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RARE EARTH INDUSTRIAL TRANSITION

Rare Earth Value Chains, Trade Networks, And The U.S. Magnet Opportunity

A client-facing transition screen for rare-earth sourcing, qualification bottlenecks, allied demand, and U.S. manufacturing exposure

PREPARED BY SYMBIOSIS UNITED ANALYTICS | VERSION 1.0

2024 U.S. CHINA-ORIGIN FOCUS IMPORTS
$636.5M

GLOBAL CHINA-ORIGIN FOCUS EXPORTS
$5.46B

ALLIED CHINA-ORIGIN FOCUS IMPORTS
$3.78B

U.S. IO FOOTPRINT OF CHINA FLOW
$1.01B

U.S. VALUE-ADDED FOOTPRINT
$410.8M

PRICE-PRESSURE MULTIPLIER
1.58x

CLIENT DECISION THIS REPORT SUPPORTS

Use this report to separate four questions that are often conflated: how large the directly contestable trade pool is, where qualification creates the binding bottleneck, which allied demand pools matter commercially, and which downstream manufacturing sectors carry the largest operating exposure.

Executive Brief For Decision Makers

Rare earths are a small direct trade line and a large industrial coordination constraint. The narrow HS6 platform used in this report - rare-earth metals, cerium compounds, other rare-earth compounds, permanent magnets, electromagnetic clutches, and electromagnets or magnet parts - records $1.37B of total U.S. imports in 2024, including $636.5M from China. That direct number understates the management problem because these inputs sit upstream of motor vehicles, electrical equipment, machinery, electronics, aerospace, telecommunications equipment, and defense-adjacent production systems.

The trade network remains China-centered. BACI records $5.46B of 2024 China-origin exports in the seven-code platform, or 39.3% of global trade in the measured HS6 universe. The allied demand pool is larger than the U.S. pool: China-origin shipments to the United States, Canada, Mexico, the European Union, the United Kingdom, Japan, Korea, Australia, Taiwan, Singapore, Switzerland, Norway, Israel, and New Zealand sum to $3.78B. This is the most commercially relevant opportunity set for U.S. firms once customer qualification, magnet-grade compatibility, and government procurement preferences enter the decision.

The input-output result sharpens the firm implication. Using the 2020 OECD ICIO matrix, we recompute technical coefficients and allocate the 2024 U.S. China-origin HS6 flow into rare-earth-relevant U.S. use sectors. The direct $636.5M flow generates a $1.01B gross-output cost-pressure footprint, implying a 1.58x propagation multiplier. The modeled U.S. value-added component is $410.8M, or 64.5% of the direct flow. This is not a causal forecast; it is a grounded exposure model that translates trade data into production-network incidence.

For MP Materials and USA Rare Earth, the commercial opportunity is real but narrower than public narratives often imply. The near-term U.S. import-displacement pool is $636.5M; the U.S. total import-replacement pool is $1.37B; the allied China-exit pool is $3.78B. Announced magnet capacity changes the physical constraint: a 10,000 metric ton line is equivalent to roughly 57.6% of 2024 U.S. China-origin permanent-magnet import tonnage. Capturing the dollar pool depends less on mining ore and more on whether the firm can produce qualified separated products and magnets at the grade, geometry, delivery cadence, and contract terms demanded by downstream manufacturers.

Bottom line. The value of the rare-earth transition for U.S. firms is an option on reliable, qualified non-Chinese supply. Direct replacement of China-origin U.S. imports can support a meaningful but not enormous domestic revenue base. The larger upside is becoming the qualified supplier of record for allied manufacturers that need China-free or China-reduced supply chains for vehicles, motors, electronics, aerospace, and defense systems.

CLIENT RELEVANCE

Use this report when a manufacturer, investor, policy team, or supplier wants to distinguish strategic narrative from executable market opportunity. The client-ready next step is a product-by-product qualification map that links material grade, origin rule, customer approval, offtake horizon, and working-capital need.

Action Table

Business problem	Evidence	Recommended action	Horizon	Confidence
Supplier qualification	China-origin U.S. imports are $636.5M; allied China-origin imports are $3.78B.	Treat magnet qualification as the binding commercial asset, not mine ownership alone. Prioritize customer-specific grades and geometries.	0–24 months	High
Revenue sizing	U.S. China-origin displacement is below $1.00B but global China-origin displacement is $5.46B.	Build two go-to-market tracks: domestic anchor demand and allied export demand. Avoid confusing global strategic value with immediate U.S. sales.	0–36 months	High
Downstream exposure	ICIO propagation maps the direct China flow into a $1.01B U.S. gross-output footprint.	Focus procurement and offtake discussions on motor vehicles, chemicals, fabricated metals, machinery, electrical equipment, and aerospace.	0–18 months	Medium-high
Physical capacity	A 10,000 ton magnet line equals 57.6% of 2024 U.S. China-origin permanent-magnet import tonnage.	Convert capacity announcements into customer-specific qualification funnels and take-or-pay demand.	12–36 months	Medium
Policy and procurement	U.S. and allied policy favors China-risk reduction, but HS6 data cannot prove compliance with origin or defense rules.	Use this report for market prioritization, then validate origin, Buy American, DFARS, and customer rules product by product.	Immediate	High

1 Scope And Method

This report estimates the commercial and value-chain implications of a U.S. manufacturing shift away from Chinese rare-earth suppliers. The product platform is deliberately narrow. It includes seven BACI HS6 codes: 280530, 284610, 284690, 850511, 850519, 850520, and 850590. These codes capture rare-earth metals and compounds plus permanent magnets and magnet assemblies. They do not capture rare-earth ores cleanly, nor do they isolate NdFeB magnets from generic permanent magnets. That limitation is material and is stated throughout.

