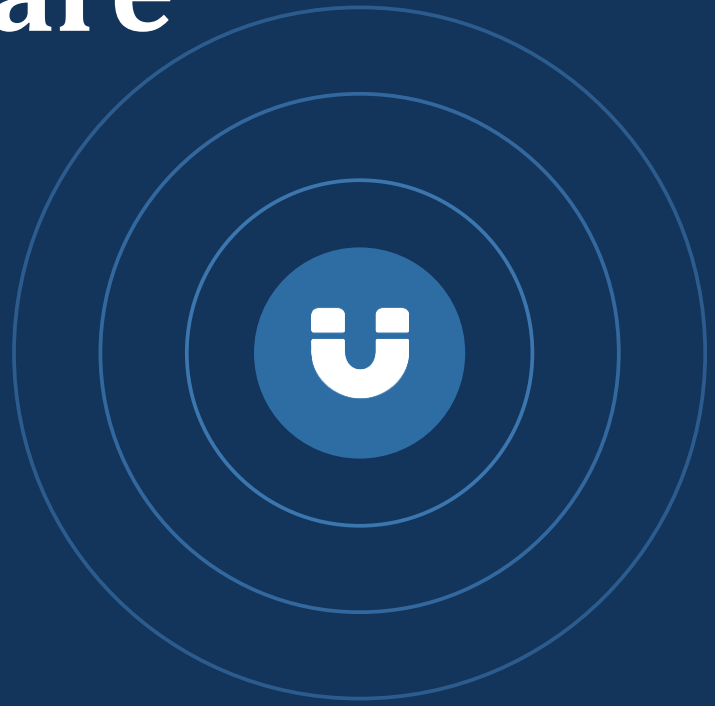
47th IAEE International Conference, July 2026

Macroeconomic Effects of Rare Earths Supply Chain Disruptions



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Featured at the IMF World Economic Outlook — April 2026
Commodity Special Feature: Market Developments and the Economics of Rare Earths

FRAMING

Why rare earths, and why now

April 4, 2025 changed the risk calculus. Shortly after new US tariffs, China — the world's top producer of rare earth elements (REEs) — introduced export licensing for seven REEs and REE-based permanent magnets. The disruption was serious but short-lived, yet it sharply raised the ***perceived probability*** of a prolonged, severe shortage in the eyes of policymakers.

That raises one research questions:

1 How costly is a shortage?

The macroeconomic impact — output lost — of a major, prolonged disruption of REE supply across sectors and major economies.

Policy Implications

Is there a need to de-risk as insurance policy (follow-up paper Bogmans et. al., 2026)

Efficiency losses from reshoring should be commensurate with the **expected damage** in a crisis (disruption losses avoided).

This paper analyses the magnitude of damages.

Source: IMF April 2026 WEO Commodity Special Feature.

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Small market, outsized leverage

17 metals, but the economics dictated by four. The “magnet-4” — neodymium, praseodymium, terbium, dysprosium — are **96% of REO market value** despite only 23% of output by weight. Their key use is **permanent magnets**, which convert electricity into motion and back.

Used in tiny quantities, hard to substitute. REEs are essential inputs across high-tech manufacturing (e.g. automotive, wind energy, semiconductors, defense systems). Substitutes often exists, or could be developed, but typically come with penalties in terms of efficiency, size, weight, or costs.

$6 bn

Rare earth oxides — the entire global market (2024). Tiny by commodity market standards.

$25 bn

Permanent magnets market (2024).

