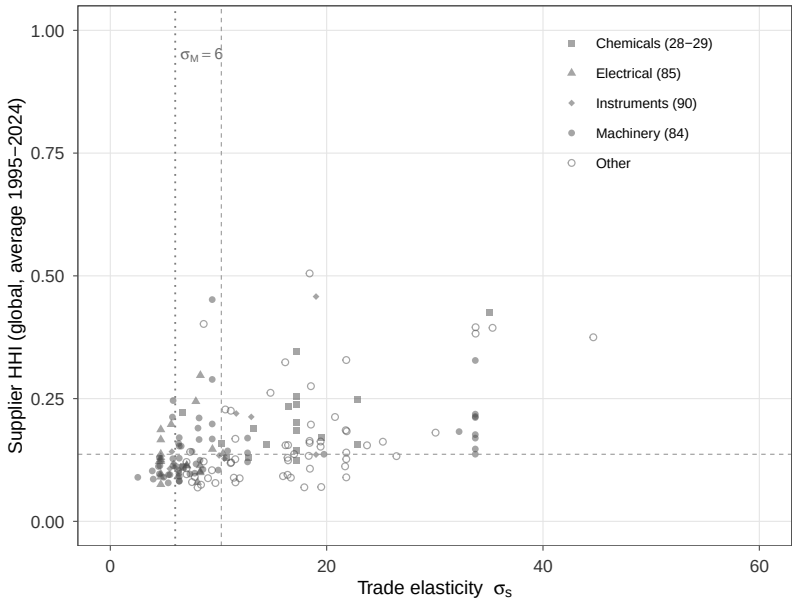


Figure 3: Substitutability versus concentration for 165 STA dual-use HS6 codes. Horizontal axis shows trade elasticity (σ_s, from Fontagné et al. (2022)). Vertical axis shows average global supplier HHI (1995–2024). The dotted line marks the manufacturing benchmark ($\sigma_M = 6$). Dashed lines mark medians. Most dual-use codes are highly substitutable ($\sigma > 6$) yet exhibit concentrated supply.

product independently, abstracting from cross-product complementarities. If a country that is cut off from supplier m's radar components also loses access to m's compatible communications equipment, the true welfare cost of exclusion may exceed the sum of per-product costs.

4 Results

4.1 Rankings and Time Series

Table 2 reports the top 15 countries by total dual-use power in 2024 under the STA classification, where total power is the sum of Power_{mn}^{DU} across all importers n. China ranks first at 18.61, nearly twice the U.S. level of 9.65. France, Australia, and Germany round out the top five. The STA classification produces rankings that align more closely with conventional assessments of strategic supply-chain importance than the broader all-codes classification. France (7.62, third) ranks high because of its nuclear and aerospace exports. Australia (4.04, fourth) reflects its role in nuclear-related materials. Russia does not appear in the top 10, reflecting its limited presence in commercially traded strategic goods outside the energy and arms sectors.

Figure 4 plots total Power^{DU} for China and the United States from 1995 to 2024. China's dual-use power has grown sharply since the mid-2000s, overtaking the United States around 2015. The crossover reflects China's expanding market shares across dual-use product categories, particularly machinery, electronics, and chemicals. The United States has declined from its 1990s peak as

Table 2: Top 15 exporters by total dual-use power, 2024

Rank	Exporter	Total Power^{DU}
1	CHN	18.61
2	USA	9.65
3	FRA	7.62
4	AUS	4.04
5	DEU	3.76
6	GBR	3.12
7	ZAF	2.60
8	NZL	2.42
9	IND	2.05
10	ITA	2.02
11	NLD	0.805
12	KOR	0.738
13	BEL	0.718
14	ESP	0.676
15	THA	0.667

Notes. Total Power^{DU} is the sum of Power$^{DU}_{mn}$ across all importers n in 2024 (most recent year in BACI). Small territories, dependencies, SACU members other than South Africa, and North Korea excluded.

global supply chains have diversified and as China has entered markets previously dominated by Western suppliers.

4.2 Bilateral Relationships

Aggregate power rankings mask the bilateral structure of geoeconomic leverage. Figure 5 plots Power$^{DU}_{mn,t}$ for selected bilateral pairs of geopolitical interest, organized in two panels. The left panel shows China as exporter, with power over the United States, Pakistan, India, and Saudi Arabia. The right panel shows the United States as exporter over China, Pakistan, India, and Saudi Arabia.

China's power over Pakistan has increased sharply since 2010, consistent with the deepening of the China-Pakistan Economic Corridor and growing Chinese dominance in Pakistan's dual-use imports. By 2024, the China-Pakistan relationship is the largest bilateral dual-use power pair in the data. China's power over India follows a similar trajectory, though at a lower level, consistent with India's more diversified sourcing strategy. China has also gained power over Saudi Arabia, reflecting growing Chinese presence in the Kingdom's dual-use imports.

The United States retains substantial power over Saudi Arabia, India, and Pakistan, though these relationships have weakened from their 1990s and early-2000s peaks. U.S. power over China has remained low throughout the sample, consistent with China's effective import diversification in dual-use categories. The decline in U.S. bilateral power is broad-based across traditional security partners.

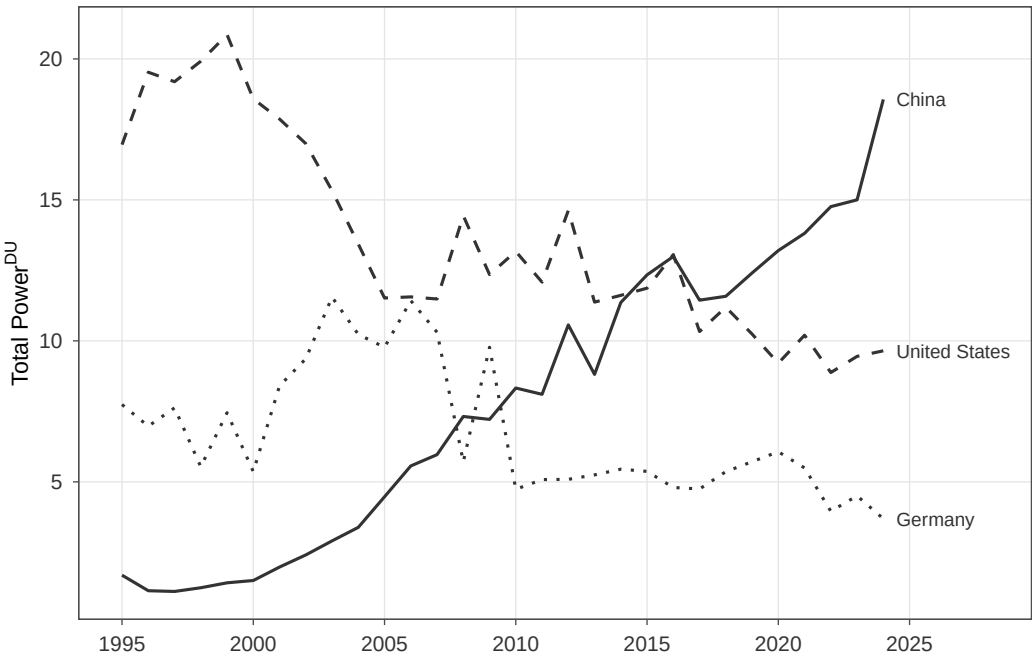


Figure 4: Total dual-use power (Power^{DU}) for China, the United States, and Germany, 1995–2024. China overtakes the United States around 2015. Total power is the sum of Power$^{DU}_{mn}$ across all importers n.

4.3 Decomposition

How much of total goods power flows through dual-use channels? Figure 6 decomposes total goods power into manufacturing (non-dual-use), dual-use, and arms components for six major exporters. The composition varies substantially. For China, dual-use goods account for 61% of total goods power, with manufacturing contributing 26% and arms 14%. China's power comes primarily from its dominance in commercially traded strategic inputs. For the United States, the composition is reversed. Arms account for 55% of total goods power, dual-use goods for 36%, and non-strategic manufacturing for 9%. The United States projects power primarily through direct weapons trade. France (54% dual-use, 40% arms) and Australia (53% dual-use, 41% arms) are more balanced across channels.

The decomposition demonstrates that aggregate frameworks that pool strategic and non-strategic goods miss a quantitatively important dimension of variation. Two countries with similar total goods power may have very different compositions, with different implications for the coercive leverage that power represents.

