Derisking in the Time of Decoupling: U.S. Critical Supply Chains and Reliance on China

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The Balancing Act Between U.S. Trade-Policy and Industrial Goals

- U.S. wants to ensure access to Critical Minerals and Information Communication Technologies (ICT), Green, and Public-Health Products.
- Simultaneously, geopolitical tensions between the U.S. and China have risen.

E.O. 14017

- U.S. firms must rely on imports to source many of these goods.
  - In many cases, they rely on imports from China.
- Firms face barriers to entry when importing from new countries.
  - These may be industry specific.
  - Limit the ability of firms to enter new markets in response to shocks.

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What are the Sunk Costs of Sourcing Critical Sector Products?

1. Do these vary by sector? Country?
2. How do sunk costs limit the ability of U.S. importers to respond to unexpected (decoupling) shocks?
3. Are policies meant to incentivize importers to diversify (derisking) more effective when implemented prior to the realization of an unexpected shock?

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What are the Sunk Costs of Sourcing Critical Sector Products?

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3. Are policies meant to incentivize importers to diversify (derisking) more effective when implemented prior to the realization of an unexpected shock?

Decoupling: Any increase in bilateral trade costs between the U.S. and China.

Derisking: Policy meant to incentivize U.S. firms to add new source countries.

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This Paper

Use Confidential Census Data to Document new stylized facts about the Executive Order 14017 products.

China exports these products to more U.S. firms compared to other countries.

Build and quantify a firm-level model of endogenous U.S. sourcing.

- Generalize Antràs, Fort, and Tintelnot, 2017 to multiple sectors, including a new estimation approach, and nest a model of shipping mode choice as in Jaworski, Kitchens, and Nigai, 2023 and Allen and Arkolakis, 2014.
- Firms pay a sunk cost in first year of importing a critical sector from a new country as in Hoang, 2022.
- Use a revealed preference approach to bound sunk costs across critical sectors.

Estimate Counterfactuals of *Derisking* and *Decoupling*

Show that sunk costs can make *proactive* Derisking policies more effective than *reactive* ones.

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Critical Products Identified in Executive Order 14017

Aggregate Sector	Subsector	Aggregate Sector	Subsector
Energy	Carbon Capture	ICT	Audiovisual Equipment
	Electric Grid		Computer Equipment
	Fuel Cells		Other Electronic Components
	Hydropower		Semiconductors
	Large Capacity Batteries		Telecom/Network Equipment
	Neodymium Magnets	Critical Minerals	Primary
	Nuclear Power	and Materials	Processed
	Platinum Group Metals	Public Health	PPE and Durable Medical Equipment
	Solar		Pharmaceuticals & API
	Wind		Testing and Diagnostics

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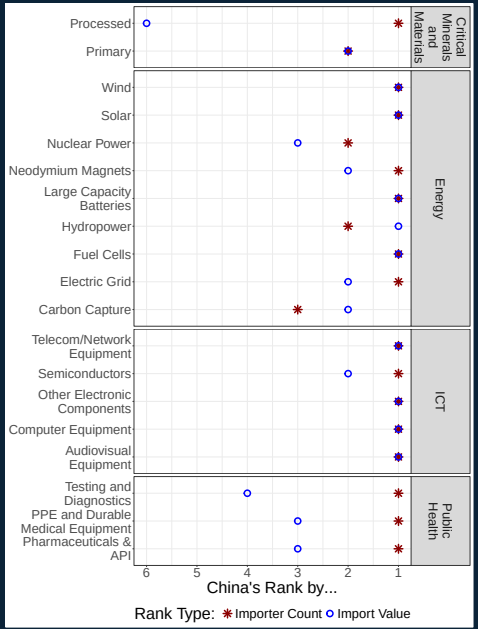
New Facts on U.S. Imports of Critical Products

1. Critical-sector importer carry a larger importer premium.
   - Large firms more likely to source from multiple countries.
2. Divergence in country rankings of number of U.S. importers and U.S. import Values.
   - Varies by critical subsector
   - Most subsectors have greater divergence compared to normal commodities.
3. Reliance on China is worse when using the number of U.S. importers rather than import values.