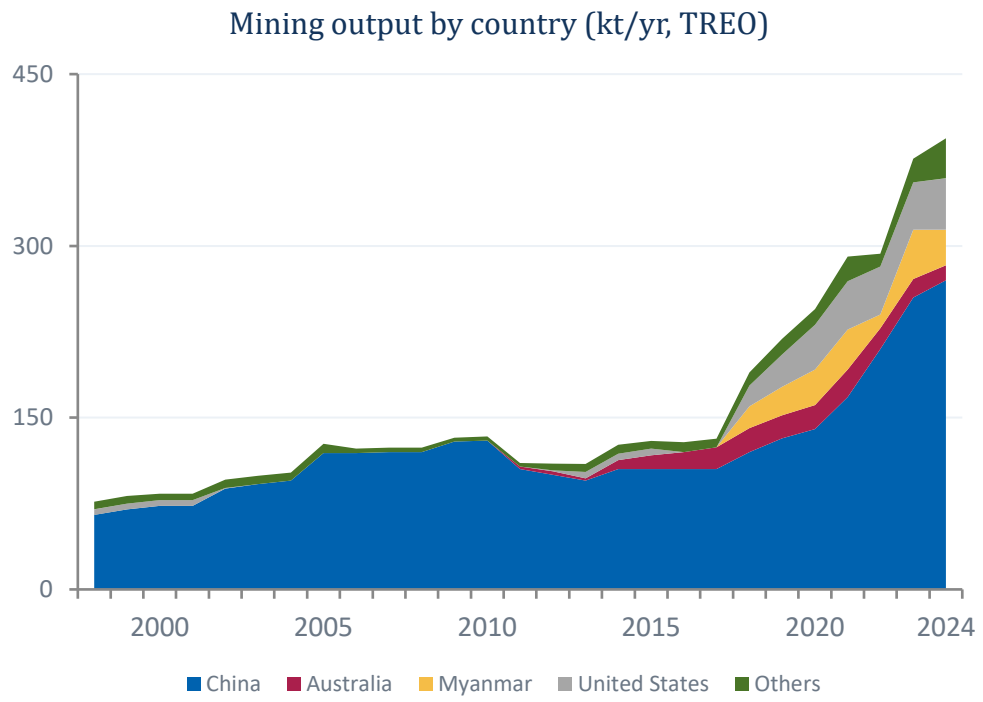
Why so small a market matters

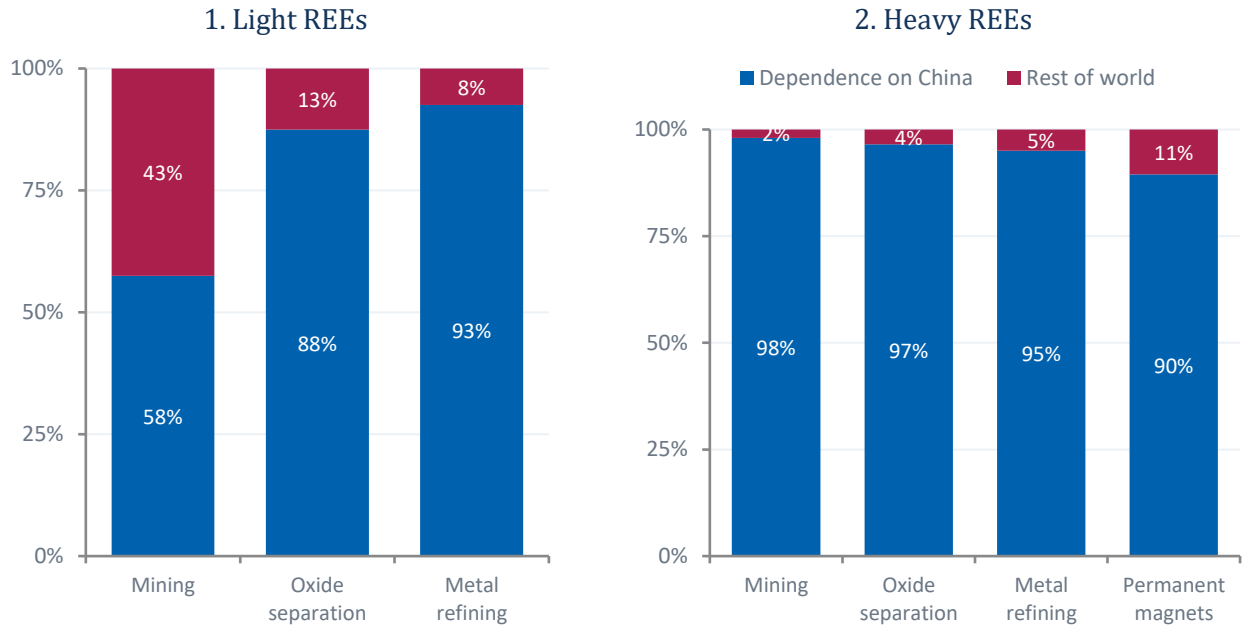
(1) These inputs “unlock” **trillions of dollars** of downstream value in high-tech manufacturing. Disruption of supplies would not only affect sectors that use REE as inputs, but also sectors that built on them.

(2) Manufacturing has regained strategic importance: innovation in 'atoms,' not just 'bits'

Sources: Market Data Forecast (2025); Nassar et al. (2025); IMF staff. REO = rare earth oxide.