The analysis uses two linked data systems. First, BACI HS02 V202601 provides bilateral product trade through 2024. Values are reported in thousands of current U.S. dollars and quantities in metric tons. Second, the OECD ICIO 2023-edition small table provides the 2020 input-output matrix in current million U.S. dollars. We use the raw 2020 ICIO matrix rather than the preprocessed convenience coefficient file. For each country-industry column j, the technical coefficient is:

$$a_{ij} = \frac{z_{ij}}{x_j},$$

where z_{ij} is intermediate input flow from sector i to use sector j, and x_j is gross output. The downstream propagation model uses the U.S. domestic price-pressure inverse:

$$p = (I - A'_{US})^{-1} s,$$

where s is the vector of direct rare-earth input exposure allocated to U.S. use sectors. This is a cost-pressure and exposure footprint, not a causal pass-through estimate. The ICIO sectors C20, C25, and C27 are broad, so the report uses a rare-earth-specific allocation filter over strategic U.S. use sectors: C20, C24, C25, C26, C27, C28, C29, C30, C31T33, D, J61, and J62_63. This avoids mechanically assigning rare-earth magnets to every broad metal-product use, while preserving the empirical input-output weights inside the relevant manufacturing system.

2 Direct HS6 Trade Exposure

The direct U.S. market is concentrated in four product lines: metal permanent magnets, electromagnets and magnet parts, other rare-earth compounds, and non-metal permanent magnets. China supplied 46.6% of the U.S. import value across the seven-code platform in 2024. The measured China share is highest in metal permanent magnets, where China accounts for most U.S. imports by value and tonnage.

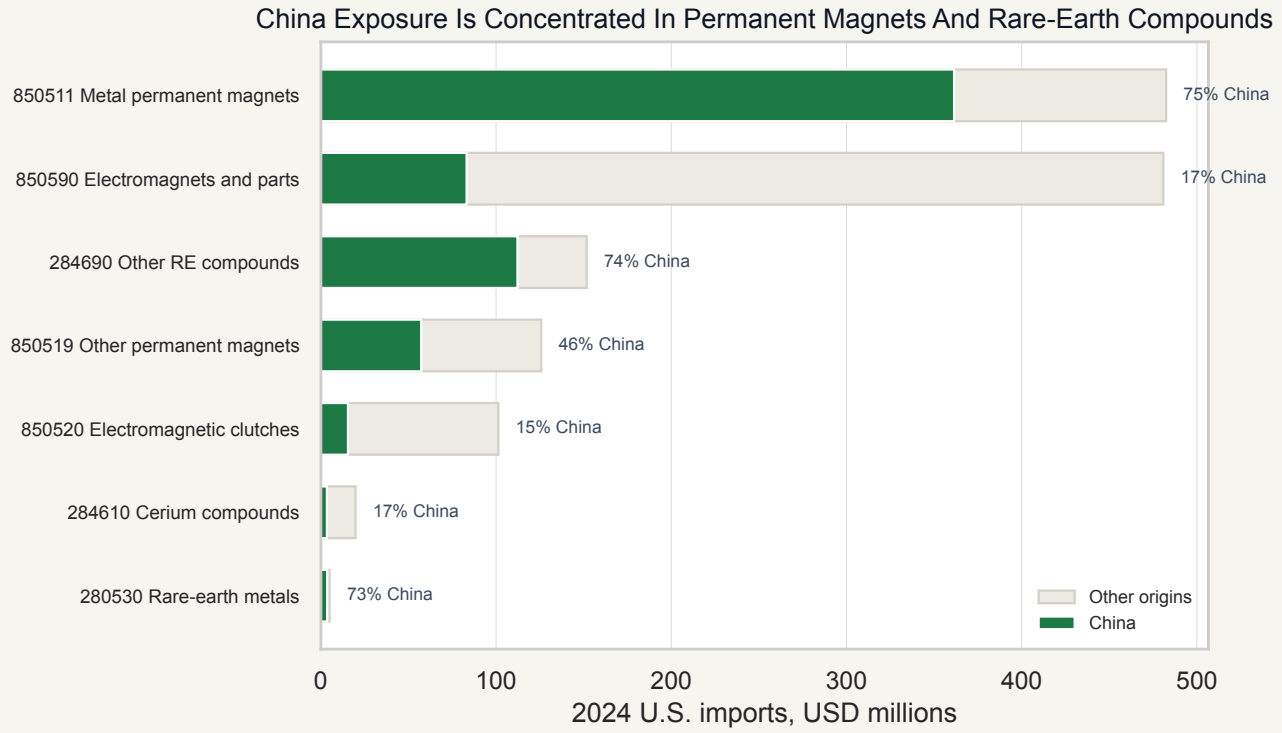


Figure 1: U.S. import exposure by HS6 product. Bars show total 2024 U.S. imports and the China-origin component.