4.4 Arms Versus Dual-Use Power

The arms power measure, Power$^{A}_{mn,t}$, constructed from 27 HS codes covering direct weapons trade, reveals a different geography of power than the dual-use measure. Figure 7 plots arms

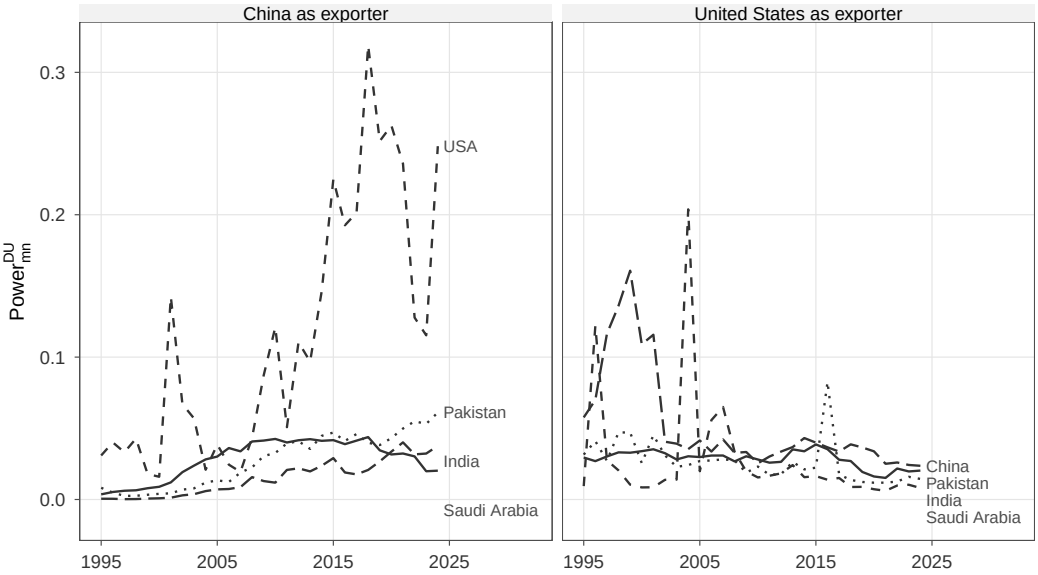


Figure 5: Bilateral dual-use power (Power$^{DU}_{mn,t}$) for selected bilateral pairs, 1995–2024. Left panel shows China as exporter to the United States, Pakistan, India, and Saudi Arabia. Right panel shows the United States as exporter to China, Pakistan, India, and Saudi Arabia.

power for the top exporters over time. The United States retains clear dominance in arms power throughout the sample period. France, Russia, and the United Kingdom are significant arms power projectors. China's arms power is growing but remains well below the U.S. level.

Table 3 quantifies the arms-versus-dual-use composition under the STA classification. For the United States, arms power (14.8) exceeds dual-use power (9.7), making direct weapons trade 61% of military-linked power. For China, dual-use goods account for 82%. France, Germany, Australia, and India are more balanced across the two channels. These compositional differences are not captured by measures that focus on direct weapons transfers alone, such as SIPRI's Trend Indicator Values (Stockholm International Peace Research Institute, 2024).

4.5 Chokepoint Products

The aggregate power measure weights all products by expenditure shares and elasticities, combining the extensive margin (how many products a supplier dominates) with the intensive margin (how large its share is in each). To examine the extensive margin directly, we define a "chokepoint product" for importer n as an HS6 code where the top supplier's import share exceeds 0.80. These are the products where the $\log(1/(1-\omega))$ term in Equation (2) is largest, so they contribute disproportionately to the aggregate power measure.

Figure 8 maps chokepoint dominance for 15 geopolitically significant importers. In 2024, China holds near-monopoly positions in 79 strategic dual-use products imported by Russia and 36 by Pakistan. China is the dominant chokepoint supplier for most importers in the sample.

Figure 9 traces the evolution of chokepoint dominance over time for six importers. The pattern

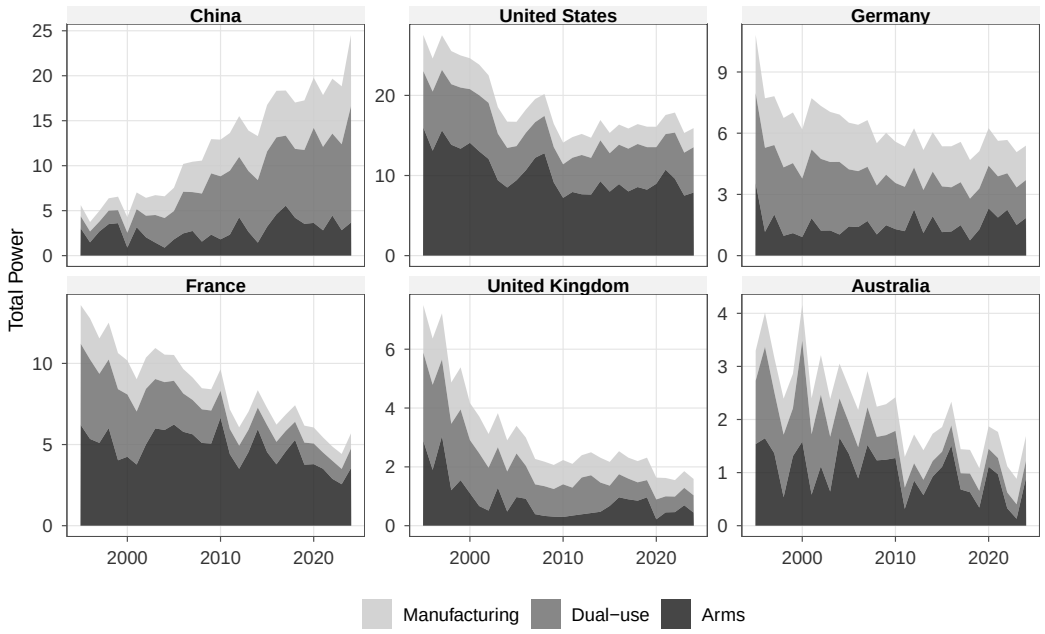


Figure 6: Decomposition of total goods power into manufacturing (non-dual-use), dual-use, and arms components for six major exporters, 1995–2024.

is consistent across panels. China's chokepoint count rises sharply from the mid-2000s, displacing the United Kingdom, Germany, and the United States as the dominant near-monopoly supplier. In Pakistan, China's chokepoint count rose from approximately 30 products in 1995 to over 200 by 2024. In Japan, the United Kingdom's count collapsed from 55 to near zero while China's rose from zero to 60. Saudi Arabia shows a similar displacement of British dominance by Chinese supply. These product-level dynamics are the micro-foundation of the aggregate power trends documented in Section 4.1.

The United States and China are notable for their mutual resilience. Under the STA classification, both countries hold zero chokepoint products over each other in 2024. Neither country depends on the other as a near-monopoly supplier for any of the 165 strategic dual-use goods. This finding reflects effective import diversification by both great powers in the product categories that matter most for strategic vulnerability. The mutual invulnerability contrasts sharply with the asymmetric dependencies documented in Figure 8. China holds 79 chokepoint products over Russia and 36 over Pakistan. The coercive leverage implied by the dual-use power measure flows primarily from large economies to dependent partners, not between the two largest economies themselves.

Table 3: Arms versus dual-use power for top exporters, 2024

	Power^{DU}	Power^{A}	Total	Arms share
United States	9.7	14.8	24.5	61%
China	18.6	4.1	22.4	18%
France	7.6	5.6	13.2	42%
Australia	4.0	3.1	7.2	44%
Germany	3.8	2.9	6.7	44%
United Kingdom	3.1	1.7	4.8	35%
South Africa	2.6	4.0	6.6	61%
India	2.1	1.4	3.5	41%
Italy	2.0	1.9	3.9	49%
New Zealand	2.4	2.6	5.0	52%

Notes. Power^{DU} is the sum of dual-use power across all importers. Power^{A} is the sum of arms power. Arms share = $\text{Power}^{A}/(\text{Power}^{DU} + \text{Power}^{A})$.

