# Foreign Ships in U.S. Waters

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# Motivation

- The U.S. once dominated global shipbuilding and maintained a large U.S.-flagged fleet
- Today, U.S. trade relies heavily on **foreign-built** and **foreign-operated** ships
- Rising geopolitical risk has prompted scrutiny of *foreign investment in critical infrastructure* and policy proposals (e.g. Section 301 surcharges, differentiated **port call fees**) aimed at China-linked vessels
- Foreign supply can *raise efficiency* (scale) but may *weaken reliability* and create *national-security* exposure.

**This paper:**

How exposed is U.S. trade to foreign fleets, what are the welfare effects of port call fees, and what are the risks of foreign dependence in critical infrastructure?

# This Paper

- **Evidence**
  - **New data** that combine stock of global fleet, global port rotations and dis-aggregated US import records
  - **Document** the global distribution of ships across builder and operator countries
  - **Quantify U.S. exposure** in the import profile to foreign ships
- **Model:** Quantitative model of **global shipping**
  - QSM that features **dis-aggregate shipping equilibria** stemming from:
    - Endogenous **shipping supply** to the global market (i.e. shipbuilding) and to individual edges (i.e. operators)
    - Endogenous **shipping demand** (i.e. spatial equilibrium with endogenous routing)
  - Closed-form expressions for **incidence** of shipping fees
  - Risk in shipping and reliability of infrastructure (not today)
    Newbery & Stiglitz (1981,1984), Clayton, Maggiori & Schreger (2024)
- **Quantitative analysis**
  - **Today:** Incidence of proposed U.S. port call fees (Section 301)
  - **In progress:** Quantitative evaluation of efficiency-reliability trade-off and geoeconomic interactions on critical infrastructure

# What We Find

- **Exposure & concentration**
  - East Asia dominates shipbuilding; China's share is rising fastest.
  - U.S. imports rely on foreign *built* and *operated* fleets.
- **Scale & prices**
  - Larger vessels $\downarrow$ \$ /TEU (strong *size economies*).
  - At fixed size/class, China-built ships are generally cheaper.
- **Policy incidence**
  - *National EV:* About **\$3.43 bn** (**0.01%** of GDP) in **October 2025**, rising to **\$6.17 bn** (**0.02%**) by **April 2028**.
  - *Heterogeneity:* Biggest impacts on China-reliant lanes and goods.
  - *Adjustment:* Re-routing/substitution may soften, but don't remove, costs.

# Related Literature

- **Transport networks in spatial eqm**: *We embed foreign-owned transport supply into a spatial GE network and quantify GE incidence of targeted fleet shocks.*

  Allen & Arkolakis (2014, 2022), Fajgelbaum & Schaal (2017, 2020), Fan & Luo (2020), Fan, Lu & Luo (2021), Jaworski, Kitchens & Nigai (2023), Bonadio (2022), Cosar & Fajgelbaum (2016), Cosar & Demir (2016), Tsivanidis (2019, 2022), Kreindler & Miyauchi (2022), Miyauchi, Nakajima & Redding (2022), Almagro, Barbieri, Castillo, Hickok & Salz (2022), Fuchs & Wong (2025),

- **Shipping & maritime trade**: *We combine endogenous shipping supply and demand into dis-aggregated quantitative model of global trade*

  Kalouptsidi (2014), Brancaccio, Kalouptsidi & Papageorgiou (2020), Kalouptsidi, Jia Barwick & Zahur (2023,2024), Heiland, Moxnes, Ulltveit-Moe & Zi (2023), Ganapati, Wong & Ziv (2022), Wong (2022), Brooks, Gendron-Carrier & Rua (2018), Ducruet, Notteboom & Rodrigue (2020), Notteboom & Rodrigue (2008, 2011), Cristea, Hummels, Puzzello & Avetisyan (2013), Shapiro (2016), Lugovskyy, Skiba & Terner (2022), Feyrer (2009, 2011), Hummels & Schaur (2013), Cosar & Demir (2016), Dunn & Leibovici (2025)

- **Geoeconomics**: *We operationalize geoeconomic dependence on foreign-controlled transport in a calibrated GE model and evaluate resilience–efficiency policy trade-offs.*

  Farrell & Newman (2019, 2024), Blackwill & Harris (2016), Baldwin (2022), Rodrik (2024), Rodrik & Sabel (2020), Antràs (2020, 2022), Bonadio, Huo, Levchenko & Pandalai-Nayar (2021), Freund, Maliszewska & Mattoo (2021), Grossman, Helpman & Lhuillier (2023), Adamopoulous & Leibovici (2025), Gawande, Krishna & Olarreaga (2009), Levy (1997), Maggi & Rodríguez-Clare (2007)

# Evidence

# Global Distribution of Ships

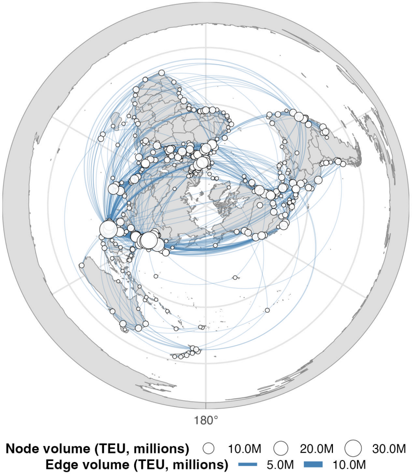
- **Questions**

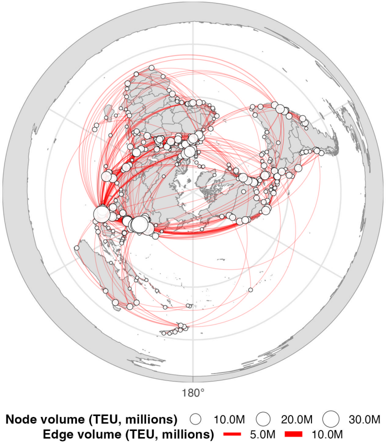
  1. What is the distribution of the **global containership fleet** across builder countries?
  2. What is the exposure of the **U.S. import profile** to foreign fleets?