HS6	Product	U.S. imports	From China	China share	HHI
850511	Metal permanent magnets	$482.4M	$361.4M	74.9%	0.57
284690	Other RE compounds	$151.7M	$112.2M	74.0%	0.56
850590	Electromagnets and parts	$480.8M	$83.2M	17.3%	0.11
850519	Other permanent magnets	$125.8M	$57.3M	45.5%	0.27
850520	Electromagnetic clutches	$101.3M	$15.5M	15.3%	0.18
280530	Rare-earth metals	$4.9M	$3.6M	72.7%	0.56
284610	Cerium compounds	$19.8M	$3.4M	17.4%	0.53

The HHI column makes the procurement problem concrete. Products with high China share and high HHI are not merely tariff or geopolitical risk categories; they are qualification bottlenecks. Moving a magnet product away from China requires metallurgy, performance testing, tooling, customer approval, and reliable material feedstock. That is why the value of domestic supply is larger than the annual customs value of the product line.

3 Time Trend And Network Position

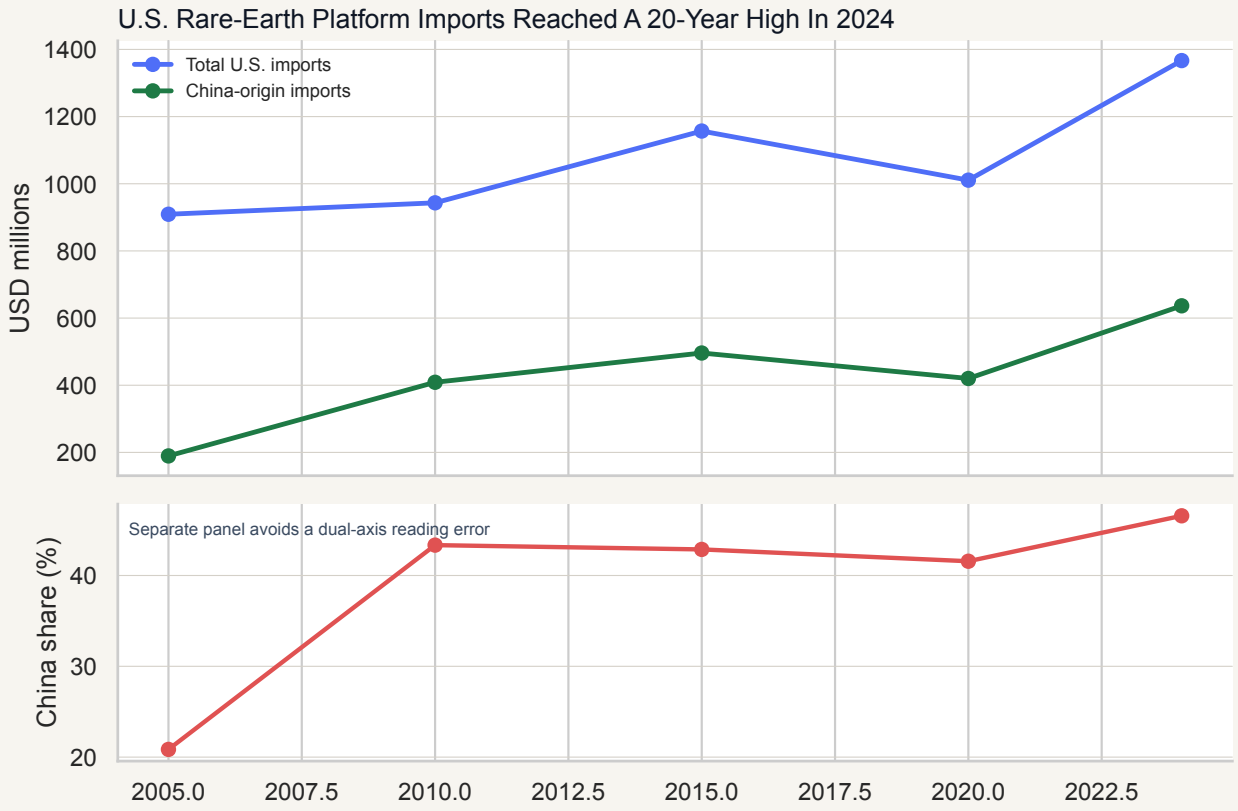


Figure 2: U.S. rare-earth platform imports and China-origin share, selected benchmark years.

The U.S. import series rises from $909.2M in 2005 to $1.37B in 2024. China-origin imports rise from $189.5M to $636.5M over the same period. The shift is not monotonic, but the strategic point is stable: U.S. manufacturers have not yet replaced China at scale in the product categories most visible in HS6 trade.

China's position is a network property, not only a market-share statistic. It exports to nearly every major downstream manufacturing hub. Germany, the United States, Japan, Vietnam, Korea, and Mexico are leading destinations for China-origin rare-earth platform products. This matters for MP Materials and USA Rare Earth because the commercial opportunity is not limited to replacing China in U.S. customs data. The broader opportunity is qualifying into allied manufacturing systems that currently buy Chinese magnets, compounds, or assemblies.