Supply chain choke points: mining diversifies, processing stays concentrated





Mining has diversified — China's share of light-REE mining fell from **97% (2010) to 58% (2024)** as Australia, Myanmar and the US scaled up.

But processing is the chokepoint. China still holds **88–97% of separation & refining and ~90% of magnets** — almost all concentrate, wherever mined, is processed in China.

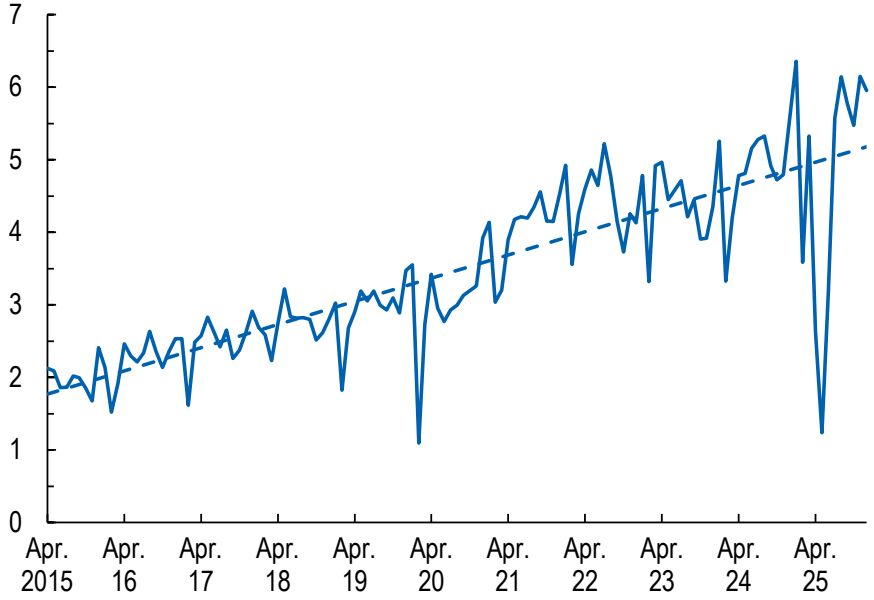
Sources: Fig. 1.SF.2–1.SF.3 — Nassar et al. (2023); USGS; Bedford (2025); IMF staff.

FRAMING

A short, sharp disruption

China's magnet exports fell ~70% in April–May 2025 indicating a system-wide disruption that extended beyond formally controlled products, but proved short-lived, with monthly Chinese export volumes quickly returning to their positive trend and displaying double-digit year-over-year growth rates.

China's Exports of Rare Earth Permanent Magnets and Rare Earth Magnet Components Intended for Permanent Magnet Production *(Thousands of metric tons; dashed = trend)*



Sources: General Administration of Customs of the People's Republic of China (GACC); Hong Kong Trade Development Council, China Customs Statistics; and IMF staff calculations.
Note: Data from the series "CN: Export: HS 8: Permanent Magnets or Articles Going to Be Permanent Magnets, of Rare-Earth Metals," Code HS 850511.

Key events, 2025–26

Apr 2025
China introduces export licensing for 7 REEs and permanent magnets.

Apr–May
Magnet exports fall ~70% y/y — disruptions across the US, EU and India.

Jul 2025
US–MP Materials deal: price floor plus a government equity stake.