- **Data**

  - **Clarksons SIN**: vessel-level registry of all active containerships (2025 cross-section) Data Construction
    - Variables: ship size, age (vintage), **builder country**, and full **port rotation**.
  - We use each vessel's port rotation to identify the countries it regularly serves.
    Each ship thus contributes exposure to all countries on its route.
  - For every country, compute share of total ship capacity (*TEUs*) **built** in each country.

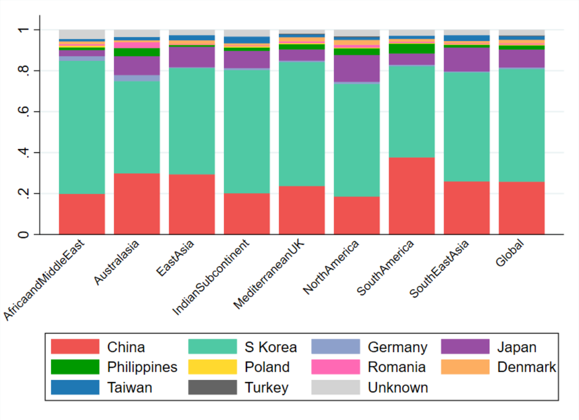
# Global Distribution of Shipbuilding Countries: by Trade Lanes



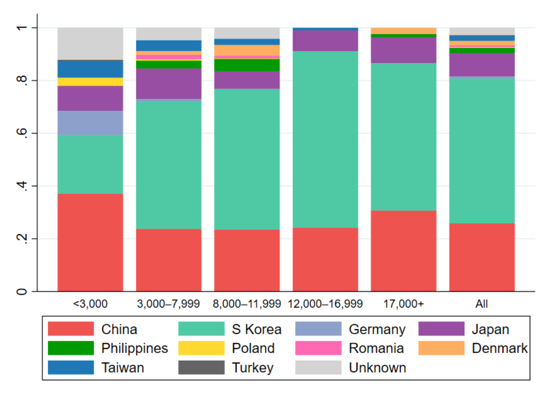

- Chinese shipping present across all major shipping lanes Shares
- Particularly prevalent in the most crucial lanes (Asia-Europe, Asia-North America) and most significant entrepots

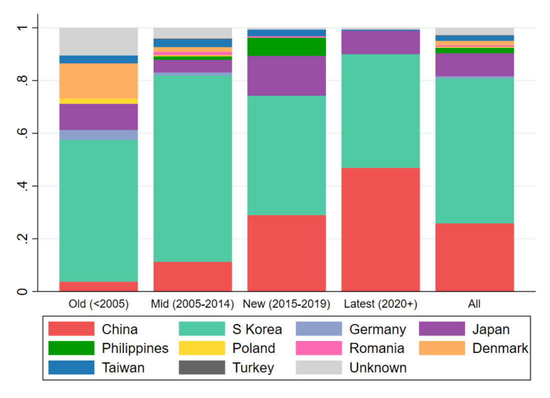
# Global Distribution of Shipbuilding Countries




- South Korea (55%) and China (26%) account for more than 80% of the global containership fleet Levels
- Shipbuilding is highly concentrated in these two countries, with only a small share built elsewhere

# Global Shipbuilding: by Size and by Age




- China+Korea build >80% of large containerships.
- For smaller vessels their share falls to ∼60%; production is more dispersed. Levels

- Since 2020, China+Korea built ∼90% of new ships (China ∼47%, Korea ∼43%).
- China built $< 4\%$ of older vessels—its rise is recent and abrupt. Levels

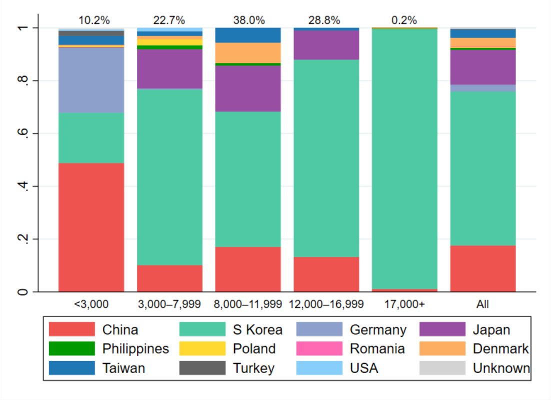
# Taking Stock

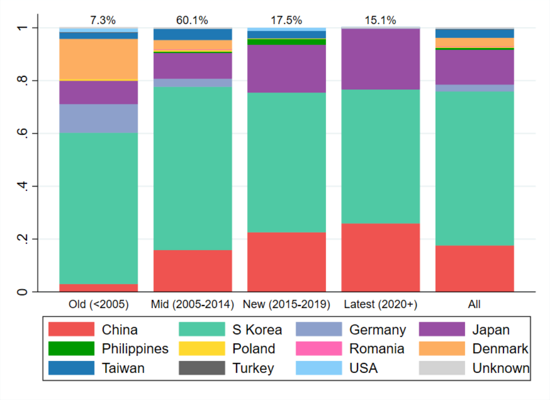
**Stylized Fact 1: High concentration of the global fleet**
*More than 80% of the global containership fleet is built in China and South Korea, with their dominance strongest for large and new ships, while smaller vessels remain more dispersed across other builder countries.*