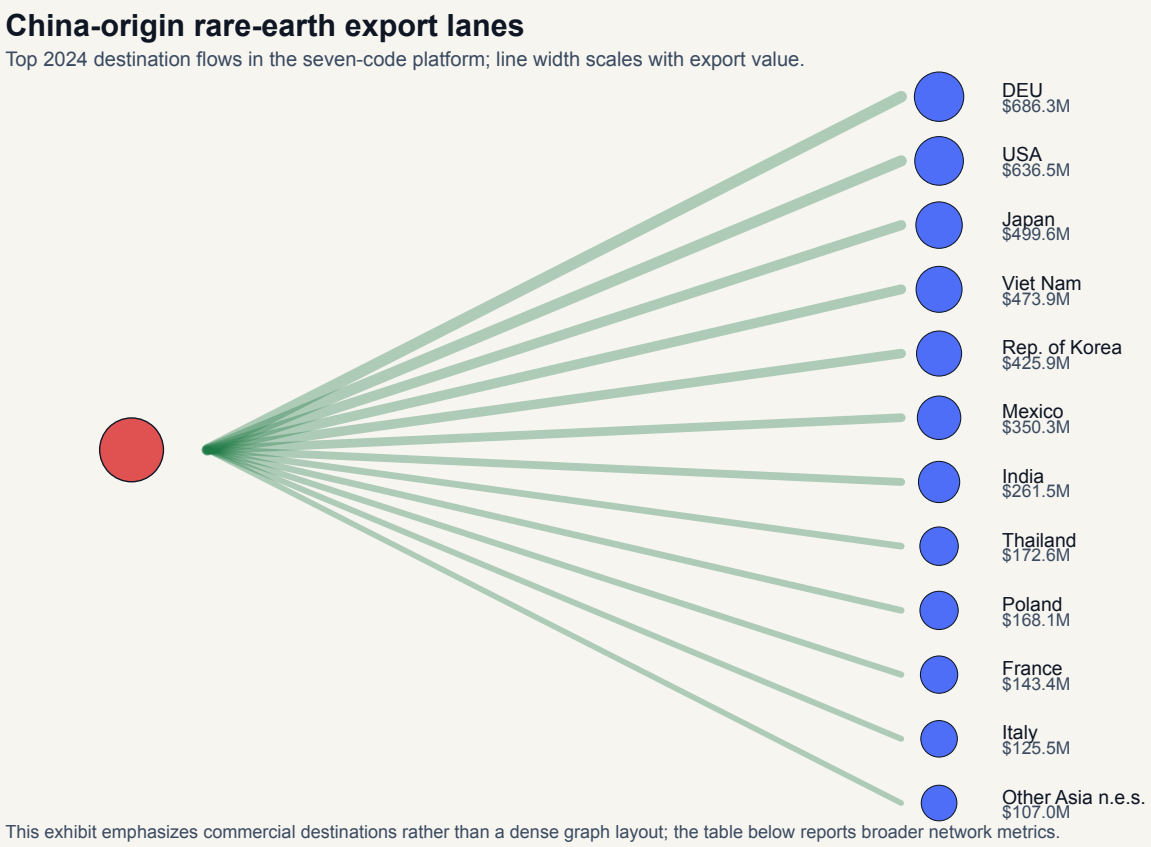
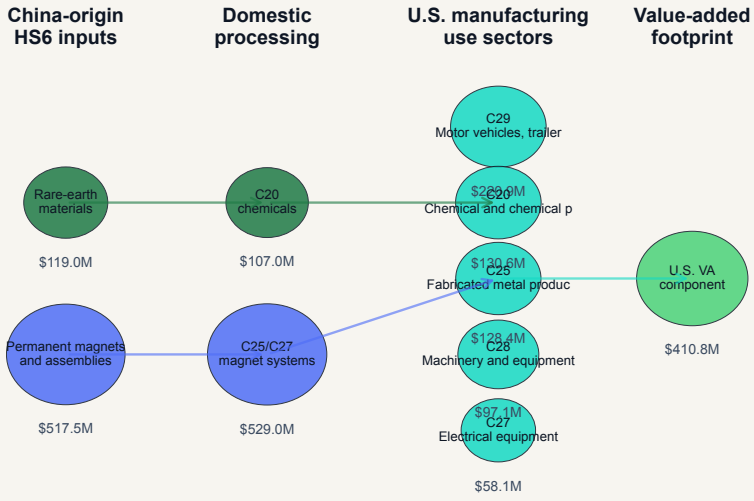


Figure 3: Largest China-origin 2024 export lanes in the seven-code rare-earth platform. Line width reflects trade value; the network table below reports broader exporter/importer position.

Country or economy	Exports	Imports	Network betweenness
China	$5.46B	$2.04B	0.67
Fed. Rep. of Germany (...1990)	$1.13B	$1.27B	0.24
Japan	$1.07B	$1.34B	0.02
Myanmar	$817.9M	$3.4M	0.00
Viet Nam	$619.4M	$766.2M	0.00
Malaysia	$565.3M	$331.5M	0.02
USA	$493.8M	$1.37B	0.18
France	$344.4M	$343.8M	0.00
Philippines	$338.2M	$470.1M	0.00
Rep. of Korea	$263.4M	$571.7M	0.02

4 Input-Output Propagation And Value Added



Node size is proportional to modeled 2024 dollar exposure. The ICIO layer uses a rare-earth-specific sector filter to avoid treating broad C25/C27 inputs as generic construction metals.

Figure 4: Rare-earth HS6 inputs mapped through the U.S. input-output system.

The ICIO model changes the interpretation of the trade data. The direct China-origin input flow is $636.5M, but the estimated U.S. downstream gross-output footprint is $1.01B. The multiplier is 1.58x. In value-added terms, the U.S. footprint is $410.8M, concentrated in motor vehicles, chemicals, fabricated metals, machinery, electrical equipment, aerospace and other transport equipment, and electronics.