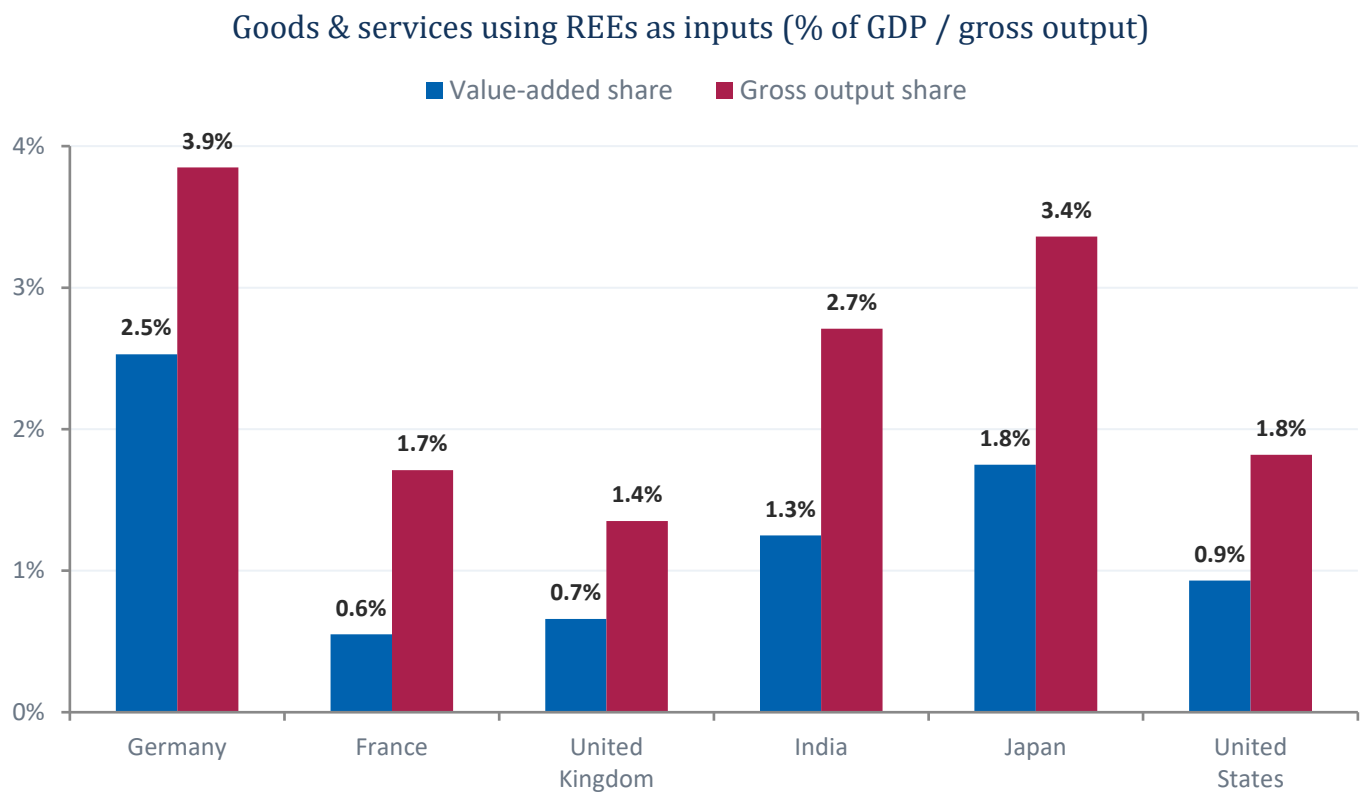
Oct 2025
Controls expanded — then suspended in November under a US–China deal.

Jan 2026
China restricts heavy-REE exports to Japan.

2026
Exports rebound to trend; double-digit growth resumes.

Source: Fig. 1.SF.4 — GACC; China Customs Statistics; IMF staff.

First pass estimate: value added at risk (VAAR)



What VAAR is

The value added of every sector that uses REEs — a simple **upper-bound snapshot** of exposure. In the US, ~0.9% of GDP (34 of 405 sectors); magnets drive ~70% of it. It ranges from ~0.5% (France) to 2.5% (Germany).

...but it is the wrong number

Understates losses — ignores how shocks cascade through the production network.
Overstates losses — assumes zero substitution; treats the whole exposed share as lost.

Source: Fig. 1.SF.5 — Nassar et al. (2025); OECD I-O tables; IMF staff.

The model: a production-network approach

Dynamic, small open economy with networks

A general-equilibrium model where 50 manufacturing and services' sectors buy from and sell to one another; thus, a shock to one node propagates to the rest → backward and forward linkages.

REEs as constrained imports

Rare earths enter as imported intermediate inputs that face a supply constraint, calibrated on an REE-augmented input-output table from USGS data.