Fact 1 Fact 2 Fact 3

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Model Setup

- Final goods firm φ produces a unique variety in a monopolistically competitive market using domestic inputs and imports of critical sector goods s.
  - Love of variety with demand elasticity of substitution denoted by σ
- Intermediates are the only traded goods; perfectly competitive market.
- For each variety of a critical subsector s, a firm can outsource from a limited set of countries ($\mathcal{J}^s(\varphi)$), and purchases from the lowest priced country.
- Firms must pay a fixed cost ($f_{s,j}$) in every country j they source from.
- Additional sunk cost must be paid ($\psi_{s,j}$) if the firm did not source from the country in the previous year, $j \in \mathcal{J}_t^s(\varphi) \setminus \mathcal{J}_{t-1}^s(\varphi)$.

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Firm Import Share Equation

Share of firm-φ's imports of subsector-s goods from j:

$$x_j^s(\varphi) = \frac{T_j^s (w_j^s \tau_{j\varphi}^s)^{-\theta_s}}{\Phi^s(\varphi)} E(\varphi)^s$$

Define a country's *Sourcing Potential* as $T_j^s (w_j^s \tau_{j\varphi}^s)^{-\theta_s}$

- Informs how efficiently country-j supplies subsector-s on **per-unit basis**.
- Increasing in country's technology T_j^s
- Decreasing in import costs, τ_j^s, and production costs, w_j^s.

A firm's *Sourcing-Capacity* ($\Phi^s(\varphi)$) is the sum of the Sourcing Potential for the countries it sources from.

- $\Phi^s(\varphi) \equiv \sum_{j \in \mathcal{J}^S(\varphi)} T_j^s (w_j^s \tau_{j\varphi}^s)^{-\theta_s}$

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Change in Profits from Adding/Dropping a Supplier

- Sourcing from additional country increases variable profits if $(\sigma - 1) > \theta_s$.
- Sourcing Potential, relative to firm's current Sourcing Capacity determines how impactful the country is as a supplier.

$$r^s_{\varphi jt}(\mathcal{J}^s_t(\varphi)) = \begin{cases} r_t(\varphi)\left(\left[\frac{\Phi^s_t(\varphi) + T^s_{tj}(\tau_{t,\varphi j} w^s_{t,j})^{-\theta_s}}{\Phi^s_t(\varphi)}\right]^{(\sigma-1)/\theta_s} - 1\right) & \text{if } j \notin \mathcal{J}^s_t(\varphi) \\ r_t(\varphi)\left(1 - \left[\frac{\Phi^s_t(\varphi) - T^s_{tj}(\tau_{t,\varphi j} w^s_{t,j})^{-\theta_s}}{\Phi^s_t(\varphi)}\right]^{(\sigma-1)/\theta_s}\right) & \text{if } j \in \mathcal{J}^s_t(\varphi) \end{cases}$$

To decide if it should or drop a supplier country for a critical subsector, the firm weighs the above expression against the fixed and sunk-costs of importing (f^s_j and ψ^s_j, respectively).

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Data

Census Data

- *Economic Censuses*: Revenues, Employment, Total Expenditures, Industry
- *Longitudinal Business Database*: Revenues, Employment
- *Longitudinal Firm Trade Transactions Database*: Import values and cost of shipment

External Data

Use to create a cost shifter that varies by firm, country, subsector and year.

- Distance Data: Shortest maritime distance and great circle distance between U.S. and foreign ports.
- Quarterly prices of diesel and jet fuel.

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Estimation

Transport Costs Detail

- Estimated using firm specific shipping costs by shipping mode
- Result: Predicted shipping costs $\tau^s_{j\varphi}$ and mode-choice elasticity ρ_s

Sourcing Potential

- Estimated using firm-country trade costs, country-sector fixed effects, and firm-sector fixed effects.
- Result: Firm-country-sector sourcing potential and sector specific import elasticities θ_s

Fixed and Sunk Costs

- Estimated using sourcing potential, θ_s, and firm revenues
- Result: Sector fixed and sunk costs ranges

Sourcing Potential and Import Elasticities

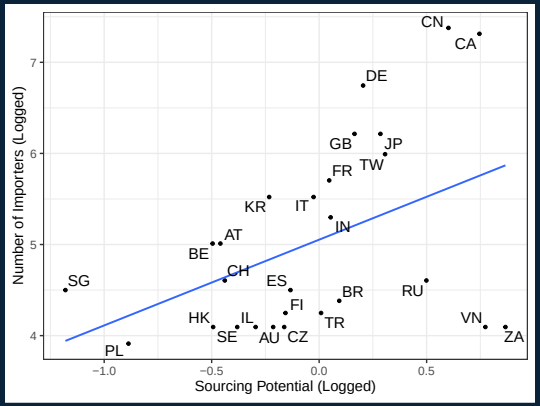
- Use estimated firm-country-subsector specific transport cost estimates as cost shifters.
- Take logs of import share equation and use as estimating equation.
- Normalize by domestic expenditures to control for any correlated domestic sourcing.