ICIO	Downstream use sector	Direct allocation	Gross-output footprint	Value added
C29	Motor vehicles, trailers and semi-trailers	$168.5M	$220.9M	$49.3M
C20	Chemical and chemical products	$107.4M	$130.6M	$56.6M
C25	Fabricated metal products	$108.7M	$128.4M	$51.8M
C28	Machinery and equipment, nec	$77.6M	$97.1M	$43.5M
C27	Electrical equipment	$43.9M	$58.1M	$28.2M
C24	Basic metals	$24.4M	$39.4M	$12.2M
C31T33	Manufacturing nec; repair and installation of machinery and equipment	$27.7M	$37.7M	$20.6M
J61	Telecommunications	$26.8M	$33.1M	$17.1M
C30	Other transport equipment	$20.6M	$32.3M	$18.0M
C22	Rubber and plastics products	$0.0M	$24.6M	$8.3M

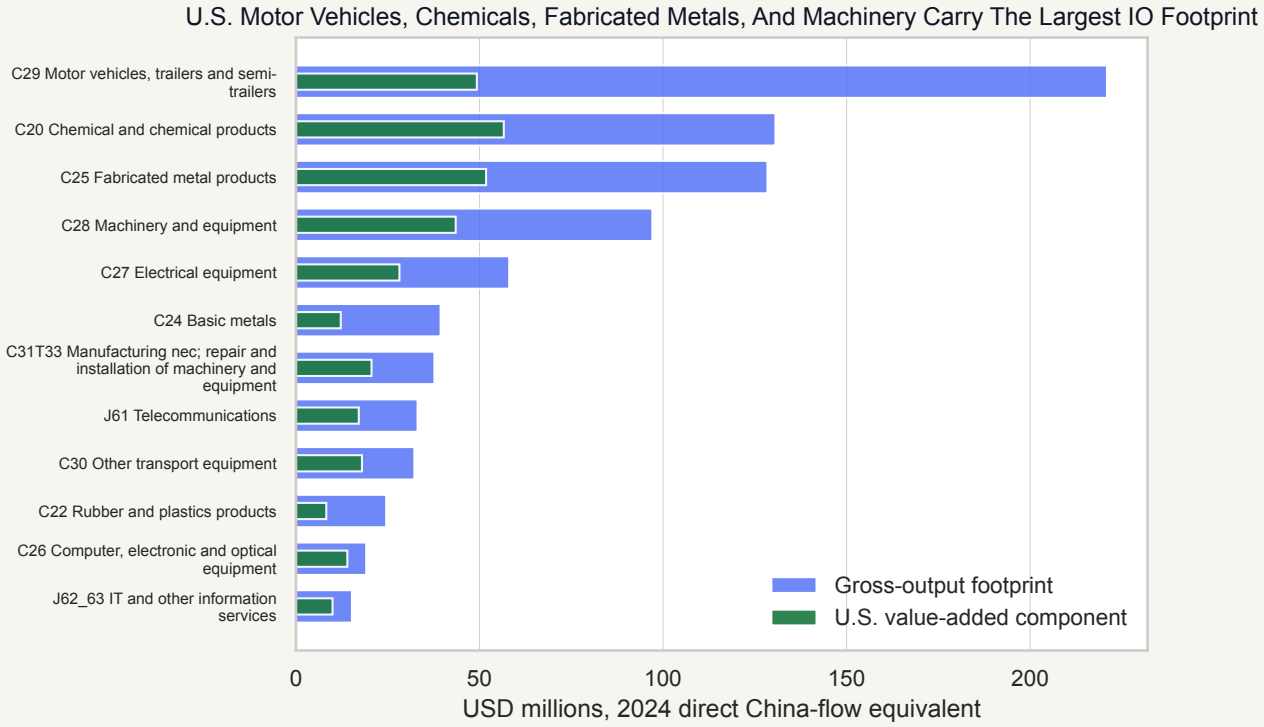


Figure 5: Top U.S. downstream sectors by ICIO gross-output footprint and value-added component.

The model identifies the sectors where rare-earth transition has the largest operating leverage. Motor vehicles and machinery are not rare-earth sectors in the narrow customs sense, but they are the industrial systems in which qualified magnets and motor components create the largest procurement option value. This is the key GVC point: the strategic value of MP Materials or USA Rare Earth is not measured only by oxide or magnet revenue. It is measured by the downstream manufacturers whose production plans become less dependent on Chinese suppliers.