5 Discussion and Extensions

5.1 What the Measure Captures and Misses

The dual-use power measure captures bilateral coercive leverage flowing through commercially traded goods that are subject to international export-control regimes. It reflects market-share concentration at the product level, weighted by expenditure shares and trade elasticities. Several features of the real world are not captured.

First, the measure does not account for domestic production. Our expenditure weights treat the foreign-input share as one within each HS6 category, overstating power levels for countries with substantial domestic dual-use production capacity. The ranking and time-series patterns may be less affected, since the bias is approximately proportional across country pairs, but the absolute magnitudes should be interpreted with caution until domestic production data are incorporated.

Second, the tariff-based elasticities from Fontagné et al. (2022) may not reflect the effective substitutability under export controls. As discussed in Section 3.3, export controls remove suppliers from the choice set rather than raising prices, potentially making the true elasticity of substitution lower than the tariff-based estimate. The measure is therefore conservative in this dimension.

Third, the measure excludes services trade (including financial services), technology transfers, foreign direct investment, and other channels of geoeconomic influence. The finance component of the Clayton et al. (2025) framework requires OECD-WTO BaTIS data on bilateral services trade, which we plan to incorporate in future work to produce a complete power decomposition across all sectors.

5.2 China's Manufacturing Rise and Strategic Trade

A natural concern is that China's growing dual-use power simply reflects its general manufacturing expansion. We examine this by comparing China's market shares in dual-use goods with its shares in all goods. China's median import share across countries grew from 1.3% in 1995 to 16.0%

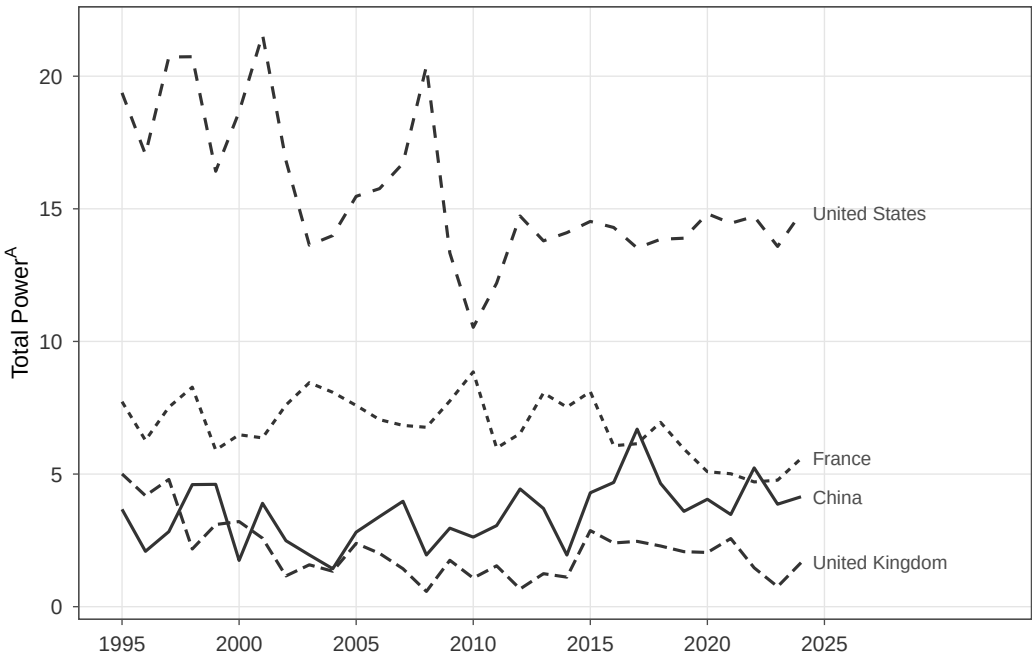


Figure 7: Arms power (Power^A) for top exporters, 1995–2024. The United States retains dominance in direct arms power, in contrast to dual-use power where China leads.

in 2024 for all goods and from 0.8% to 16.4% for dual-use goods. At the level of average market shares, the two series track each other closely.

The picture changes at the product level. For Russia, China holds near-monopoly positions (import share above 80%) in 46% of dual-use products, compared to 27% of non-dual-use products. For sanctioned or geopolitically isolated importers (Russia, Iran), dual-use concentration is disproportionately high relative to general trade patterns. For most other importers (India, Japan, South Korea, Brazil), China's dual-use near-monopoly rate is lower than its non-dual-use rate, consistent with the general manufacturing story.

China's dual-use power therefore reflects two overlapping forces. For most countries, the dominant driver is China's general manufacturing expansion, which raises its market share in dual-use and non-dual-use goods alike. For geopolitically isolated countries, sanctions, export controls, and supply-chain restructuring channel trade toward China specifically in dual-use categories, creating disproportionate concentration. More broadly, the paper documents that supplier concentration in dual-use goods is high and persistent, but does not identify why importers do not switch to alternative suppliers despite high measured substitutability. Price competitiveness, policy-induced trade diversion, and supply-chain switching costs are all candidate explanations. Disentangling these forces is a priority for future work.

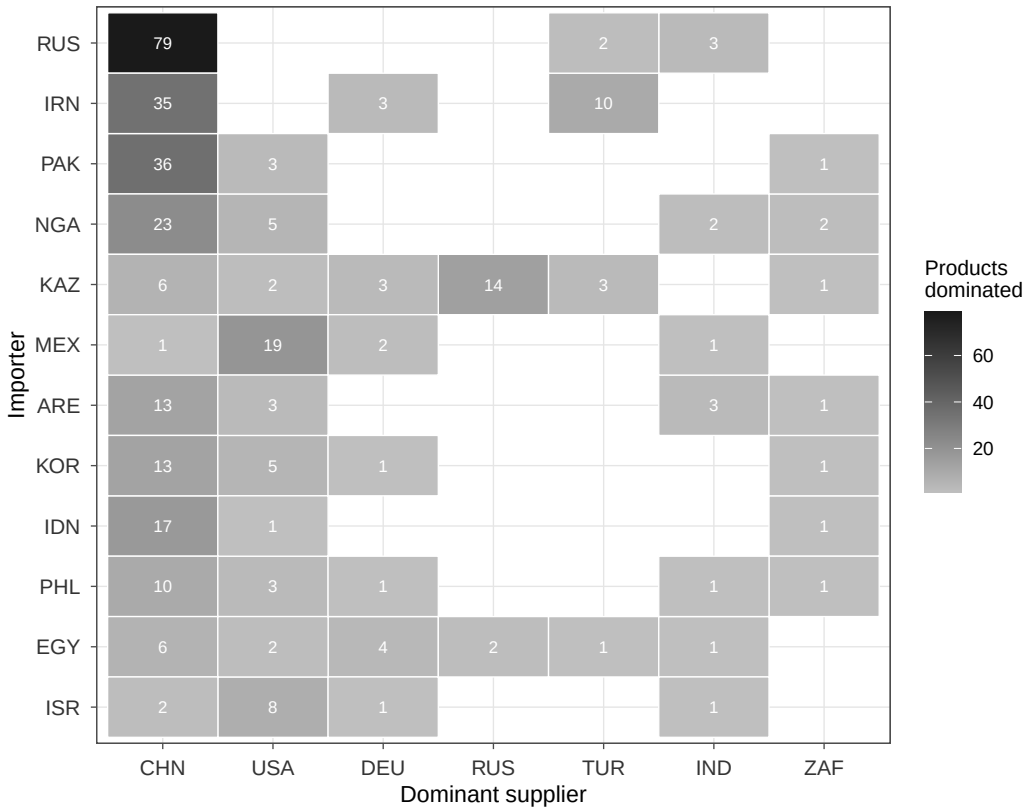


Figure 8: Chokepoint dominance across 15 importers, 2024. Each cell shows the number of dual-use HS6 codes where the column supplier holds $\omega > 0.80$ of the row importer's purchases. China dominates the chokepoint landscape for most importers. The United States dominates Mexico and Israel. Russia appears only for Kazakhstan.

6 Concluding Remarks and Next Steps

We extend the Clayton et al. (2025) geoeconomic power framework to the product level and construct bilateral measures of dual-use and arms power for all country pairs from 1995 to 2024. The evidence shows that dual-use power is quantitatively large, operates through supplier concentration rather than low substitutability, and is distributed differently across countries than either aggregate goods power or direct arms power. China overtook the United States in dual-use power around 2015, while the United States retains dominance in arms power. These patterns are not apparent in aggregate frameworks that treat all manufactures as a single sector.