$$\widehat{\xi^s_{j\varphi t}} = -\theta_s log(\widehat{\tau^s_{\varphi jt}}) + \gamma^s_{jt} + \iota^s_{\varphi t} + \epsilon^s_{j\varphi t}$$

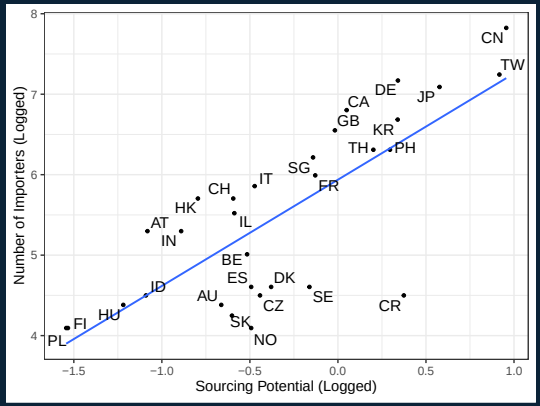
- $\widehat{\xi^s_{j\varphi t}}$: Import share normalized by domestic expenditures.
- $\widehat{\tau^s_{\varphi jt}}$: Estimated per-unit trade cost
- γ^s_{jt}: country-sector fixed effects
- $\iota^s_{\varphi t}$: firm-sector fixed effects

Estimates

Estimates: Sourcing Potential



Critical Minerals: Processed



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Moments to Bound Fixed and Sunk Costs

- **Deviation 1:** Imports in both t and t-1 (Fixed cost upper bound)

$$\Pi_{\varphi jt} = \sigma^{-1} r^s_{\varphi jt}(\mathcal{J}^s_{\varphi t}) - \gamma^f_{sj} - \epsilon^f_{\varphi jt} \geq 0$$

Revenue

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- **Deviation 2:** Imports in t but not t-1 (Fixed and sunk cost upper bound)

$$\Pi_{\varphi jt} = \sigma^{-1} r^s_{\varphi jt}(\mathcal{J}^s_{\varphi t}) - \gamma^f_{sj} - \gamma^S_{sj} - \epsilon^f_{\varphi jt} \geq 0$$

Revenue

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- **Deviation 3:** Imports in t-1 but not t (Fixed cost lower bound)
$$\Pi_{\varphi jt} = \sigma^{-1} r^s_{\varphi jt}(\mathcal{J}^s_{\varphi t}) + \gamma^f_{sj} + \epsilon^f_{\varphi jt} \geq 0$$

- **Deviation 4**: Does not import in t or t-1 (Fixed and sunk cost lower bound)
$$\Pi_{\varphi jt} = \sigma^{-1} r^s_{\varphi jt}(\mathcal{J}^s_{\varphi t}) + \gamma^f_{sj} + \gamma^S_{sj} + \epsilon^s_{\varphi jt} \geq 0$$

Revenue

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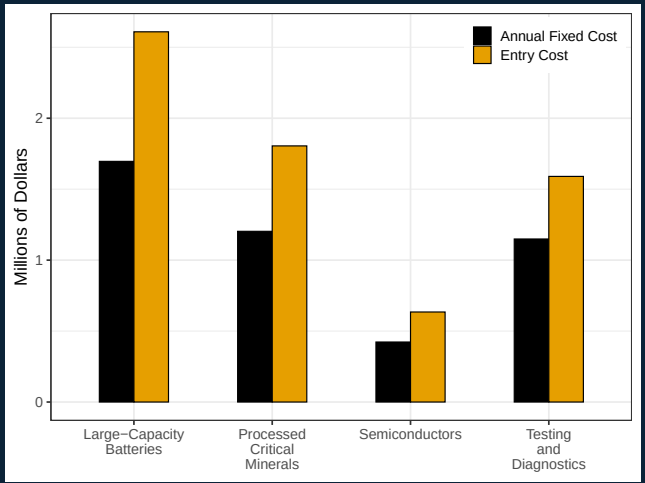
Estimates: Fixed and Sunk Cost

- Plots estimates of upper bounds.
- Different relationships between sunk and fixed costs across sectors.



