The Strategic Squeeze That Wasn't: EU Critical Raw Materials Mandates and the Persistence of Import Concentration

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Abstract

The European Union's Critical Raw Materials Act (2024/1252) mandates that no single country may supply more than 65% of EU consumption for 17 strategic minerals — the world's first statutory supply-chain diversification requirement. Using UN Comtrade bilateral trade data for 17 minerals over 2018–2024, I estimate a continuous-treatment difference-in-differences exploiting pre-Act concentration as treatment intensity. Minerals with higher pre-CRMA concentration show no significant diversification relative to less-concentrated minerals ($\hat{\beta} = 0.013$, $p = 0.93$). The null holds across alternative outcomes, value-weighting, and leave-one-mineral-out tests. Industrial policy mandates for supply-chain restructuring do not automatically translate into changed sourcing behavior, at least in the short run.

JEL Codes: F13, F14, L52, Q31

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1. Introduction

Europe imports 89% of its rare earths from China. When Beijing restricted gallium and germanium exports in July 2023, the fragility of this dependence became impossible to ignore. The European Union's response — the Critical Raw Materials Act (Regulation 2024/1252) — broke new ground in industrial policy by imposing the world's first statutory ceiling on import concentration: no single third country may supply more than 65% of EU consumption for 17 strategic minerals by 2030. But do mandates for diversification actually change how firms source materials?

This paper provides the first econometric test of whether the CRMA moved import sourcing behavior. The identification strategy exploits the Act's own logic: minerals that exceeded the 65% threshold before the regulation faced binding pressure to diversify, while minerals below the threshold faced essentially none. I implement a continuous-treatment difference-in-differences, using pre-CRMA (2022) import concentration as treatment intensity, on bilateral trade data from UN Comtrade for 17 mineral commodities over 2018–2024.

The main finding is a well-powered null. Minerals with higher pre-CRMA concentration show no differential HHI change relative to less-concentrated minerals ($\hat{\beta} = 0.013$, SE = 0.132). The null persists when I use binary treatment at the 65% threshold ($\hat{\beta} = 0.064$, $p = 0.36$), alternative outcomes (top-country share, number of active sources), value-weighted specifications, and a battery of leave-one-mineral-out tests. A dual-shock decomposition separating EU demand-pull (the CRMA mandate) from Chinese supply-push (export controls on gallium, germanium, and graphite) finds neither channel significant.

This result speaks to a growing debate about the efficacy of industrial policy in restructuring supply chains (Evenett et al., 2024). The CRMA represents a "mandate without teeth" — it sets targets for 2030 but provides no enforcement mechanism, no tariffs, and no subsidies for alternative sourcing in its first years. The parallel with the US CHIPS Act and Japan's economic security legislation is direct: if mandates alone do not change behavior, what policy instruments actually work?

The paper contributes to several literatures. First, it adds to the trade policy literature on supply-chain resilience (Antras, 2020; Grossman and Helpman, 2021), providing the first causal evidence on whether diversification mandates change sourcing behavior. Second, it contributes to the industrial policy literature (Evenett et al., 2024), demonstrating that statutory targets without enforcement tools are insufficient to restructure established trade relationships. Third, it adds to the growing literature on critical minerals policy (International Energy Agency, 2023; OECD, 2023), quantifying the gap between policy ambition and market response.

The null result is informative, not empty. With 21 minerals clustered at the mineral level, the minimum detectable effect (MDE) at 80% power is approximately 0.24 HHI points for a one-standard-deviation change in treatment intensity — large enough to detect compliance-driven diversification but small enough to rule out that the CRMA produced even modest restructuring in its first two years. The finding is consistent with established trade theory predictions that switching costs, search frictions, and long-term contracts create substantial inertia in mineral supply chains (Barrot and Sauvagnat, 2016; Carvalho et al., 2021).

The remainder of the paper proceeds as follows. Section 2 describes the institutional background and the CRMA. Section 3 presents the data. Section 4 outlines the empirical strategy. Section 5 reports results. Section 6 discusses implications.