The measure documented here is descriptive. Several extensions are underway. First, we plan to incorporate domestic production data from the OECD Inter-Country Input-Output tables to compute proper expenditure shares that account for the domestic alternative, relaxing the assumption that the foreign-input share equals one. Second, we are developing identification strategies to test whether arms trade causally generates dual-use power, or whether the correlation reflects common geopolitical causes such as political alignment. Third, we plan to incorporate bilateral

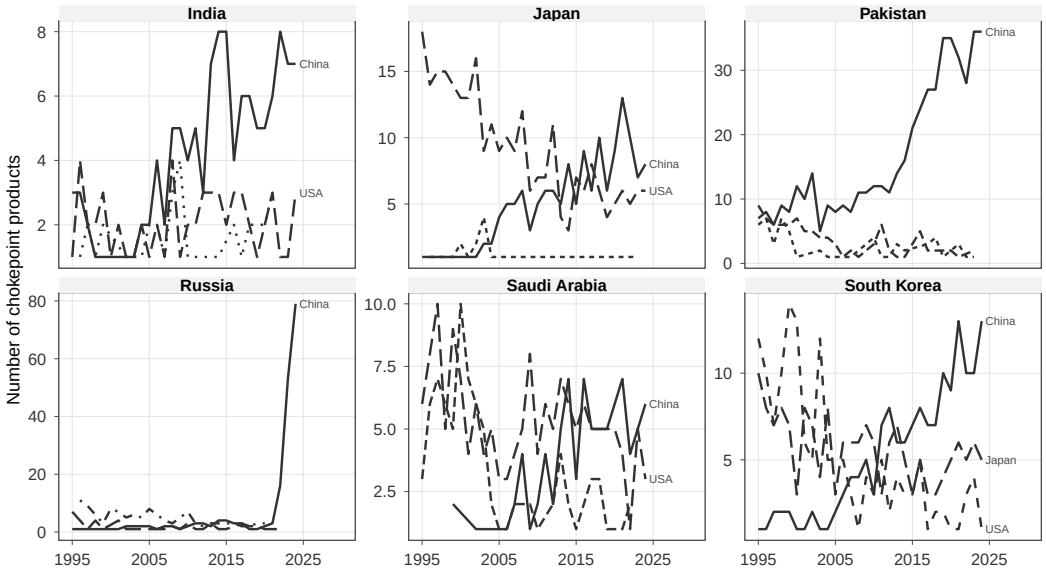


Figure 9: Number of chokepoint products ($\omega > 0.80$) by dominant supplier, 1995–2024, for six importers. China's chokepoint count rises sharply across all panels, displacing the United Kingdom, Germany, and the United States as the dominant near-monopoly supplier.

services trade to produce a complete power decomposition across goods and financial sectors.

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A Robustness to Alternative Classifications and Elasticities

This appendix examines the sensitivity of the five main findings to alternative dual-use classifications and elasticity assumptions.

A.1 Alternative Dual-Use Classifications

The baseline uses the Strategic Trade Atlas (STA) classification with 165 pure dual-use codes, covering approximately 6% of global merchandise trade. We verify robustness to two broader classifications. The WCO Strategic Trade Control Enforcement Guide (STCE) identifies 267 pure dual-use codes (approximately 11% of trade). The EU TARIC Annex I identifies 862 pure dual-use codes (approximately 35% of trade). All arms codes are excluded from each dual-use set to ensure a clean decomposition.

Table A1 reports the five main findings across all three classifications. All qualitative conclusions are robust. Under all three classifications, China ranks first in dual-use power and the United States ranks second. The China-to-US ratio ranges from 1.6 (EU) to 2.1 (STCE). The US arms share ranges from 57% (EU) to 61% (STA). China holds near-monopoly chokepoint positions over Russia under all three definitions, while US-China mutual chokepoints are negligible (0 under STA, 1 under STCE, 10 combined under EU). The broader the classification, the more chokepoints mechanically (more products to dominate), but the qualitative pattern is identical. The median elasticity ranges from 8.7 (STCE) to 10.0 (STA), always well above the manufacturing benchmark.

A.2 Elasticity Sensitivity

The baseline uses all 165 matched elasticities from Fontagné et al. (2022), including those replaced with HS4-digit averages when the HS6 tariff coefficient was not significant. Restricting to the 149 STA codes with significant HS6 estimates yields a median σ_s of 10.6, slightly above the full-sample median of 10.0. Rankings and time-series patterns are unchanged.

As a second check, we scale all σ_s values uniformly downward by 25% and 50% to approximate the possibility that effective substitutability under export controls is lower than the tariff-based estimate. Scaling σ_s downward increases the power weight $1/(\sigma_s - 1)$ and raises measured power levels, but leaves the cross-country rankings and time-series patterns essentially unchanged.

As a third check, we replace the Fontagné et al. (2022) elasticities with HS 3-digit estimates from Broda and Weinstein (2006), which are identified using the Feenstra (1994) GMM method. Coverage at HS3 is coarser but complete. The resulting power measure is highly correlated with the baseline across country-year observations.

Table A1: Five facts across alternative dual-use classifications

	STA (159)	STCE (256)	EU (774)
Fact 1: Mechanism			
Median σ_s	10.0	9.4	10.2
% below $\sigma_M = 6$	19%	23%	19%
Fact 2: Structural shift			
China power gain, 1995–2024	+16.9	+19.6	+15.8
Top losers	JPN, USA	USA, JPN	JPN, FRA
Fact 3: Two channels			
US arms share	61%	61%	57%
China arms share	18%	16%	19%
Fact 4: Chokepoints			
China → Russia	79	127	345
China → US	0	1	7
US → China	0	0	3
Fact 5: Realignment			
China → Russia growth	203×	160×	11×
US → Saudi decline	≈halved	≈halved	≈70%

Notes. STA = WCO Strategic Trade Atlas (Versino et al. 2021). STCE = WCO Strategic Trade Control Enforcement Guide. EU = TARIC Annex I (Council Regulation 428/2009). Code counts exclude arms (27 codes). Chokepoints defined as $\omega > 0.80$ in 2024. Growth factors computed from bilateral power in 1995 versus 2024.

A.3 STCE Classification (256 Codes)

Figures A1–A8 replicate the main-text figures using the WCO Strategic Trade Control Enforcement Guide (STCE) classification with 256 dual-use codes (approximately 11% of global trade). All qualitative patterns from the baseline are preserved. China's dual-use power exceeds the U.S. level by a factor of 2.25 (compared to 1.92 under STA). The chokepoint heatmap shows the same asymmetric pattern, with larger counts reflecting the broader code set.

A.4 EU Classification (774 Codes)

Figures A9–A16 replicate the main-text figures using the EU TARIC Annex I classification with 774 dual-use codes (approximately 35% of global trade). This is the broadest classification and includes many products with limited strategic significance. Despite the much larger code set, all qualitative patterns hold. China remains the dominant dual-use power. The US-China mutual chokepoint count rises to 10 (7 Chinese over the US, 3 US over China) but remains negligible relative to the 774 codes in the classification.

B Arms Power Details

The arms power component, $\text{Power}^{A}_{mn,t}$, is constructed using our "Arms (HS)" classification. This list contains 26 HS6 codes (after concordance matching) capturing conventional weapons, con-

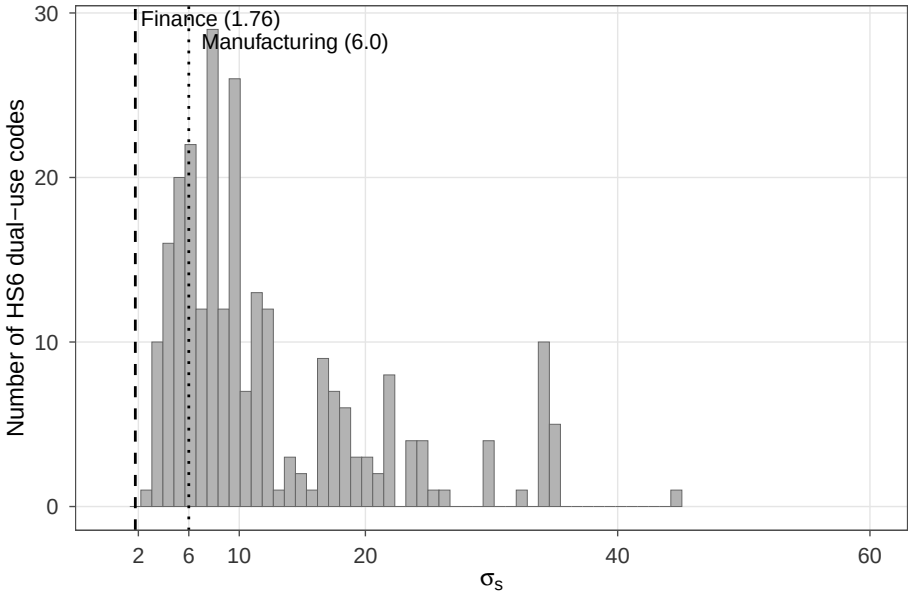


Figure A1: STCE classification. Distribution of trade elasticities across 256 dual-use HS6 codes. Median $\sigma_s = 9.4$.