5 Value-Added Distribution

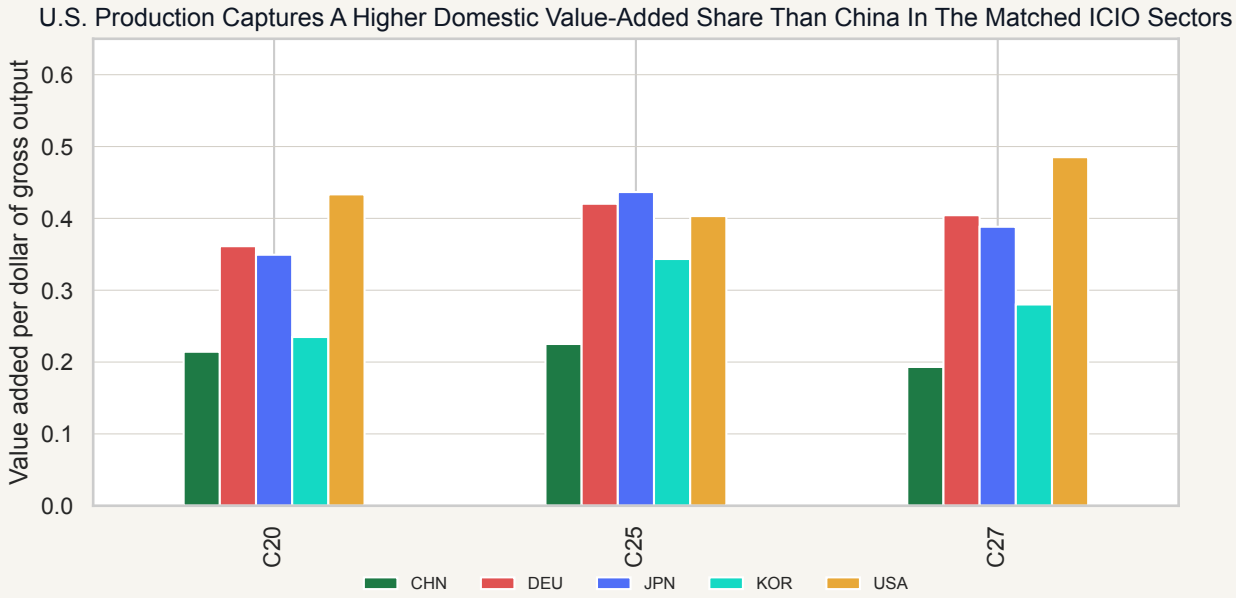


Figure 6: Value-added coefficients for matched ICIO sectors.

The ICIO value-added coefficients show why domestic supply carries strategic value even when direct import values appear modest. In 2020 ICIO data, U.S. value added per dollar of gross output is higher than China's in the matched sectors C20, C25, and C27. The coefficient comparison is not a prediction of firm margins, but it indicates that replacing China-origin imports with U.S. production changes where income is recorded in the GVC.

Country	Sector	Industry	VA/output
CHN	C20	Chemical and chemical products	21.4%
USA	C20	Chemical and chemical products	43.3%
CHN	C25	Fabricated metal products	22.5%
USA	C25	Fabricated metal products	40.3%
CHN	C27	Electrical equipment	19.3%
USA	C27	Electrical equipment	48.5%

Two interpretations follow. First, domestic production can increase U.S. value-added capture if it replaces imported Chinese intermediate goods and qualifies into downstream U.S. manufacturing. Second, the transition is capacity- and qualification-constrained. A higher value-added coefficient does not automatically translate into firm revenue unless downstream customers accept the product and the upstream feedstock chain is stable.

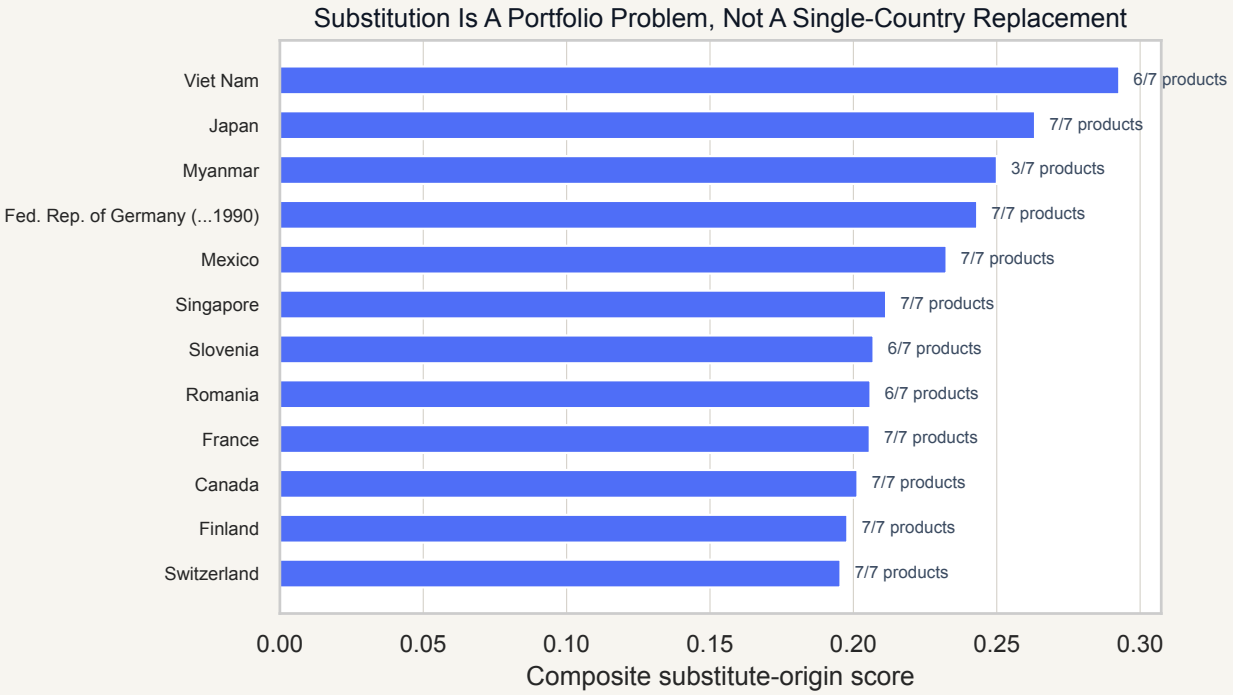


Figure 7: Non-China substitute-origin score based on export capacity, U.S. market presence, 2019–2024 growth, and product coverage.