**Then, we ask:** How does U.S. dependence look against this global backdrop?

- Merge U.S. import shipments (Panjiva) with vessel registry data (Clarkson SIN)
  - Shipment-level record (Panjiva) matched on names/IMO against vessel registry (Clarkson SIN) Data construction
  - First dataset linking *global ship ownership/source to U.S. import activity*
- Compute TEU-weighted exposure of U.S. imports by builder country and operator nationality
- Characterize patterns of reliance across ship types and sources to assess the extent of foreign dependence

# U.S. Imports: by Size and Age




- U.S. imports mostly ride East Asian–built fleets (Korea, China, Japan).
- China builds ∼35% of feeders but ∼15% of ultra-large vessels; Korea/Japan dominate largest sizes. Levels Operators

- Older vessels show little Chinese presence; Korea/Japan dominate.
- Nearly half of newest (2020+) ships serving U.S. trade are China-built.

# Taking Stock: U.S. Reliance on Foreign Ships

**Stylized Fact 2:**
*U.S. imports are overwhelmingly carried on foreign-built ships, with East Asian yards (South Korea, China, Japan) dominating across both size and vintage. China has rapidly gained ground in smaller and newer vessels, while Korea and Japan remain central in larger and mid-aged ships.*

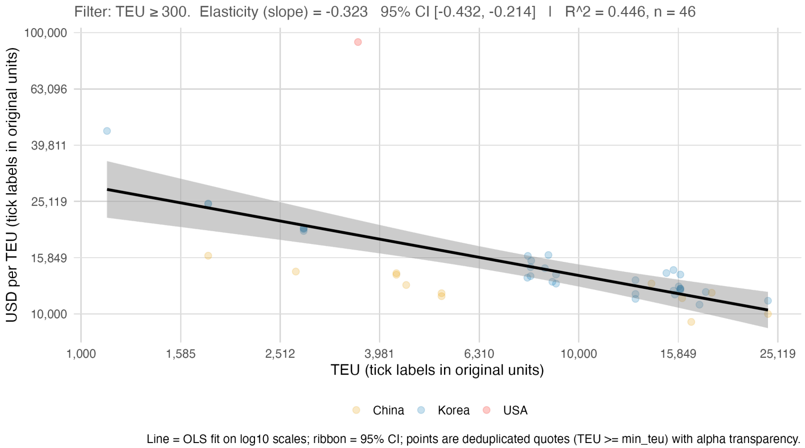
**So far:** The evidence highlights *exposure*—a concentrated dependence on a small set of shipbuilding countries.

**Risk–return tradeoff?**

- Concentrated exposure raises vulnerability to disruptions
- At the same time, it can deliver benefits through **scale and efficiency**
- Understanding both sides is key to assessing U.S. dependence

# Potential Benefits of Concentration

**Let's take a look at prices per TEU in the current containership orderbook:**




- Ship prices per TEU decline with size, showing high efficiency in both China and Korea. Country Evidence

  Kalouptsidi (2018), Barwick, Kalouptsidi & Zahur (2025)

- Chinese ships are generally cheaper.

# Taking Stock: Risk-Return Tradeoff

**Stylized Fact 3: Concentration can yield scale and efficiency gains**

*Both China and South Korea build highly efficient ships, with prices per TEU falling sharply with vessel size. Chinese-built ships are generally cheaper.*

**This raises a broader question:**

What are the costs of concentrated exposure to foreign-built ships, and what are the potential gains it brings?

**To answer this, we develop a model of shipping supply, exposure, and trade risk. . .**

# Model

# Model Overview

**Spatial equilibrium ⇒ endogenous transport demand**

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**Shipping model ⇒ supply of edge services**

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routing, factor alloc.

capacity, rentals

**Shipping equilibrium at the edge**

$$\Xi_e^D(p^e) \;=\; \Xi_e^S(p^e)$$

# Model Overview

**Spatial equilibrium ⇒ endogenous transport demand**

- CES trade across locations; within-country mobility equalizes welfare.

# Model: Setup

- **Network & countries.**
  - Directed transport graph $G = (\mathcal{N}, \mathcal{E})$ with nodes $i$ (locations) and edges $e = (i \to j)$ (links).
  - Nodes partitioned into countries $\{\mathcal{N}_m\}_{m=1}^M$.
    - Labor is mobile within $m$, immobile across countries; $\sum_{i \in \mathcal{N}_m} L_i = \bar{L}_m$.
- There is a state of the world $\Omega$

- **Preferences & mobility.**
  - At node $j$, households consume CES bundles:

$$C_j = \Big( \sum_{i \in \mathcal{N}} \phi_{ij}^{1/\sigma} q_i^{(\sigma-1)/\sigma} \Big)^{\sigma/(\sigma-1)}, \quad \sigma > 1.$$

  - Local amenity $u_j = \bar{u}_j L_j^{\beta_{m(j)}}$; free mobility equalizes welfare within each country.