Substitution elasticity between REEs and intermediate goods is a key parameter

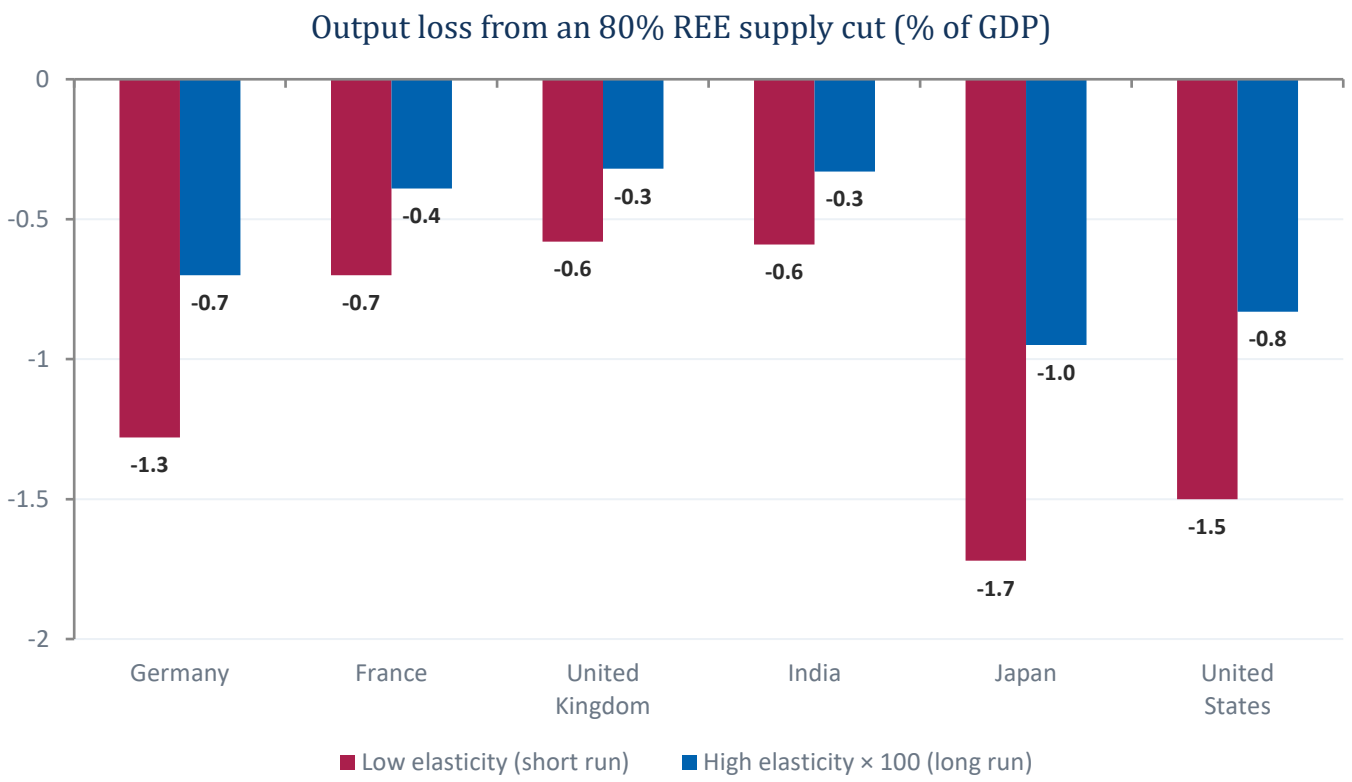
Short run (<1 yr): firms can barely substitute — near-Leontief — so output drops significantly. Longer run (>5 yrs): firms adapt, and losses shrink dramatically.

The experiment

A persistent 80% cut to all REE inputs — oxides, metals, compounds, magnets — consistent with average dependence of advanced economies on imports from the world's largest producer, China. Then assess the GDP loss.

Method: Silva et al. (2024), extended for imported REE constraints; calibrated on USGS-augmented I-O tables.

Accounting for network linkages narrows Germany's loss and widens the US's



Networks can amplify but also mitigate

US loss reaches 1.5% — nearly 2× its VAAR — via auto, electrical & electronics linkages (US car output −9%). Japan is most exposed (−1.7%); Germany's loss (−1.3%) is below its 2.5% VAAR.

Short run damages are substantial

With little scope to substitute in the first year, the most exposed economies lose 1.3–1.7% of GDP.

Long run: losses ≈ 0 Given >5 years to adapt, the average GDP loss is ~0.006% (note the long-run bars are ×100).

Source: Fig. 1.SF.6 — IMF staff. Low elasticity ≈ <1 yr; high-elasticity series shown ×100.