6 Substitution And Supplier Portfolio

Substitution is not a single-country replacement. Japan, Germany, Malaysia, Vietnam, the United States, Korea, France, and several European suppliers appear in the data as potential non-China nodes depending on product. However, HS6 trade cannot distinguish high-performance NdFeB magnets from generic permanent magnets, nor can it verify qualification for a particular motor, defense, or electronics program. The substitution score is therefore a sourcing screen, not a supplier approval list.

Candidate origin	2024 non-China exports	Product coverage	Score
Viet Nam	$619.4M	6.0	0.29
Japan	$1.07B	7.0	0.26
Myanmar	$817.9M	3.0	0.25
Fed. Rep. of Germany (...1990)	$1.13B	7.0	0.24
Mexico	$173.9M	7.0	0.23
Singapore	$48.2M	7.0	0.21
Slovenia	$31.4M	6.0	0.21
Romania	$68.4M	6.0	0.21

7 Market Opportunity For MP Materials And USA Rare Earth

The addressable market should be sized in layers. The narrow U.S. China-origin displacement pool is $636.5M. Total U.S. imports across the focus platform are $1.37B. Allied China-origin imports are $3.78B. Global China-origin exports are $5.46B. These numbers are annual 2024 trade values, not discounted cash flow forecasts.

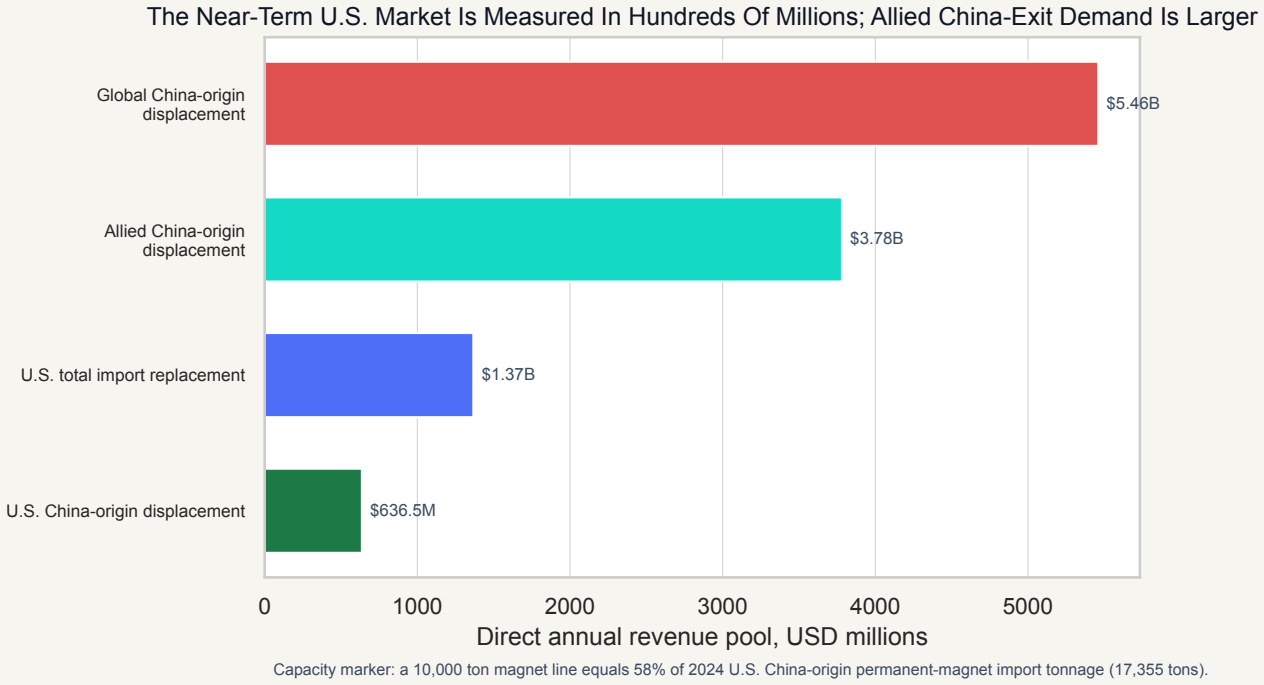


Figure 8: Market pools that U.S. rare-earth firms can contest under China-risk reduction scenarios.

Market pool	Capture	Direct revenue pool	U.S. IO footprint proxy	U.S. VA proxy
U.S. China-origin displacement	25.0%	$159.1M	$252.2M	$102.7M
U.S. China-origin displacement	50.0%	$318.3M	$504.4M	$205.4M
U.S. China-origin displacement	100.0%	$636.5M	$1.01B	$410.8M
U.S. total import replacement	25.0%	$341.7M	$541.6M	$220.5M
U.S. total import replacement	50.0%	$683.4M	$1.08B	$441.0M
U.S. total import replacement	100.0%	$1.37B	$2.17B	$882.0M
Allied China-origin displacement	25.0%	$945.3M	$1.50B	$610.0M
Allied China-origin displacement	50.0%	$1.89B	$3.00B	$1.22B
Allied China-origin displacement	100.0%	$3.78B	$5.99B	$2.44B
Global China-origin displacement	25.0%	$1.36B	$2.16B	$880.9M
Global China-origin displacement	50.0%	$2.73B	$4.33B	$1.76B
Global China-origin displacement	100.0%	$5.46B	$8.65B	$3.52B

The scenario table should be read as a market-sizing map. A 50 percent capture of the U.S. China-origin displacement pool is roughly $318.3M of direct annual revenue opportunity. The same capture rate applied to allied China-origin demand is roughly $1.89B. The latter is much larger, but it requires exportable capacity, quality systems, and customer relationships in Germany, Japan, Korea, Mexico, Vietnam, and other manufacturing hubs.