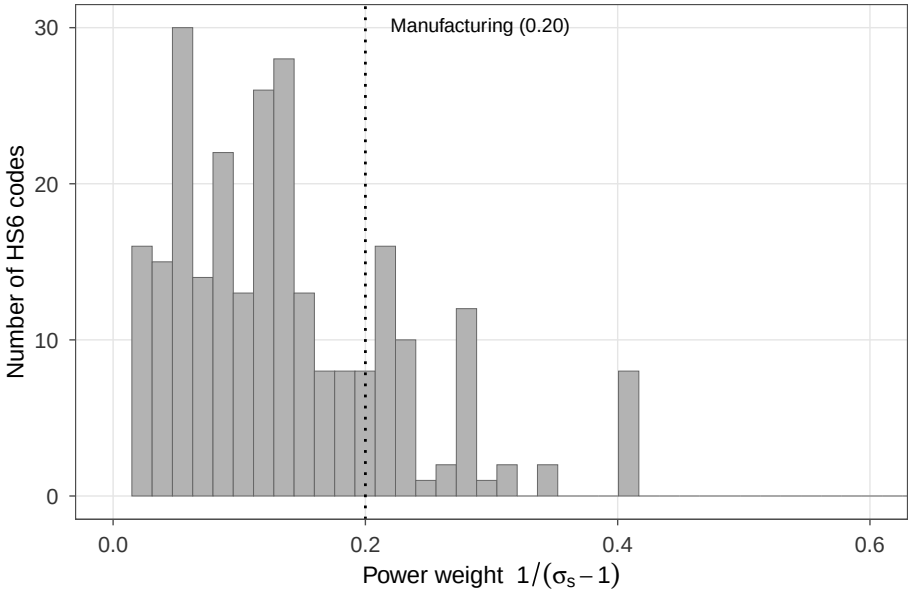


Figure A2: STCE classification. Power weights $1/(\sigma_s - 1)$ across 256 dual-use codes.

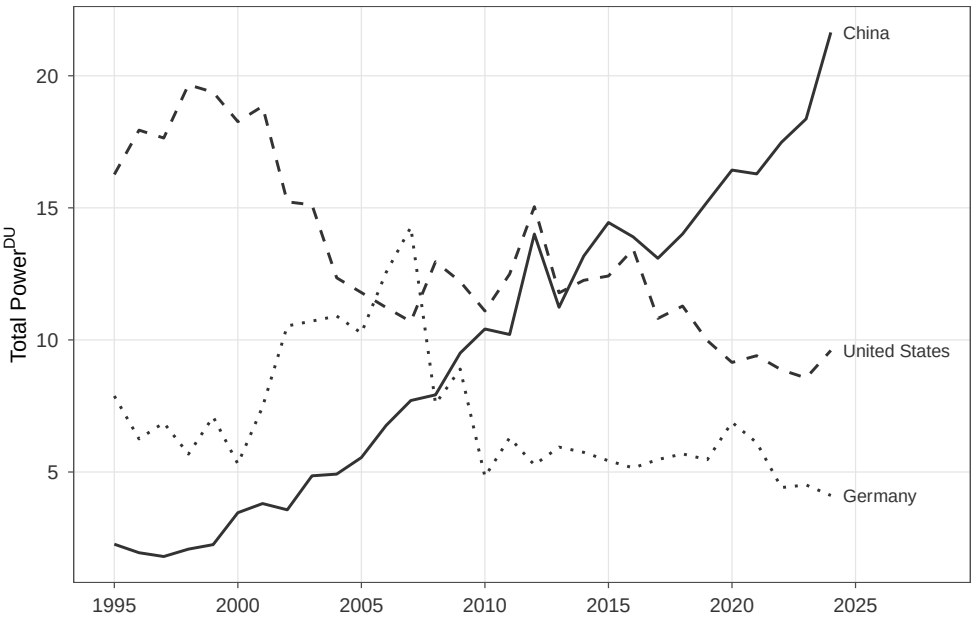


Figure A3: STCE classification. Total dual-use power for China, the United States, and Germany, 1995–2024.

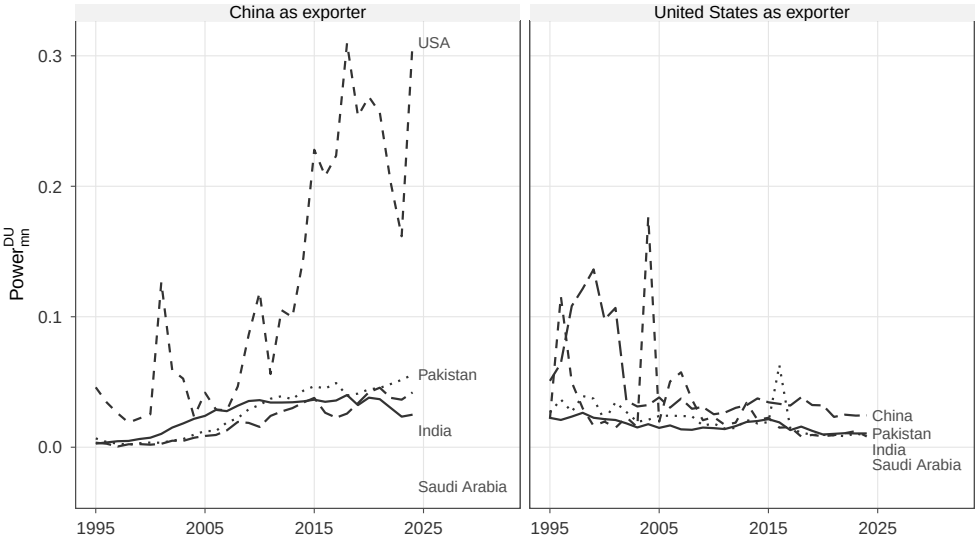


Figure A4: STCE classification. Bilateral dual-use power for selected pairs, 1995–2024.

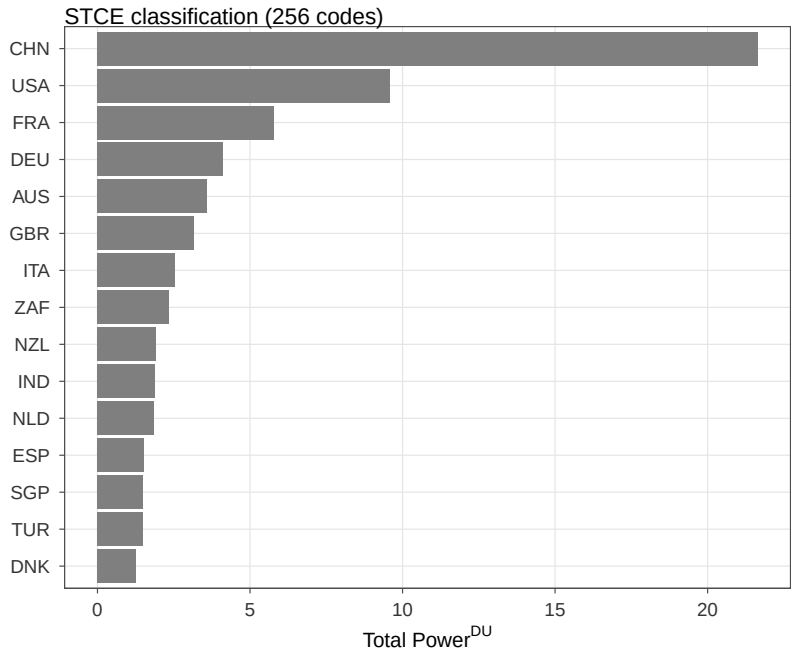


Figure A5: STCE classification. Top 15 exporters by total dual-use power, 2024.