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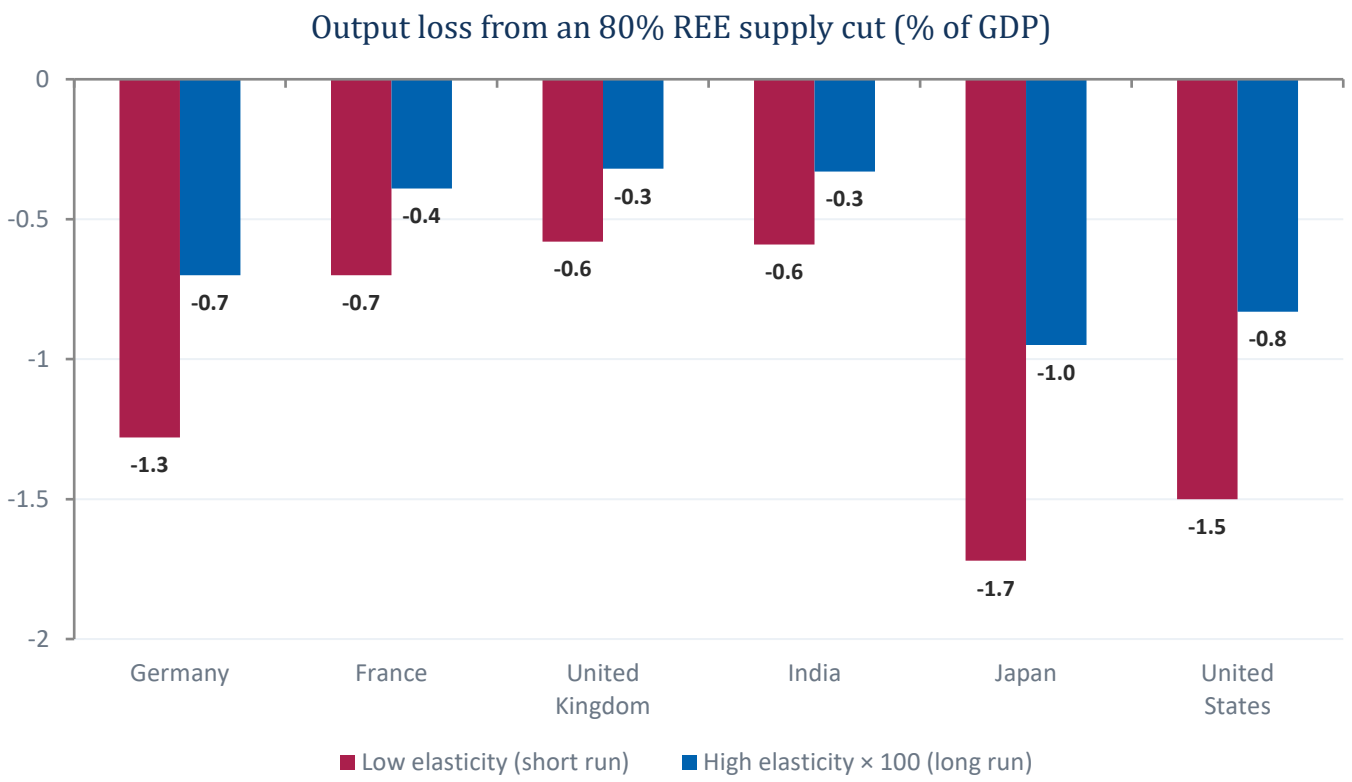

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SYNTHESIS

Putting it together: pricing the insurance

The premium

paid every year, crisis or not

- Efficiency losses from reshoring: higher-cost domestic processing.
- ≈ $1.2 bn over a decade to reach 25% US self-sufficiency; less if importers coordinate.

The payout

damage avoided in a crisis

- A severe shortage costs up to ~1.5–1.8% of GDP in the most exposed economies — short run.
- Concentrated in the first year, before firms can substitute; near zero once they adapt.

Implications for industrial policy

Diminishing returns

The first 10–20% of self-sufficiency removes most of the vulnerability.

De-risk, don't decouple

Full self-reliance over-insures and wastes resources.

Same logic elsewhere

Applies to energy, food, fertilizers and semiconductors — REEs are one case of a general problem.

Sources: IMF staff; Clayton, Maggiori & Schreger (2024) on diminishing security returns.

CONCLUSION

Five things to take away

Free trade is the first-best

Avoiding trade tensions keeps supply steady at the lowest cost. Everything else is second-best insurance.

A severe shortage is genuinely costly

Up to ~1.5–1.8% of GDP for the most exposed economies in the short run — but modest once firms can substitute.

Treat de-risking as insurance

Balance the fiscal cost from using industrial policy to de-risk against the expected damages from supply shortages. Don't over-insure: de-risk, don't decouple.

Act simultaneous and target capacity directly

Acting simultaneous and using subsidies that build new capacity cuts the fiscal cost (≈140% → ~90% of the market).