- **Technology.**
  - Each node $i$ produces a unique variety with local labor: $Y_i = A_i L_i$
  - Productivity with scale effects:

$$A_i = \bar{A}_i L_i^{\alpha_{m(i)}} \quad \text{(agglomeration } \alpha > 0\text{, congestion } \alpha < 0\text{).}$$

  - Trade subject to iceberg transport cost $\tau_{ij}$

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**Spatial equilibrium $\Rightarrow$ endogenous transport demand**

- CES trade across locations; within-country mobility equalizes welfare.
- Recursive routing maps link costs into path costs and yields O–D flows $X_{ij}$ and edge usage $\Xi_e$.

# Model: Shipping Routing

- Goods must be delivered from origin $i$ to destination $j$ along a route (sequence of edges) on the network.
- Importers face idiosyncratic route shocks.
- **Effective iceberg cost** from $i$ to $j$ in state $\Omega$ Recursive Routing

  (Fuchs & Wong, 2025)

$$\tau_{ij}(\Omega)^{1-\sigma} = \mathbf{1}\{i=j\} + \sum_{k\in N(i)} \kappa_{ik}(\Omega)^{1-\sigma}\,\tau_{kj}(\Omega)^{1-\sigma}.$$

- **Routing share** of edge $(k\to\ell)$ for shipment $i\to j$:

  (Allen & Arkolakis, 2022)

$$\theta_{(k\to\ell)}(i\to j;\Omega) = \frac{\tau_{ik}(\Omega)^{1-\sigma}\,\kappa_{k\ell}(\Omega)^{1-\sigma}\,\tau_{\ell j}(\Omega)^{1-\sigma}}{\tau_{ij}(\Omega)^{1-\sigma}}.$$

- **Total transport demand at edge level (country $m$).**

$$\Xi_{(k\to\ell)}(m;\Omega) \;=\; \sum_{j\in\mathcal{N}_m}\sum_{i\in\mathcal{N}} X_{ij}(\Omega)\,\theta_{(k\to\ell)}(i\to j;\Omega),$$

  *the value of $m$'s shipments that use edge* $(k\to\ell)$. This aggregates bilateral flows and probabilistic routing into a single edge-level demand object that feeds congestion and pricing.

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**Shipping model $\Rightarrow$ supply of edge services**

- Fleets invest capacity $f_n$ and rent it at $\rho_n$.

.

# Model: Risk and Fleet Producers

- **Fleet producers and investment**
  - Each producing country $m(n)$ chooses fleet capacity $f_n$ *before* shocks realize.
  - Investing is costly:
$$\tfrac{1}{2}\mu_n f_n^2.$$
  - Ex-post, available capacity is rented at rate $\rho_n(\Omega)$.
  - Producers maximize expected utility–weighted profits:
$$\max_{f_n \geq 0} \mathbb{E}_\Omega\Big[\Lambda_{m(n)}(\Omega)\Big(\rho_n(\Omega) f_n - \tfrac{1}{2}\mu_n f_n^2\Big)\Big].$$
  - Risk affects investment through expected rentals and their correlation with the owner's marginal utility.

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- **Shipping risk in the global fleet** Detail
  - Each fleet $n$ (owned by different countries) may be unavailable on some routes due to geopolitical shocks or sanctions.
$$\Omega_{e,n} \in \{0,1\}, \qquad \Pr(\Omega_{e,n} = 0) = p_n^{\text{war}}.$$
  - $\Omega_{e,n} = 0$: fleet $n$ cannot operate on edge $e$; $\Omega_{e,n} = 1$: available as normal.
  - These shocks capture the risk that foreign fleets are disrupted.

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- Fleets invest capacity $f_n$ and rent it at $\rho_n$.
- Operators assemble services $S_e$ with congestion. .

# Model: Operators and Shipping Costs

- **Operators and service aggregation** Detail
  - On each trade link $e = (i \to j)$, **operators** rent capacity $s_{e,n}$ from available fleets $n$.
  - They combine these fleets into a composite shipping service via CES aggregation:

$$S_e(\Omega) = \Big( \sum_{n \in \mathcal{F}} \Omega_{e,n}\, \omega_{e,n}^{1/\eta}\, s_{e,n}^{(\eta-1)/\eta} \Big)^{\eta/(\eta-1)}.$$

  - Greater $S_e$ raises congestion costs on that edge:

$$\Psi_e(S_e) = \tfrac{\zeta_e}{1+\delta_e}\, S_e^{1+\delta_e}.$$

  - The resulting **operator price** for shipping one unit on edge $e$ is:

$$p_e(\Omega) = \Big( \sum_n \Omega_{e,n}\, \omega_{e,n}\, \rho_n^{1-\eta} \Big)^{\frac{1}{1-\eta}} + \zeta_e S_e(\Omega)^{\delta_e}.$$

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- **From shipping prices to trade costs**
  - Effective iceberg cost on edge $e$:

$$\kappa_e(\Omega) = \bar{\kappa}_e \left[ 1 + \frac{p_e(\Omega)}{v_e} \right],$$

    where $p_e/v_e$ is the ad-valorem shipping cost.
  - Higher fleet rentals or congestion $\to$ higher $p_e$ $\to$ higher trade costs.
  - *Interpretation:* Operators translate fleet prices and congestion into the effective iceberg costs that govern trade flows.