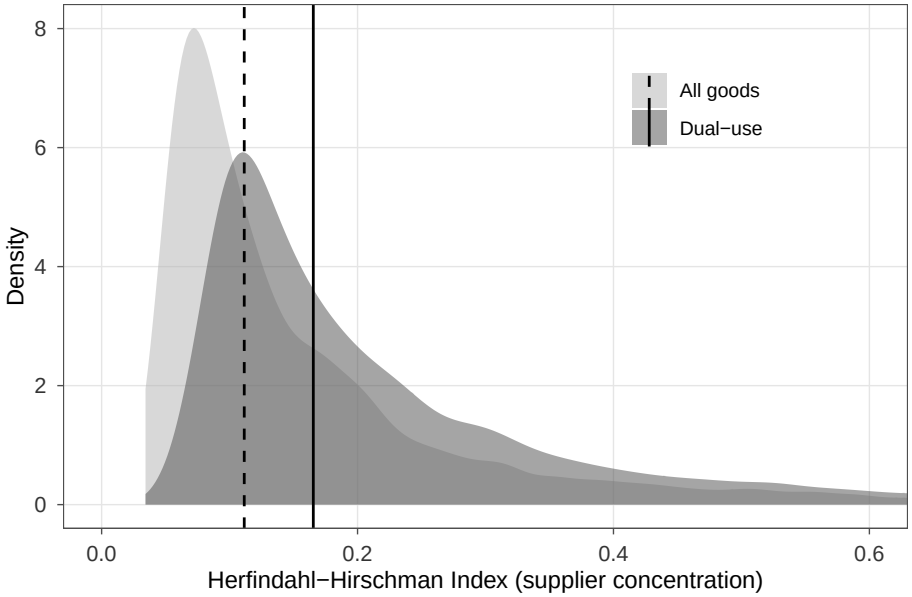


Figure A6: STCE classification. Supplier HHI for dual-use goods versus all goods, 1995–2024.

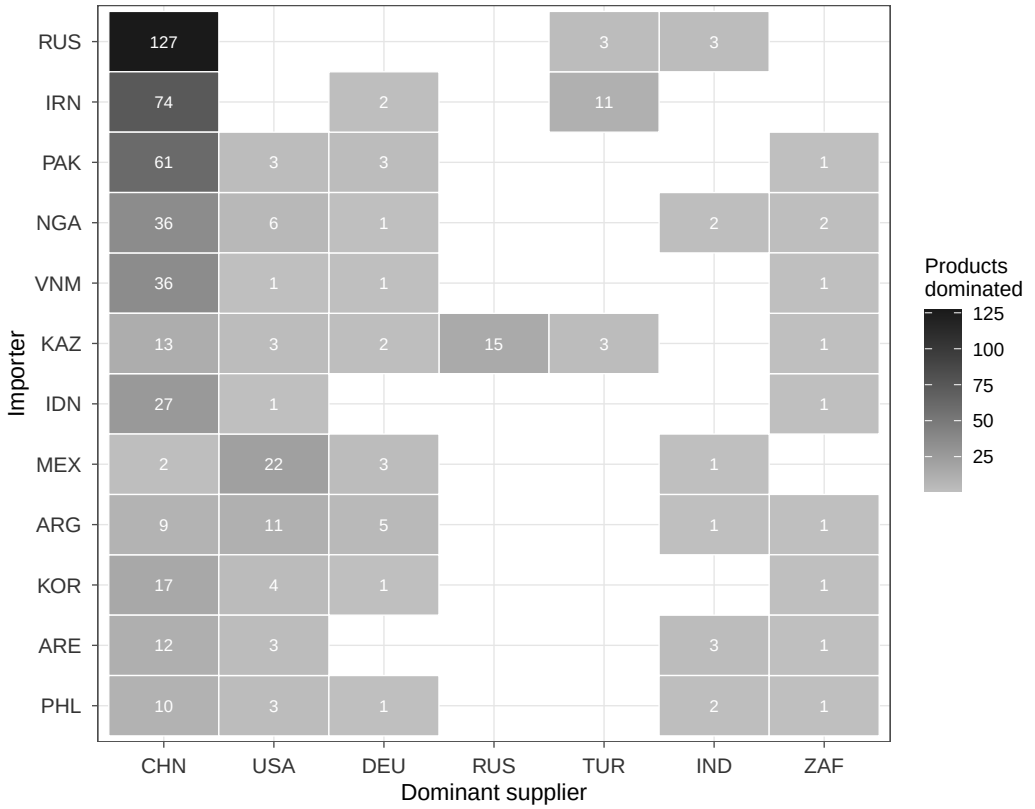


Figure A7: STCE classification. Chokepoint dominance ($\omega > 0.80$) across importers, 2024.

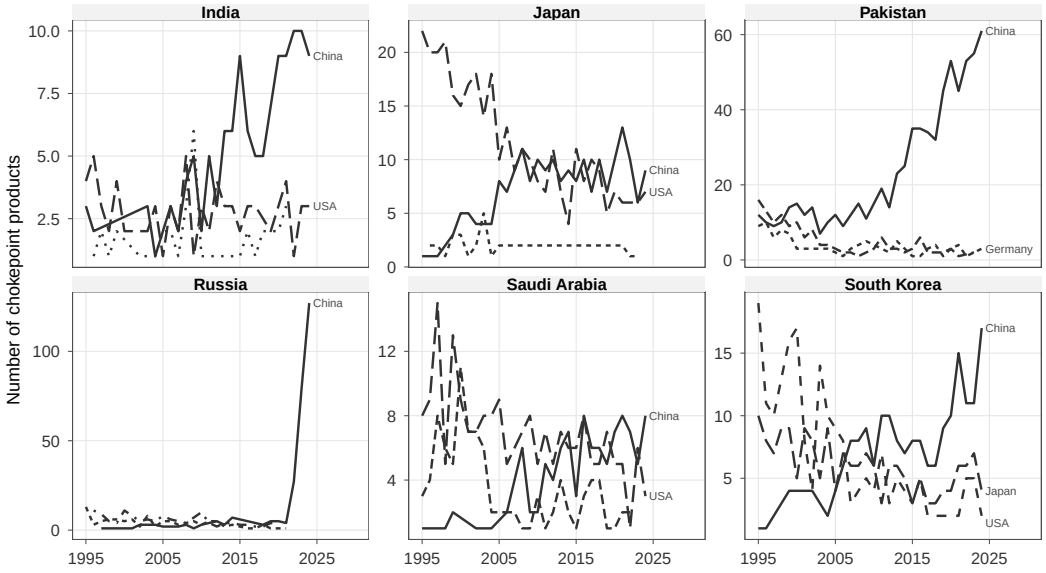


Figure A8: STCE classification. Chokepoint products by dominant supplier for six importers, 1995–2024.

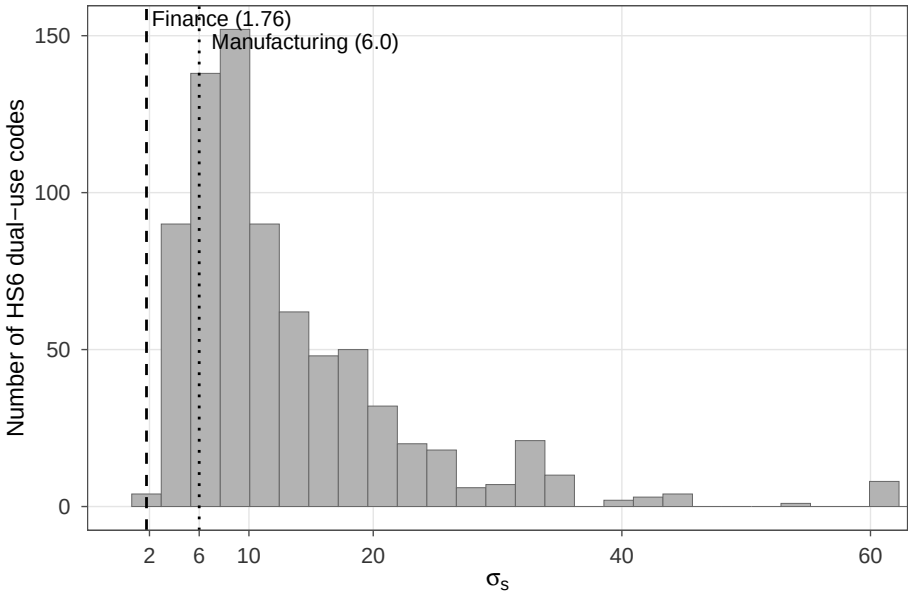


Figure A9: EU classification. Distribution of trade elasticities across 774 dual-use HS6 codes. Median $\sigma_s = 10.2$.