Use industrial policy cautiously

Pair it with structural reforms — faster permits, skills in separation chemistry & metallurgy, competitive allocation.
The literature on industrial policy is quickly evolving, highlighting aspects like (i) competent bureaucracies, (ii) export discipline, (iii) fierce domestic competition, (iv) accountable support.

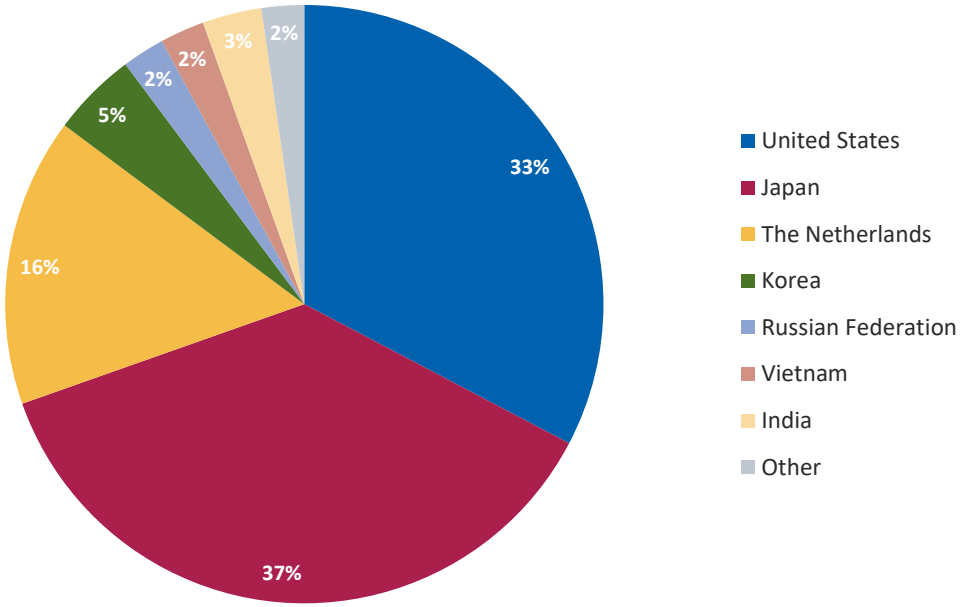
Sources: IMF April 2026 WEO Commodity Special Feature and companion working papers (2026).

APPENDIX

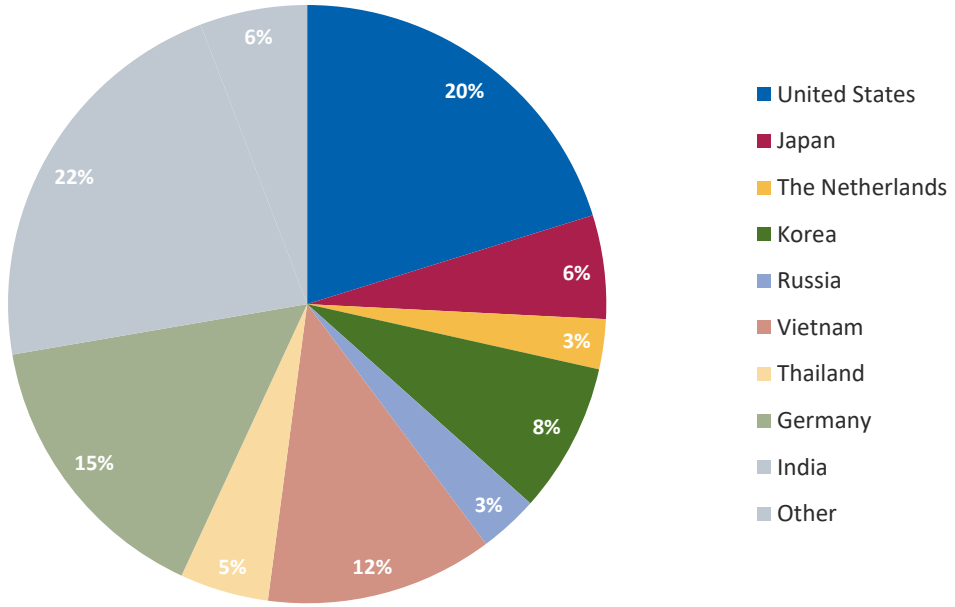
Where do China's rare-earth exports go?

the Netherlands is the **third-largest destination** for China's permanent-magnet exports (15.6%) — a major gateway for magnets into Europe.