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- Operators assemble services $S_e$ with congestion.
- Edge user price $p_e$ (fleet mix + congestion); generalized cost $\kappa_e = \bar{\kappa}_e \left(1 + \frac{p_e}{v_e}\right)$.

routing, factor alloc.

capacity, rentals

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path risk

availability $\Omega$

**Shipping equilibrium at the edge**

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**Risk (two layers)**

- *Aggregate risk (today):* availability shocks $\Omega_{e,n}$ change which fleets enter $p_e \Rightarrow$ shifts $\kappa_e$ and routing.
- *Dis-aggregate / path risk (work in progress):* path-level uncertainty raises effective edge costs and reweights routing shares. Risky Routing

# Model: Competitive Equilibrium

A competitive equilibrium of the world economy (in state $\Omega$) consists of:

- Wages, prices, and allocations such that:
  - Households choose expenditures and location $\Rightarrow$ CES demand + mobility equalization
  - Firms hire labor and produce $\Rightarrow$ $Y_i(\Omega) = A_i L_i(\Omega)$
  - Edge operators assemble services $\Rightarrow$ $S_e(\Omega)$ from available fleets, zero profit
  - Fleet producers choose $f_n$ ex-ante; ex-post they rent out services at $\rho_n(\Omega)$ Fleet Producers Fleet: Risk
- Markets clear in each state $\Omega$: Solution Algorithm Recursive Eq

$$Y_i(\Omega) = \sum_j q_{ij}(\Omega) \qquad \text{(goods)}$$

$$S_e(\Omega) = \sum_{i,j} q_{ij}(\Omega)\, \theta_e(i \to j; \Omega) \qquad \text{(edge services)}$$

$$\sum_e s_{e,n}(\Omega) = f_n \qquad \text{(fleet capacity)}$$

$$\sum_{i \in \mathcal{N}_m} L_i(\Omega) = \bar{L}_m \qquad \text{(labor)}$$

# Comparative Statics: Supplier Loss / Fee

- **Shock / policy.** Details
  - *Removal (availability):* $\Omega_{e,n_0} \downarrow \Rightarrow a_{e,n_0} \to 0$ on affected edges.
  - *Fee / surcharge:* $\rho_{n_0} \uparrow (1+\tau)$ raises user prices where $a_{e,n_0}$ is material.

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- Effects
  1. **Shipping equilibrium (edge).**
     - Investments adjust $f_n$
     - Operators recombine fleets; congestion may amplify local increases.
     - *Edge pass-through (pre-congestion):*

$$\frac{\partial \ln \kappa_e}{\partial \ln \rho_{n_0}} = a_{e,n_0} \frac{p_e}{p_e + v_e} \quad \Rightarrow \quad \Delta \ln \kappa_e \simeq a_{e,n_0} \frac{p_e}{p_e + v_e} \tau.$$

  2. **Routing equilibrium (paths).**
     - Flows re-route until generalized route costs re-equalize.
     - Pressure is greatest where $\Xi_e(m)\, a_{e,n_0}$ is large; substitutes pick up traffic until hitting frictions/capacity.
  3. **Spatial equilibrium (locations/sectors).**
     - Delivered prices and shares shift; activity tilts toward nodes with cheaper access.
     - Mobility cushions local shocks but cannot fully offset bottlenecks/longer routes.

# Evaluating U.S. Shipping Fees on Chinese Ships

The Guardian
Int

# US forges ahead with plans for steep port fees on China-built vessels

**New rules part of effort to revive US shipbuilding, but penalties scaled back after warnings about impact on consumers**

Joanna Partridge *and agencies*

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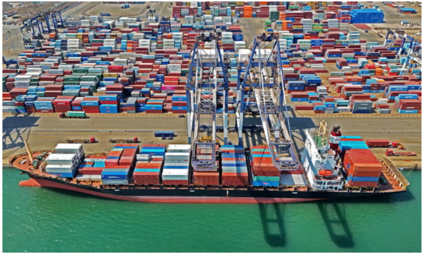

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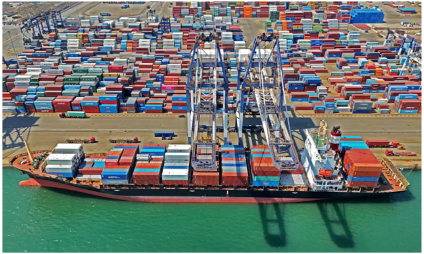

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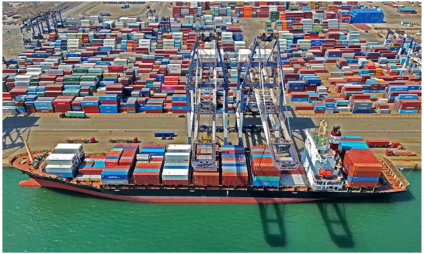

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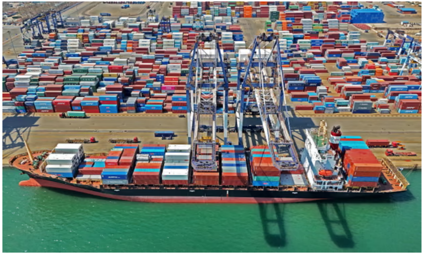