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Two Counterfactual Scenarios of Supply Chain Disruption

Decoupling from China

1. Reduce China's sourcing potential by half
2. Enact preemptive Indo-Pacific Economic Framework (IPEF) with market-access provisions
   - Reduce China's sourcing potential with preemptive IPEF agreement in place

   Difference in impact is IPEF's effectiveness at reducing U.S. exposure to decoupling shocks.

Currently incomplete, don't allow for changes in firm sourcing strategies!

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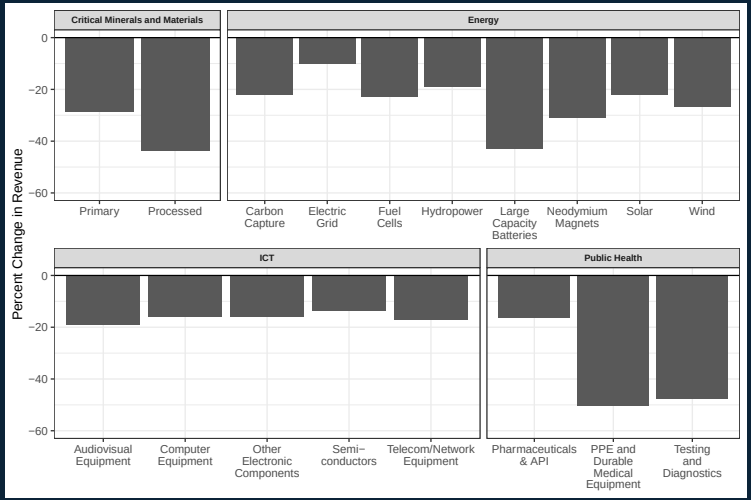
China Decoupling Counterfactual: Importer Revenues (No IPEF)

Preliminary: Different subsectors have varying levels of exposure to decoupling shocks.



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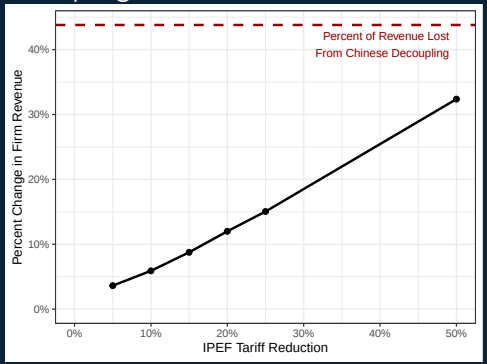
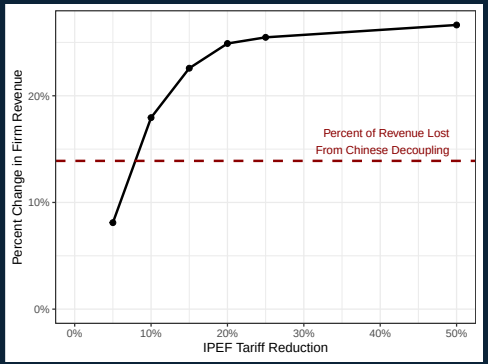
China Decoupling Counterfactual: Importer Revenues (With IPEF)

Size of market access in IPEF determines effectiveness of Derisking in insulating U.S. firms from Decoupling shock. In some industries IPEF could not offset losses from Decoupling.



Critical Minerals and Materials: Processed



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Thank you! Questions/Comments

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Fact 1: Critical-Sector Inputs Carry a Larger Importer Premium

- Estimate sales revenue importer premium for critical sector imports and all other imports.
- Importer premium is higher for critical sectors.
- Similar pattern for employment.

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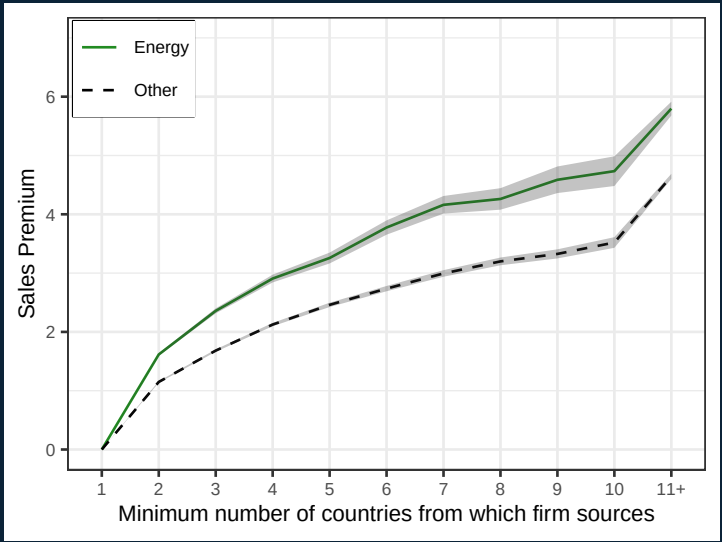