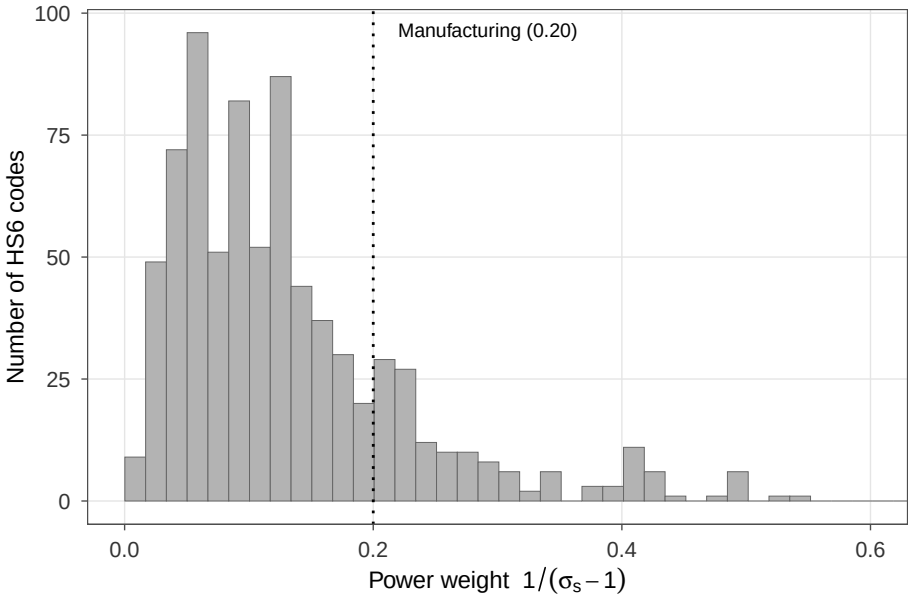


Figure A10: EU classification. Power weights $1/(\sigma_s - 1)$ across 774 dual-use codes.

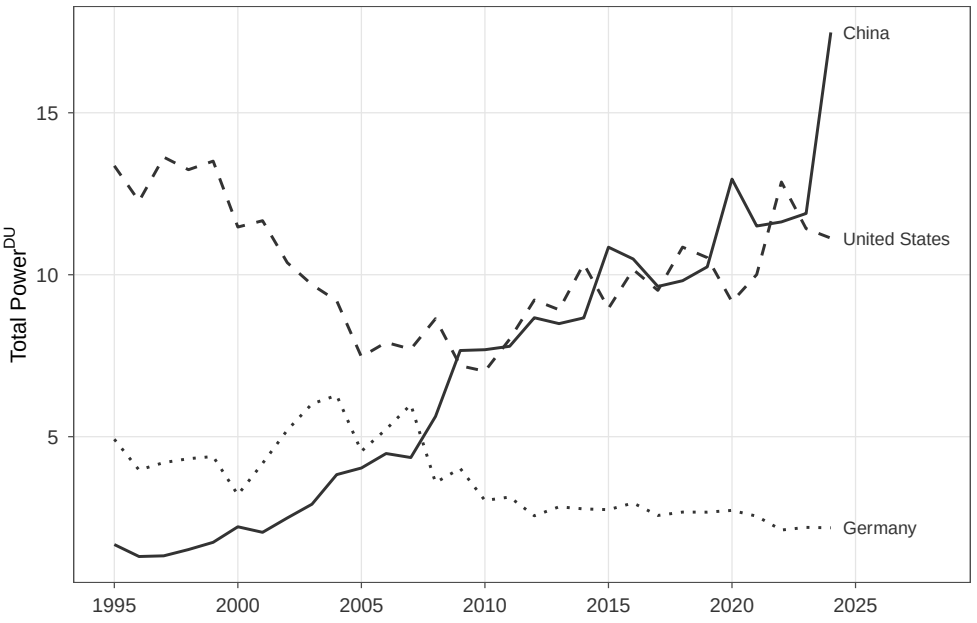


Figure A11: EU classification. Total dual-use power for China, the United States, and Germany, 1995–2024.

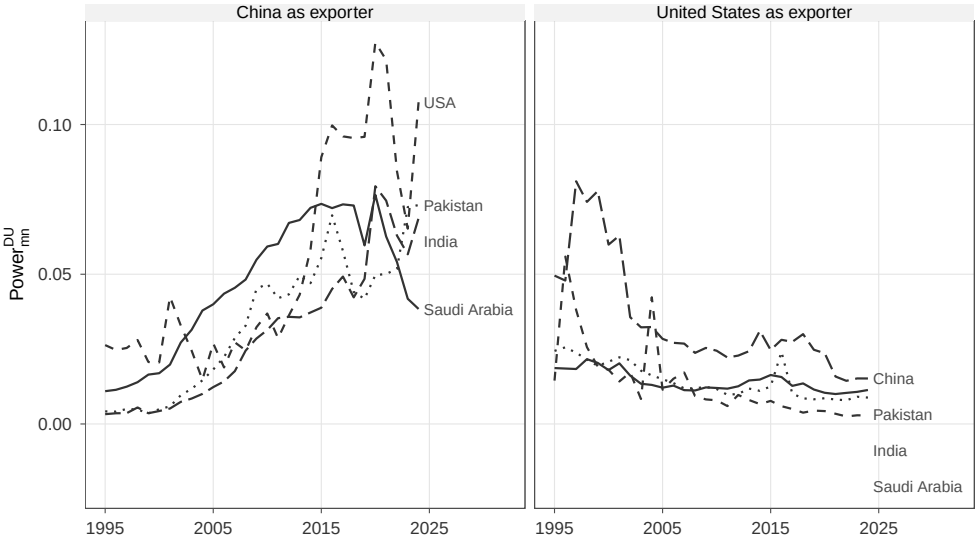


Figure A12: EU classification. Bilateral dual-use power for selected pairs, 1995–2024.

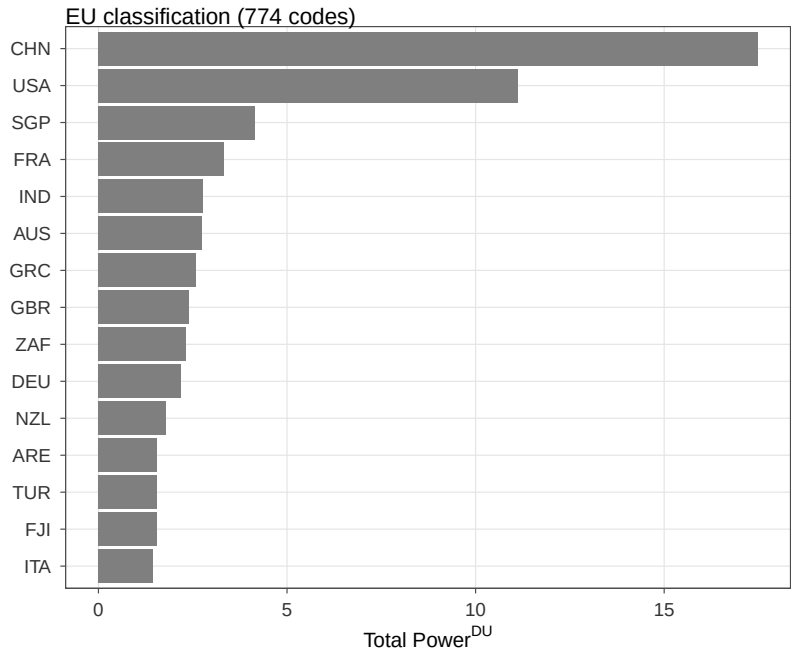


Figure A13: EU classification. Top 15 exporters by total dual-use power, 2024.