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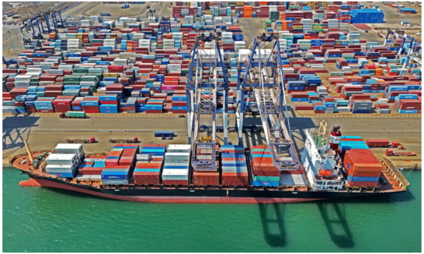

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Financial Times

China slaps sanctions on Korean shipbuilder accused of helping US

2 days ago

# U.S. Shipping Fees on Chinese Ships

- Two fees imposed via Section 301, effective October 14, 2025:
  - A fee on Chinese-operated ships, set at \$50 per net ton per U.S. port rotation (up to five times per year).
  - A fee on Chinese-built ships, applied per net ton or per container (whichever higher), starting at \$18 per NT in 2025 and rising to \$33 by 2028.

- Both fees apply independently when a vessel is Chinese-built and Chinese-operated. Rates

# U.S. Shipping Fees on Chinese Ships

- Two fees imposed via Section 301, effective October 14, 2025:
  - A fee on Chinese-operated ships, set at $50 per net ton per U.S. port rotation (up to five times per year).
  - A fee on Chinese-built ships, applied per net ton or per container (whichever higher), starting at $18 per NT in 2025 and rising to $33 by 2028.

- Both fees apply independently when a vessel is Chinese-built and Chinese-operated. Rates

- In the model, we interpret these measures as per-container taxes on shipping services from affected fleets:
  - Each fee raises the effective user price $\rho_n$ for the relevant fleets.
  - This increase maps into higher effective shipping costs $\kappa_e$ on routes served by those fleets.
  - The implied ad-valorem equivalents are:
    - about 48 percent for Chinese-operated ships, and
    - between 17 and 32 percent for Chinese-built ships over the phase-in period.

# Incidence Roadmap: Efficiency vs. Resilience

**Goal.** Decompose welfare effects of U.S. fees on China-linked fleets into first- and second-moment components.

Newbery & Stiglitz (1981,1984)

- **Small-change decomposition.**

$$\Delta \ln W \;\approx\; \underbrace{-\sum_{\ell} w_\ell\, \Delta\mu_\ell}_{\text{(F) First moment: efficiency loss}} \;+\; \underbrace{\frac{\Gamma}{2}\sum_{\ell} w_\ell\, \Delta\sigma_\ell^2}_{\text{(R) Second moment: resilience gain}} ,$$

$$\mu_\ell = \mathbb{E}[\ln C_\ell], \qquad \sigma_\ell^2 = \mathrm{Var}(\ln C_\ell),$$

  where $C_\ell$ is the delivered cost on lane/market $\ell$ and $w_\ell$ is an exposure weight.

  - Surcharges $\Rightarrow \Delta\mu_\ell > 0$ on affected services $\Rightarrow$ *first-order* losses (F).
  - Diversification/reliability $\Rightarrow \Delta\sigma_\ell^2 < 0 \Rightarrow$ *second-order* gains (R).

- **Way ahead.**
  1. **Today:** quantify (F);
  2. **Future:** quantify (R) with aggregate and dis-aggregate risk.

# Welfare Elasticities of Shipping Fees: Spatial $\times$ Shipping

- **Chain rule.**

$$\frac{d\ln W}{d\ln T_{e,m}} = \sum_{e'} \underbrace{\frac{d\ln W}{d\ln \kappa_{e'}}}_{\text{Spatial response}} \cdot \underbrace{\frac{d\ln \kappa_{e'}}{d\ln T_{e,m}}}_{\text{Shipping response}},$$

where $T_{e,m}$ scales the cost of services on edge $e$ provided by $m$ (China-linked), and $\kappa_{e'}$ are route costs.

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- **Spatial response.**

Allen, Fuchs & Wong (2025)

$$-\frac{d\ln W}{d\ln \kappa_e} = \rho\, \Xi_e \left(M^{\text{in}}_{o(e)} + M^{\text{out}}_{d(e)}\right), \quad \rho = \frac{1+\alpha+\beta}{1+\beta(\sigma-1)+\alpha\sigma}.$$

  - $\Xi_e$: baseline usage (routing weight); $M^{\text{in}/\text{out}}$: node multipliers; $\rho$: model scaling.

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- **Shipping response.**

$$\frac{d\ln \kappa_{e'}}{d\ln T_{e,m}} = \underbrace{\mathbf{1}\{e'=e\}\,\chi_{e,m}}_{\text{direct}} + \underbrace{\psi_{e'}\sum_n a_{e',n}\,\phi_{n;\,e,m}}_{\text{fleet rents}} + \underbrace{(1-\psi_{e'})\,\delta_{e'}\,g_{e'e}\,\chi_{e,m}}_{\text{routing + congestion}}.$$