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Fact 2: High Divergence in Number of Importers and U.S. Import Values

- Compare country rankings of import values and the number of U.S. firms.
- *Divergence in the order of rankings suggests fixed-cost barriers to importing.*
- Use rank-based order (RBO) to compare the two ranking.s
  - Score equal to 1 indicates rankings are identical.
- Most critical sectors are less-similar relative to aggregate similarity.

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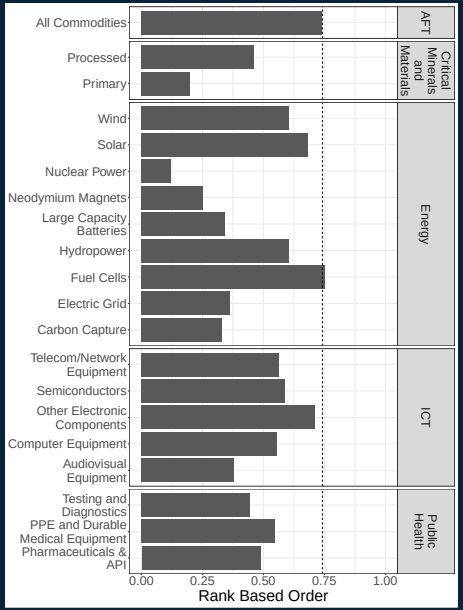

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Rank Based Order (RBO)

- Compare the similarities of two ranked lists.
- Higher weight on top ranks.
- RBO = 0 implies no similiarities, RBO = 1 implies perfect match
- We rank countries by:
  - The number of U.S. firms that import from the country (N_j).
  - The total value of those imports (V_j).
- Apply rank based order to these two lists

Definitions:

- The element at rank i in set S as S_i
- $S_{:d}$ as $\{S_i : 1 \leq i \leq d\}$

$$A_d = |N_{:d} \cap V_{:d}| \Big/ d$$

- Choose a weighting factor p (we chose $p = 0.95$)
- Rank based order is:

$$RBO(p) = (1-p) \cdot \sum_{d=1}^{|V_j|} p^{(d-1)} \cdot A_d$$

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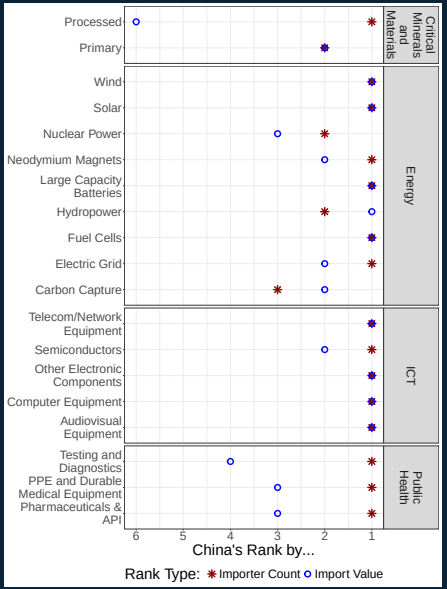

Fact 3: More U.S. Firms Import Critical Products from China than Other Countries

- Exposure to China is worse in critical sectors when considering the number of U.S. firms that import over import values.
- Suggests that U.S. firms have knowledge or experience in sourcing from China.
- ... or U.S. variable costs of importing from China may be low.

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Change in Profits from Adding/Dropping a Supplier

- Sourcing from a new country increases variable profits if $(\sigma - 1) > \theta_s$.
- Sourcing Potential, relative to firm's current Sourcing Capacity determines how impactful the country is as a supplier.

$$r^s_{\varphi jt}(\mathcal{J}^s_t(\varphi)) = \begin{cases} r_t(\varphi)\left(\left[\frac{\Phi^s_t(\varphi) + T^s_{tj}(\tau_{t,\varphi j} w^s_{t,j})^{-\theta_s}}{\Phi^s_t(\varphi)}\right]^{(\sigma-1)/\theta_s} - 1\right) & \text{if } j \notin \mathcal{J}^s_t(\varphi) \\ r_t(\varphi)\left(1 - \left[\frac{\Phi^s_t(\varphi) - T^s_{tj}(\tau_{t,\varphi j} w^s_{t,j})^{-\theta_s}}{\Phi^s_t(\varphi)}\right]^{(\sigma-1)/\theta_s}\right) & \text{if } j \in \mathcal{J}^s_t(\varphi) \end{cases}$$

To decide if it should or drop a supplier country for a critical subsector, the firm weighs the above expression against the fixed and sunk-costs of importing (f^s_j and ψ^s_j, respectively).