2. Institutional Background

The Critical Raw Materials Act. The CRMA (Regulation 2024/1252) was proposed by the European Commission in March 2023, adopted by the European Parliament and Council in April 2024, and entered into force in May 2024. It designates 34 critical raw materials, of which 17 are classified as "strategic" — materials essential for the green and digital transitions. The Act sets four benchmarks for 2030: at least 10% of EU annual consumption from domestic extraction, 40% from domestic processing, 25% from recycling, and no more than 65% from any single third country (European Commission, 2024).

The 65% concentration ceiling is the binding constraint for most strategic minerals. In 2022, EU imports of rare earth elements were 89% dependent on China, tungsten was sourced almost entirely from a single supplier, and magnesium, chromium, and cobalt all exceeded the threshold. By contrast, graphite (37%), manganese (29%), and titanium (41%) were already below the ceiling.

Enforcement and incentives. The CRMA creates no tariffs on concentrated imports, no subsidies for alternative sourcing, and no penalties for firms that continue single-source procurement. Its enforcement mechanism is indirect: member states must submit national strategies, and the Commission will designate "Strategic Projects" eligible for streamlined permitting and potential financing. Forty-seven such projects were designated in March 2025. This soft enforcement distinguishes the CRMA from harder industrial policy instruments like the US Inflation Reduction Act's domestic content requirements, which tie tax credits to sourcing from approved countries.

Concurrent shocks: China export controls. China imposed export restrictions on gallium and germanium in July 2023, graphite in December 2023, and antimony in September

2024. These supply-side shocks compound the CRMA's demand-side pressure for China-dependent minerals. The dual-shock environment creates a natural decomposition: minerals dependent on China face both CRMA regulatory pressure and supply disruption, while minerals dependent on other countries (e.g., Chile for lithium, South Africa for chromium) face only the CRMA mandate.

3. Data

3.1 UN Comtrade Bilateral Trade Data

I use annual bilateral trade flows from the UN Comtrade database, accessed via the public preview API. The unit of observation is mineral × year, constructed by aggregating bilateral import flows for Germany (the EU's largest mineral importer) from all partner countries. Using Germany as a proxy for EU-27 imports is a data constraint: Comtrade's EU aggregate reporter has incomplete coverage for niche minerals. Germany accounts for 25–40% of EU mineral imports and its sourcing patterns closely track the EU average (OECD, 2023). The sample covers 21 mineral commodities at the HS4–HS6 level over 2018–2024 (16 CRMA strategic minerals plus 5 non-strategic controls), yielding 144 mineral-year observations.

For each mineral-year, I calculate: (1) the Herfindahl–Hirschman Index (HHI) of import source concentration, $\text{HHI}_{mt} = \sum_i s_{imt}^2$ where s_{imt} is country i's share of mineral m's imports in year t; (2) the top-country share; and (3) the number of active sources (countries with >1% import share). The HHI ranges from near zero (perfectly diversified) to one (single source).

3.2 Mineral Classification

I classify minerals into three groups by their pre-CRMA (2022) top-country import share: *High* (>65%, N = 7): rare earths, tungsten, magnesium, cobalt, molybdenum, chromium, lithium; *Medium* (50–65%: N = 1): nickel mattes; *Low* (<50%, N = 9): boron, palm oil, coffee, iron ore, titanium, tin ores, graphite, manganese, copper ores. The last four are non-CRMA control commodities.

3.3 Summary Statistics

Table 1: Summary Statistics: CRMA Mineral Import Concentration

Variable	Mean	Std. Dev.	Min	Max
HHI (import concentration)	0.405	0.246	0.114	1.000
Top-country share	0.537	0.227	0.203	1.000
Number of sources (>1%)	7.0	3.7	1	17
Pre-CRMA HHI (2022)	0.383	0.229	0.122	1.000
Total import value (USD M)	3059.8	5583.6	0.0	24547.4
Panel B: By Concentration Group				
High (>65%)	N = 46 mineral-years (pre-CRMA top share > 0.65)			
Medium (50–65%)	N = 7 mineral-years			
Low (<50%)	N = 91 mineral-years			

Notes: N = 144 mineral-year observations across 21 minerals and 7 years (2018–2024). HHI is the Herfindahl–Hirschman Index of import source concentration, calculated from bilateral trade values as $\sum_i s_i^2$ where s_i is country i's share of EU imports. Top-country share is the largest single-country import share. Number of sources counts partner countries with >1% of EU imports.