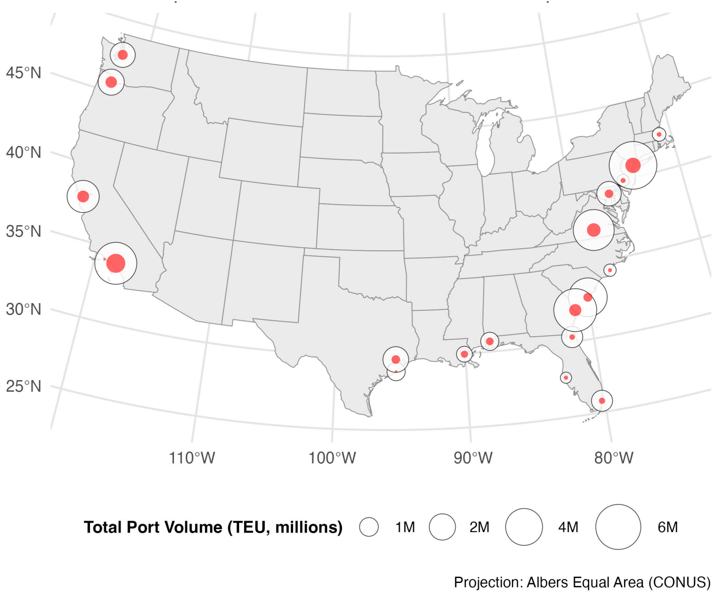
  - Direct pass-through $\chi_{e,m}$ scaled by exposure and price share; ripples via rental markets and detours.

# Incidence Calculation

- **Special case.** No spatial externalities ($\alpha = \beta = 0$) and no congestion ($\delta = 0$):

$$\frac{d \ln W_m}{d \ln T_{e,\mathrm{CHN}}} = \underbrace{\Xi_e \, s_{e|\mathrm{CHN}}}_{\text{direct exposure}} + \underbrace{\sum_{e'} \Xi_{e'} \, \psi_{e'} \sum_n a_{e',n} \, \phi_{n;e,\mathrm{CHN}}}_{\text{fleet-rental spillovers}} .$$

# U.S. Import Dependence



# From Model to Data: Lane-Level Equivalent Variation

**Goal:** Implement welfare effects using *lane-level* exposure and *ship-size–specific* ad valorem rates.

- **Unit of analysis:** directed lane $e = (o \to d)$ and size bin $b \in \{< 3\text{k}, 3\text{k–}8\text{k}, 8\text{k–}12\text{k}, 12\text{k–}17\text{k}\}$.
- **Lane effective tariff (period $t$):**

$$\tau^{\text{eff}}_{e,t} = \sum_b \underbrace{\tau_{b,t}}_{\text{ad valorem by size}} \cdot \underbrace{s_{\text{CHN}}(e,b)}_{\text{Chinese-built TEU share on }(e,b)} \cdot \underbrace{s^{\text{imp}}_{\text{ship}}}_{\text{shipping share in import price}} .$$

- **Aggregate incidence (EV as share of GDP):**

$$\frac{\Delta \text{EV}_t}{Y} \approx -\kappa \sum_e \underbrace{w_e}_{\text{lane TEU weight}} \tau^{\text{eff}}_{e,t}, \qquad w_e = \frac{\text{TEU}_e}{\sum_{e'} \text{TEU}_{e'}}.$$

- **Inputs from data:**
  - $\tau_{b,t}$: size-specific ad valorem rates (Oct 2025, Apr 2026/27/28). Calculation Rates
  - $s_{\text{CHN}}(e,b)$: Chinese-built share by lane and size (from builder country & TEU).
  - $s^{\text{imp}}_{\text{ship}}$: shipping-cost share in import prices (e.g., $\approx 5\%$).
  - $w_e$: lane volume weights from observed TEU.
- **Interpretation:** compute *policy* $\times$ *exposure* $\times$ *pass-through* at the lane$\times$size level, then volume-weight to obtain national EV (with welfare mapping $\kappa$, e.g. $\kappa = 0.25$).

# Estimated Welfare Effects of U.S. Fees on Chinese Ships

**Equivalent variation implied by the phase-in of Section 301 shipping fees:**

| Date | Ad-valorem fee (%) | EV ($ bn) | EV / GDP (%) | Effective tariff (%) |
|---|---|---|---|---|
| October 2025 | 0.20 | $3.43 | 0.01% | 0.05% |
| April 2026 | 0.25 | $4.44 | 0.02% | 0.06% |
| April 2027 | 0.30 | $5.31 | 0.02% | 0.07% |
| April 2028 | 0.35 | $6.17 | 0.02% | 0.08% |

- **Gradual escalation:** Incidence rise from $3.43 bn at 0.20 to $6.17 bn at 0.35.
- **Aggregate scale:** EV/GDP increases from 0.01% (Oct 2025) to 0.02% (Apr 2028).

# Concluding Remarks

# Concluding Remarks & Next Steps

- **So far — findings & contributions**
  - **Concentrated dependence.** East Asia dominates shipbuilding; China's share is rising, and U.S. imports rely on foreign-built fleets.
  - **Efficiency vs. exposure.** Larger ships lower $ / TEU and China-built vessels are cheaper, but dependence raises policy/geopolitical exposure.
  - **Incidence quantification.** EV using *size-specific* ad valorem schedules: Incidence rise from $3.43 bn at 0.20 in 2025 to $6.17 bn at 0.35 in 2028

- **Next steps**
  1. **Full *hat-algebra* general equilibrium**
     - Capture global reallocation of trade and shipping flows.
     - Calibrate with worldwide lane-level data on Chinese fleets and volumes.
     - Run counterfactuals: shipping equilibrium changes, incidence by country/sector, welfare.
  2. **Risky routing & geoeconomic strategy**
     - Introduce spatially heterogeneous risk in routing; quantify resilience margins.
     - Model taxes/subsidies as non-cooperative instruments on shared infrastructure; assess strategic substitution/complementarity across lanes.