7.1 Firm Implications

MP Materials. MP has the strongest U.S. upstream position because Mountain Pass is already the core domestic rare-earth mine and concentrate node, and the company has been building separation and magnet capability. The strategic implication of the model is that MP's upside is not limited to rare-earth oxide sales. The more valuable option is becoming a qualified magnet and materials supplier to U.S. and allied manufacturers that need a China-reduced bill of materials. The direct U.S. displacement pool is large enough to support meaningful revenue, but the allied pool is what justifies a platform strategy.

USA Rare Earth. USA Rare Earth's Round Top and Stillwater strategy fits the same GVC logic from a different position: the company is building toward mine-to-magnet integration, with an announced magnet manufacturing pathway. The report's capacity comparison indicates why the physical side matters. If a full-scale 10,000 ton magnet plant is qualified and utilized, it could cover a majority of current U.S. China-origin permanent-magnet import

tonnage. The commercial risk is execution: feedstock availability, separation economics, magnet-grade production, customer qualification, and working-capital support must all clear before announced capacity becomes realized market capture.

Platform	Tons	Share of 2024 U.S. China-origin permanent-magnet tons	China-import unit-value proxy
MP Materials 10X platform	10,000.0	57.6%	$241.2M
USA Rare Earth full magnet plant	10,000.0	57.6%	$241.2M
USA Rare Earth initial phase	1,200.0	6.9%	$28.9M

The revenue proxy uses observed 2024 BACI unit values for HS 850511 and 850519. It should be interpreted as a low-resolution trade-value benchmark, not a product-grade price forecast. High-performance NdFeB magnets, motor assemblies, and defense-qualified products can have different prices and margins.

Execution watchlist. The decisive milestones are not only announced tons of capacity. The operating watchlist is: separated oxide qualification, metal/alloy availability, magnet-grade yield, customer sample approval, offtake conversion, traceability documentation, and working-capital support through scale-up. The market is available only where these gates clear together.

8 Strategic Interpretation

The core strategic result is that rare-earth de-risking creates three layers of value. The first is direct import replacement: replacing China-origin rare-earth materials and magnets in U.S. customs flows. The second is supply assurance: enabling downstream manufacturers to certify China-reduced or China-free supply for critical products. The third is option value: giving manufacturers credible bargaining power against Chinese suppliers and a resilience path if export controls, tariffs, procurement rules, or geopolitical shocks tighten.

The second and third layers are where firm value can exceed the direct HS6 import pool. Automakers, motor manufacturers, aerospace firms, electronics producers, and defense contractors may pay for reliability, compliance, and qualification rather than simply lowest landed cost. This is why government offtake, long-term customer contracts, and qualification milestones matter as much as mining volumes.

There are also constraints. ICIO sectors are broader than rare-earth products, HS6 product codes do not isolate high-grade magnet chemistry, and BACI does not observe firm-level buyer-supplier links. The report therefore avoids claiming a precise firm revenue forecast. It provides a market-sizing and GVC-incidence model: the U.S. direct China-exit pool is $636.5M, the allied China-exit pool is $3.78B, and the U.S. downstream IO footprint for the direct China flow is $1.01B.

9 Recommendations

- For U.S. rare-earth firms: sell qualification and supply assurance, not only material volume. Customer-specific magnet specs, traceability, and delivery reliability are the scarce assets.
- For downstream manufacturers: map every rare-earth input to a qualified supplier, product grade, origin rule, and customer approval process. Use the sector exposure ranking to identify where substitution delays create production risk.
- For investors: separate mine value, separation value, magnet value, and customer qualification value. The market rewards will likely accrue to the firm that integrates these steps with credible offtake.
- For policy teams: target support at qualification bottlenecks, not only extraction capacity. The binding constraint is often midstream processing, magnet manufacturing, and customer validation.

10 Technical Appendix

10.1 HS6 Product Platform

The focus platform is intentionally narrow: 280530, 284610, 284690, 850511, 850519, 850520, and 850590. The first three products are mapped to ICIO C20. Permanent magnets are mapped to C25, and electromagnetic assemblies and parts are mapped to C27. This mapping follows the local BACI product-to-ISIC concordance and then the ICIO industry structure. Ores are not separately included because HS6 rare-earth ore classification is not clean in this release.

10.2 ICIO Construction

The raw 2020 ICIO matrix contains intermediate input rows and country-industry columns. We extract the 3,465 country-industry intermediate block, compute $A = Z\hat{x}^{-1}$, and then calculate the U.S. domestic inverse $(I - A'_{US})^{-1}$. The exposure vector s allocates direct 2024 U.S. China-origin BACI imports across rare-earth-relevant U.S. use sectors using ICIO source-sector input shares. The value-added component multiplies the resulting footprint by sector-level value-added-to-output coefficients from the VA and OUT rows.

10.3 Interpretation Boundaries

The analysis is descriptive and structural, not causal. It does not estimate pass-through elasticities, customer switching probabilities, firm margins, or defense-contract eligibility. It does not use proprietary FactSet relationship data. All dollar values are current nominal U.S. dollars from BACI or ICIO. The market scenarios are 2024-dollar annual pools, not discounted revenue projections.

10.4 Primary Sources And Citations

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