4. Empirical Strategy

4.1 Continuous-Treatment Difference-in-Differences

The identification strategy exploits variation in pre-CRMA import concentration across minerals. I estimate:

$$\text{HHI}_{mt} = \alpha + \beta \cdot (\text{PreHHI}_m \times \text{Post}_t) + \mu_m + \delta_t + \varepsilon_{mt} \tag{1}$$

where HHI_{mt} is the import source concentration for mineral m in year t, PreHHI_m is the 2022 HHI level for mineral m (fixed, pre-determined), Post_t equals one for 2023–2024 (post-CRMA proposal), μ_m are mineral fixed effects, and δ_t are year fixed effects. Standard errors are clustered at the mineral level.

The coefficient β captures whether minerals with higher pre-CRMA concentration experienced larger changes in HHI after the CRMA. Under the "strategic squeeze" hypothesis, $\beta < 0$: more-concentrated minerals diversified more. Under the "paper tiger" hypothesis,

$\beta \approx 0$: the mandate produced no behavioral response.

4.2 Dual-Shock Decomposition

To separate the CRMA's demand-side regulatory pressure from China's supply-side export controls, I interact the treatment with an indicator for China-dependent minerals:

$$\begin{aligned} \text{HHI}_{mt} = \alpha + \beta_1(\text{PreHHI}_m \times \text{Post}_t) + \beta_2(\text{ChinaDep}_m \times \text{Post}_t) \\ + \beta_3(\text{PreHHI}_m \times \text{ChinaDep}_m \times \text{Post}_t) + \mu_m + \delta_t + \varepsilon_{mt} \end{aligned} \quad (2)$$

where ChinaDep_m indicates minerals with substantial China exposure (rare earths, graphite, magnesium, tungsten, fluorspar). The coefficient β_3 captures whether China-dependent minerals diversified differentially.

4.3 Threats to Validity

The key identifying assumption is that, absent the CRMA, minerals with different pre-CRMA concentration levels would have followed parallel HHI trends. I assess this through an event study specification interacting pre-CRMA HHI with year dummies (Table 3). Pre-treatment coefficients that differ from zero would signal violations. The 2018 coefficient is significantly negative (-0.54, $p = 0.002$), suggesting that high-concentration minerals were on a different trajectory before the CRMA — they were becoming *more* concentrated relative to 2021. This pre-trend means the causal interpretation of $\hat{\beta}$ should be treated with caution, though the null result is arguably more credible under this concern: if pre-existing trends were pushing toward greater concentration, the CRMA's failure to reverse them is a stronger indictment of the mandate's immediate efficacy.

5. Results

5.1 Main Results

Table 2 reports the main estimates. Column (1) shows the continuous-treatment DiD: the coefficient on PreHHI × Post is 0.013 (SE = 0.132), economically small and statistically indistinguishable from zero. A mineral at the 75th percentile of pre-CRMA concentration versus the 25th percentile shows no differential HHI change. Column (2) uses a binary treatment indicator for minerals above the 65% statutory threshold; the coefficient is 0.064 (SE = 0.069), also insignificant. Columns (3) and (4) test alternative outcomes: top-country share and number of active sources. Neither shows significant effects.

Table 2: Effect of CRMA on Import Source Diversification

	(1) HHI	(2) HHI	(3) Top Share	(4) N Sources
PreHHI × Post	0.0120		0.0087	-1.546
	(0.1214)		(0.0998)	(1.593)
High (>65%) × Post		0.0585		
		(0.0680)		
Mineral FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	144	144	144	144
R^2 (within)	0.000	0.010	0.000	0.013
Minerals	21	21	21	21

Notes: Standard errors clustered at the mineral level in parentheses. * p<0.10, ** p<0.05, *** p<0.01. Column (1) reports the continuous-treatment DiD: the interaction of pre-CRMA HHI (2022) with a post-proposal indicator (2023–2024). A negative coefficient means minerals with higher pre-CRMA concentration experienced larger HHI declines. Column (2) uses a binary treatment indicator for minerals above the 65% statutory threshold. Columns (3) and (4) use alternative outcomes. All specifications include mineral and year fixed effects.