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Profits, Fixed and Sunk Costs

$$\Pi_t(\varphi) = \sigma^{-1} r_t(\varphi) - w_{US,t} \sum_S \sum_{j \in \mathcal{J}_t^s(\varphi)} f_j^s + \psi_j^s \cdot \mathbb{I}(j \in \mathcal{J}_t^s(\varphi) \setminus \mathcal{J}_{t-1}^s(\varphi))$$

- $\sigma^{-1} r_t(\varphi)$: variable profit (monopolistic competition)
- f: fixed costs
- ψ: sunk costs
- $w_{US,t}$: U.S. Wages (fixed costs paid using domestic labor)
- $\mathbb{I}(j \in \mathcal{J}_t^s(\varphi) \setminus \mathcal{J}_{t-1}^s(\varphi))$: indicates if firms pay sunk costs in year t

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Transportation Mode Choice

- Need variation in firm import costs that vary by supplier country and critical sector, use shipment cost from LFTTD .
- Nest a model of mode shipping choice similar to Allen and Arkolakis, 2022 and Jaworski, Kitchens, and Nigai, 2023.
- Functional form of trade costs: $\tau^s_{\varphi jt} = B^s_{\varphi t}\left(\sum_{m\in\mathbb{M}_j}\left(\tau^s_{mjt}\right)^{-\rho_s}\right)^{-1/\rho_s}$
- Estimate using:
  - Share of φ's imports, imported using mode-m is LHS variable
  - Average per-unit import cost by mode-country-sector is instrumented by quarterly fuel costs interacted with distance shipped.

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Estimates: Transportation Mode Choice Elasticities

- Mode-choice elasticities used to simulate mode-specific transportation shocks in counterfactuals.
- Use fixed effects with mode-choice elasticities to recover $\widehat{\tau^{s}_{\varphi jt}}$

	Mode-Choice Elasticity
Critical Minerals and Materials	-0.7914**
	(0.3447)
Energy	-2.618***
	(0.8547)
ICT	-3.077**
	(1.251)
Public Health	-2.841*
	(1.502)
Fixed Effects:	Firm-sector-year Country-sector-year
Bootstrap S.E. Clustered	Sector

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Elasticity Estimates and Sourcing Potential

	Import Elasticity (θ_s)
Critical Minerals	-1.839***
...and Materials	(0.0634)
Energy	-3.514**
	(1.446)
ICT	-6.048**
	(2.403)
Public Health	-2.569***
	(0.8028)
Fixed-Effects:	Country-Sector-Year Triplet
S.E.: Clustered	by: Country & Sector
R2	0.1129

Estimates of Demand Elasticity

- Establishment reported markups used to estimate demand elasticities σ under monopolistic competition assumption.
- Esitmate 28.5% average markup with a bootstrapped standard error of 0.0015.
- Implies $\sigma = 4.5$.

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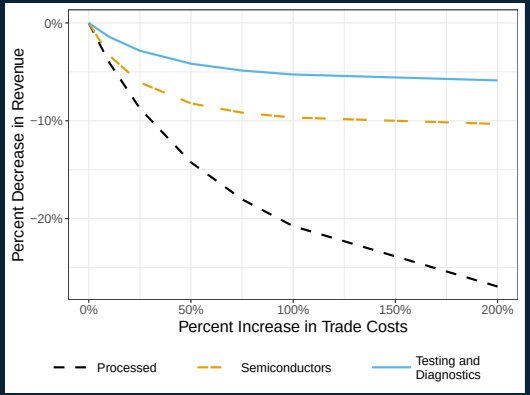
South China Sea Counterfactual: Importer Revenues



- Simulate an increase in maritime shipping costs for countries highly exposed to the South China Sea.
  - Utilize our mode-choice model.
- Future versions will utilize maritime network data and Dijkstra algorithm, and not restrict shock to select countries.

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