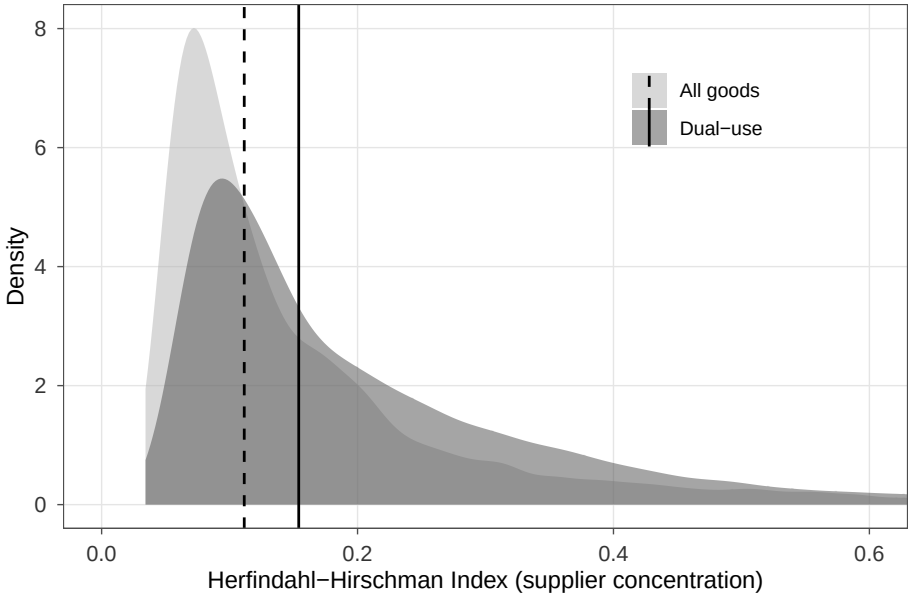


Figure A14: EU classification. Supplier HHI for dual-use goods versus all goods, 1995–2024.

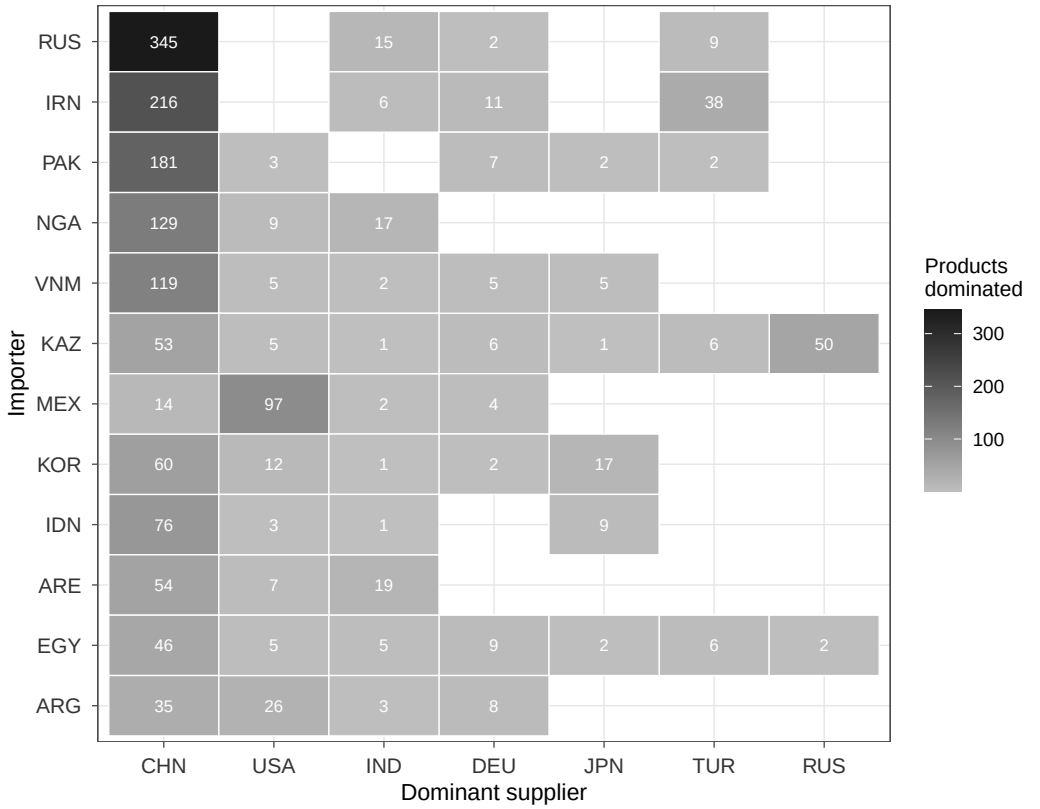


Figure A15: EU classification. Chokepoint dominance ($\omega > 0.80$) across importers, 2024.

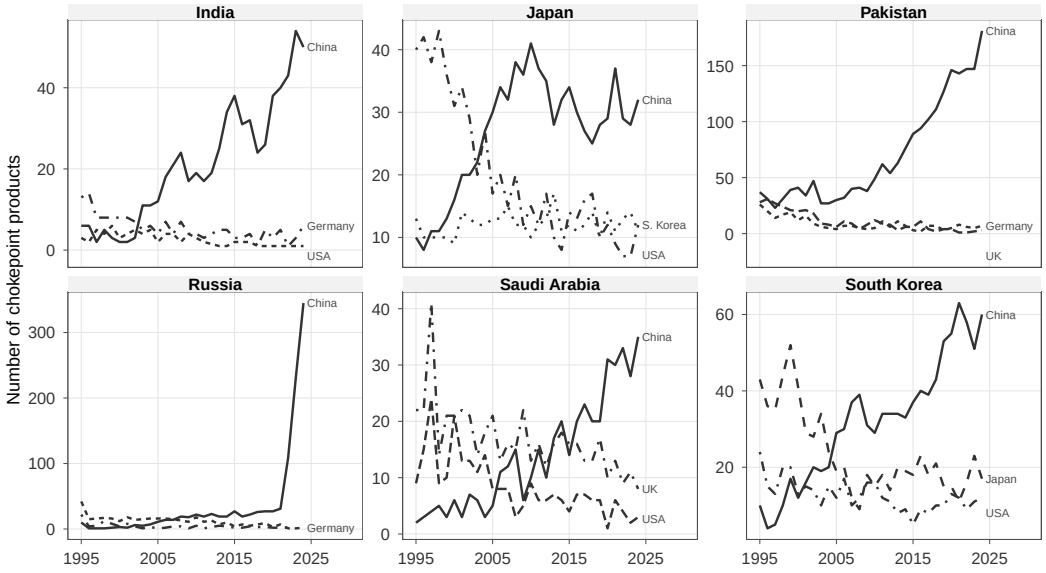


Figure A16: EU classification. Chokepoint products by dominant supplier for six importers, 1995–2024.

centrated in HS chapters 87 (military vehicles), 88 (aircraft), 89 (warships), and 93 (arms and ammunition). The list includes small arms and ammunition, armored vehicles, warships, spacecraft, and satellites. It excludes engines, radar, and sensors (which are included in the dual-use classification), and excludes aircraft over 15,000 kg to avoid mixing military and commercial aviation. Because elasticity estimates for narrowly defined weapons categories are particularly unreliable, we also construct the arms power measure using a single calibrated elasticity of $\sigma_A = 3$, reflecting the low substitutability implied by platform lock-in. The qualitative patterns in Figure 7 are robust to this alternative calibration.

Two caveats apply. First, trade data from BACI are based on customs records, which may incompletely capture government-to-government weapons transfers. The arms power measure may therefore understate the true military dimension of geoeconomic power. Second, the SIPRI Arms Transfers Database (Stockholm International Peace Research Institute, 2024) provides an alternative coverage of major conventional weapons using Trend Indicator Values (TIV) rather than market prices. We also construct a "SIPRI (HS)" list of 29 codes based on SIPRI's methodology, which differs from the Arms (HS) list in including engines, radar, and sensors while excluding small arms. We use the Arms (HS) list as our baseline and report that the qualitative patterns are unchanged under the SIPRI (HS) list.