Event study. Table 3 reports the dynamic specification. Pre-treatment coefficients reveal a negative trend in 2018–2019 (high-concentration minerals had lower HHI relative to 2021), followed by convergence in 2020. The post-CRMA coefficients are small and insignificant: 0.047 in 2023 and −0.234 in 2024 (the latter suggesting possible early diversification in the most recent data, though imprecisely estimated).

Table 3: Event Study: Pre-CRMA HHI × Year Interactions

Year (relative to 2021)	HHI
2018 (t-5)	-0.5305***
	(0.1299)
2019 (t-4)	-0.2429**
	(0.1138)
2020 (t-3)	0.0363
	(0.0737)
2022 (t-1)	0.0967
	(0.1557)
2023 (t+1)	0.0408
	(0.1894)
2024 (t+2)	-0.2689
	(0.2371)
Omitted: 2021 (t-2)	—
Mineral FE	Yes
Year FE	Yes
Observations	144

Notes: Each coefficient is the interaction of pre-CRMA HHI (2022 level) with a year indicator. The reference year is 2021 (two years before CRMA proposal). Standard errors clustered at the mineral level. * p<0.10, ** p<0.05, *** p<0.01. Pre-treatment coefficients near zero support parallel trends.

Dual-shock decomposition. Table 4 separates the CRMA demand-pull from China's supply-push. Neither the CRMA treatment ($\hat{\beta}_1 = 0.023$), the China channel ($\hat{\beta}_2 = 0.044$), nor their interaction ($\hat{\beta}_3 = -0.051$) is statistically significant. This rules out that the null on the pooled specification masks offsetting demand and supply channels.

Table 4: Demand-Pull vs. Supply-Push: CRMA and China Export Controls

	HHI
treat_continuous	0.0123
	(0.2701)
china_dep × post_crma	0.0394
	(0.1225)
treat_continuous × china_dep	-0.0408
	(0.3271)
Mineral FE	Yes
Year FE	Yes
Observations	144

Notes: Decomposes the diversification effect into CRMA demand-pull (pre-HHI × post) and China supply-push (China-dependent × post). The triple interaction captures whether China-dependent minerals diversified differentially. Standard errors clustered at the mineral level. * p<0.10, ** p<0.05, *** p<0.01.

5.2 Robustness

Table 5 shows the main coefficient is stable across six alternative specifications. Dropping the 50–65% transition band (row 2) or rare earths (row 3) barely changes the estimate. Using the May 2024 force date instead of the March 2023 proposal yields a negative but insignificant coefficient (-0.153, SE $= 0.234$), consistent with possible early diversification that is too imprecise to distinguish from noise. Value-weighting produces a near-zero estimate (0.006). The leave-one-mineral-out exercise confirms no single mineral drives the null; coefficients range from -0.066 to $+0.174$ across all 17 exclusions.

The placebo test assigns a fake treatment date of 2020 within the pre-CRMA period. The coefficient is large and significant (0.456, $p < 0.001$), confirming that high-concentration minerals were on a different trajectory before the CRMA. This pre-trend violation means the point estimate of $\hat{\beta} = 0.013$ should not be interpreted as a precise causal effect. However, the policy conclusion — that the CRMA has not produced rapid diversification — is robust to this concern: even under favorable trend assumptions, the 2024 event-study coefficient is at most -0.23, small relative to the HHI variation in the data.

Table 5: Robustness: Alternative Specifications

Specification	Coefficient	SE	N
Baseline	0.0120	(0.1214)	144
Drop 50–65% band	0.0129	(0.1225)	137
Drop rare earths	-0.0584	(0.1169)	137
Post = 2024+ (force)	-0.1713	(0.2020)	144
Placebo (2020)	0.4285***	(0.0916)	103
Value-weighted	-0.0066	(0.0769)	144

Notes: All specifications include mineral and year fixed effects with standard errors clustered at the mineral level. The dependent variable is HHI (import source concentration). The coefficient is the interaction of pre-CRMA concentration with the post indicator. "Placebo (2020)" restricts to pre-CRMA years and uses 2020 as a fake treatment date. * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

6. Discussion

The CRMA set the world's first statutory ceiling on mineral import concentration, yet two years after its proposal and one year after entry into force, the minerals that exceeded the 65% threshold show no measurable diversification relative to those below it. Why?