Permanent magnets — export destinations



RE metals — export destinations

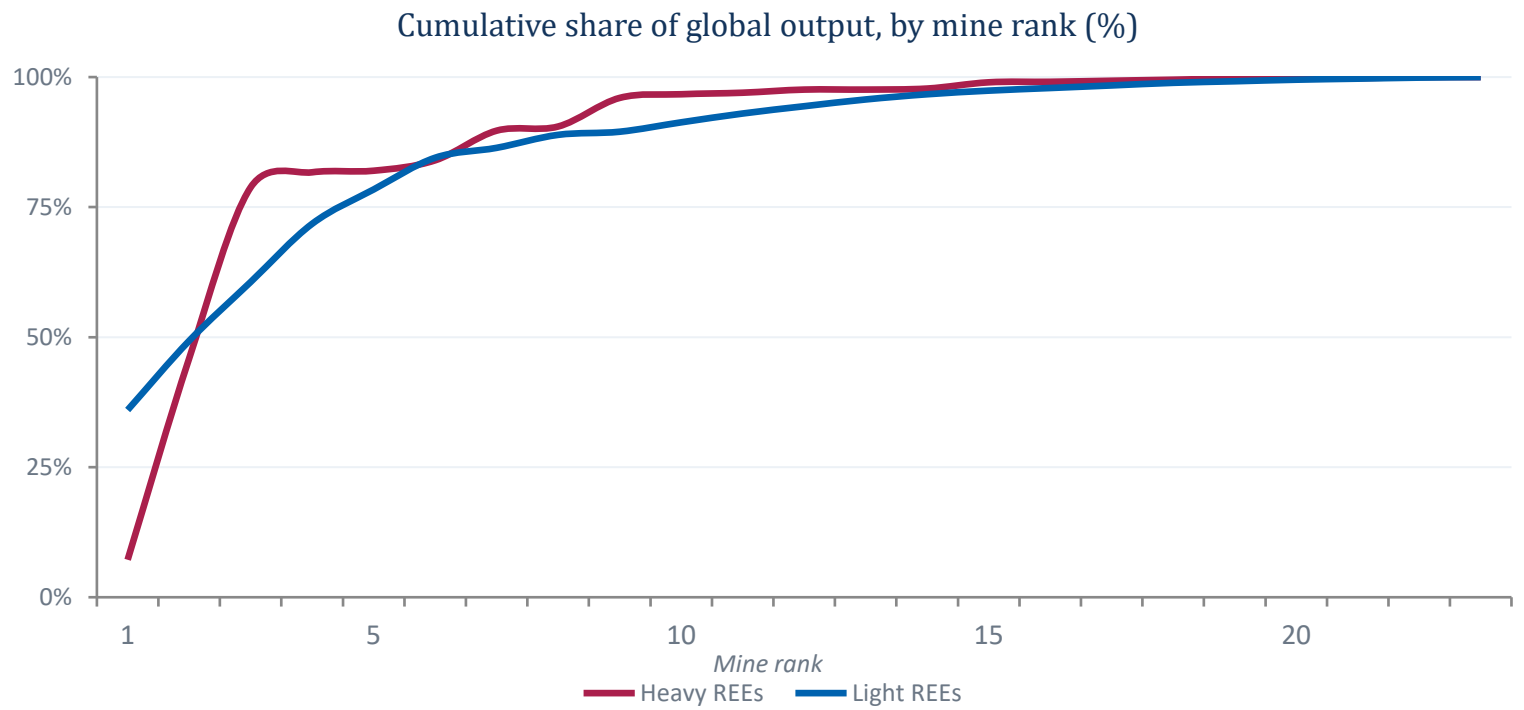


Sources: Fig. 1.SF.3 (panels 3-4) — GACC; China Customs Statistics; IMF staff. Shares of Chinese exports, 2024.

APPENDIX

Concentration runs deeper than countries

Heavy REEs are geologically scarce. A handful of mines dominate heavy-REE output — the first three account for roughly 80%, versus ~60% for light REEs — which is why heavy rare earths are the harder problem to de-risk.



Why heavy REEs are different

First 3 mines: ~80% of heavy REEs

First 3 mines: ~60% of light REEs

Fewer viable deposits and tighter geology leave less room to diversify supply.

Sources: supplementary CSF data — Bedford (2025); company reports; IMF staff. Cumulative output share by mine.