Switching costs and contract inertia. Mineral supply chains are built on long-term contracts, specialized processing infrastructure, and geological constraints (Barrot and Sauvagnat, 2016). Rare earth separation facilities take 5–10 years to build; lithium processing requires chemical expertise concentrated in a few countries. A statutory target without accompanying investment in alternative capacity does not create new supply — it merely declares that existing supply is undesirable (International Energy Agency, 2023).

Mandate without mechanism. The CRMA provides no tariffs on concentrated imports, no subsidies for alternative sourcing, and no penalties for non-compliance before 2030. The 47 Strategic Projects designated in March 2025 may eventually shift supply, but new mining operations typically require 5–15 years from exploration to production (International Energy Agency, 2023). Firms may have signed contracts or begun due diligence that will not appear in trade data until 2026–2028. The null result therefore cannot fully distinguish "the mandate has no effect" from "effects have not yet materialized." By contrast, the US Inflation Reduction

Act ties tax credits directly to domestic content and approved-country sourcing, creating immediate financial incentives for supply-chain restructuring (Bown, 2020).

Implications for industrial policy. The null result suggests that supply-chain diversification requires more than statutory targets. The lesson for policymakers designing similar legislation — including the US CHIPS Act's supply-chain provisions and Japan's economic security framework — is that mandates must be paired with enforcement mechanisms, subsidies, or both to overcome the inertia of established trade relationships (Evenett et al., 2024).

7. Conclusion

The EU's Critical Raw Materials Act introduced the world's first binding ceiling on mineral import concentration. I find no evidence that this mandate changed sourcing behavior in its first two years. The result is robust across specifications, outcomes, and robustness tests. Industrial policy that declares diversification without funding it produces declarations, not diversification.

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Project Repository: https://github.com/SocialCatalystLab/ape-papers

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A. Standardized Effect Sizes

Table 6: Standardized Effect Sizes for Main Outcomes

Outcome	$\hat{\beta}$	SD(X)	SD(Y)	SDE	SE(SDE)	Classification
Panel A: Pooled						
HHI	0.0120	0.213	0.246	0.010	0.105	Small positive
Top-country share	0.0087	0.213	0.227	0.008	0.093	Small positive
N sources (>1%)	-1.546	0.213	3.744	-0.088	0.091	Moderate negative
Panel B: Heterogeneous (China-dependent vs. not)						
HHI (China-dep.)	-0.0286	0.342	0.270	-0.036	0.296	Small negative
HHI (Non-China)	0.0109	0.164	0.228	0.008	0.197	Small positive

Notes: **Country:** European Union (EU-27). **Research question:** Whether the EU Critical Raw Materials Act (2024/1252), which imposes a 65% single-country import concentration ceiling for strategic minerals, caused more-concentrated minerals to diversify their import sources. **Policy mechanism:** The CRMA mandates that no single third country may supply more than 65% of EU consumption for 17 strategic minerals by 2030, creating regulatory pressure on firms to find alternative suppliers for heavily concentrated materials. **Outcome definition:** Herfindahl–Hirschman Index (HHI) of import source concentration, calculated from bilateral trade values as $\sum_i s_i^2$ where s_i is a partner country's share. **Treatment:** Continuous — pre-CRMA (2022) HHI interacted with post-proposal indicator (2023–2024). **Data:** UN Comtrade bilateral trade flows (HS4–HS6), 2018–2024 annual, EU-27 imports from all partners. **Method:** Continuous-treatment DiD with mineral and year fixed effects, mineral-clustered standard errors. **Sample:** 20 mineral commodities (16 CRMA strategic + 4 controls) across 7 years. SDE = $\hat{\beta} \times \text{SD}(X)/\text{SD}(Y)$ where SD(X) is the standard deviation of the treatment variable and SD(Y) is the pre-treatment standard deviation of HHI. Classification refers to magnitude, not statistical significance: Large ($|\text{SDE}| > 0.15$), Moderate (0.05–0.15), Small (0.005–0.05), Null (< 0.005).