# Appendix

# Model: Shipping Environment & Timing back

- **Network trade.** Goods move over directed edges $e = (i \to j)$ (e.g., Shanghai→Los Angeles).
- **Actors.**
  - *Operators* assemble shipping services on edges by renting capacity from multiple *fleet producers*.
  - *Fleet producers* (owned in different countries) invest in capacity ex-ante and rent it ex-post.
- **State $\Omega$.** At start of each period, availability shocks realize:

$$\Omega_{e,n} \in \{0, 1\}, \qquad \Pr(\Omega_{e,n} = 0) = p_n^{\text{war}}.$$

  - $\Omega_{e,n} = 1$: producer $n$'s fleet can operate on edge $e$.
  - $\Omega_{e,n} = 0$: fleet $n$ cannot serve $e$ (war/sanctions/embargo).
- **Timing.**
  - *Ex-ante:* producers choose investment $f_n$.
  - *Ex-post:* $\Omega$ realizes; operators, firms, households choose; routing adapts to realized costs.
- **Congestion.** Using an edge raises operating costs as flow increases.

# Model: Operators, Services, and Shipping Costs back

- **Service aggregation (edge $e$).** Operators rent capacity $s_{e,n}$ and combine available fleets via CES:

$$S_e(\Omega) = \left( \sum_{n \in \mathcal{F}} \Omega_{e,n}\, \omega_{e,n}^{1/\eta}\, s_{e,n}^{(\eta-1)/\eta} \right)^{\eta/(\eta-1)}.$$

- **Congestion cost (edge $e$).**

$$\Psi_e(S_e) = \frac{\zeta_e}{1+\delta_e}\, S_e^{1+\delta_e}.$$

- **Operator price index (per unit shipped on $e$).**

$$p_e(\Omega) = \left( \sum_{n} \Omega_{e,n}\, \omega_{e,n}\, \rho_n^{1-\eta} \right)^{\frac{1}{1-\eta}} + \zeta_e\, S_e(\Omega)^{\delta_e}.$$

- **Generalized iceberg cost.** One unit at $i$ delivers $1/\kappa_e(\Omega)$ at $j$:

$$\kappa_e(\Omega) = \bar{\kappa}_e \left[ 1 + \frac{p_e(\Omega)}{v_e} \right],$$

where $p_e(\Omega)/v_e$ is the *ad-valorem shipping cost* implied by per-unit price $p_e$ and average shipment value $v_e$.

- **Fleet composition on edge $e$ (CES share).**

$$a_{e,n} = \frac{\omega_{e,n}\, \rho_n^{1-\eta}}{\sum_{h \in \mathcal{F}} \omega_{e,h}\, \rho_h^{1-\eta}}, \quad \eta > 1$$

Interprets $p_e$ movements via cost shares $a_{e,n}$ (pass-through $\propto a_{e,n}$).

# Theory (Comparative Statics): Import Composition & Exposure

back

- **Edge-level fleet share (technology/prices).**

$$a_{e,n} = \frac{\omega_{e,n}\, \rho_n^{1-\eta}}{\sum_{h \in \mathcal{F}} \omega_{e,h}\, \rho_h^{1-\eta}}, \qquad \eta > 1$$

- **Importer $m$'s use of edge $e$ (routing/demand).**

$$\Xi_e(m) = \sum_{j \in \mathcal{N}_m} \sum_{i \in \mathcal{N}} X_{ij}\, \theta_e(i \to j)$$

- **Exposure of $m$ to fleets from country $n$.**

$$s_m(n) = \frac{\sum_{e \in \mathcal{E}} \Xi_e(m)\, a_{e,n}}{\sum_{j \in \mathcal{N}_m} \sum_{i \in \mathcal{N}} X_{ij}}$$

- **Interpretation.** $s_m(n)$ links *fundamentals* (fleet efficiency $\rho_n, \omega_{e,n}, \eta$) and *network use* ($\Xi_e(m)$) to importer $m$'s *exposure* to supplier $n$.

- **Elasticity hints (at interior).**

$$\frac{\partial \ln a_{e,n}}{\partial \ln \rho_n} = -(\eta - 1)\,(1 - a_{e,n}), \qquad \frac{\partial \ln a_{e,h}}{\partial \ln \rho_n} = +(\eta - 1)\, a_{e,n} \quad (h \neq n)$$

# Solution: Fleet Producer back

- Problem of producer $n$:

$$\max_{f_n \geq 0} \; \mathbb{E}_\Omega\Big[\Lambda_{m(n)}(\Omega)\,\Big(\rho_n(\Omega)\, f_n - \tfrac{1}{2}\mu_n f_n^2\Big)\Big]$$

- First-order condition:

$$\mu_n f_n \;=\; \mathbb{E}_\Omega\Big[\Lambda_{m(n)}(\Omega)\,\rho_n(\Omega)\Big]$$

- Rewrite using covariance:

$$\mu_n f_n \;=\; \mathbb{E}[\Lambda_{m(n)}]\cdot\mathbb{E}[\rho_n] \;+\; \mathrm{Cov}\Big(\Lambda_{m(n)}(\Omega), \rho_n(\Omega)\Big)$$

- Interpretation:
  - Investment rises with expected rentals $\mathbb{E}[\rho_n]$ and owner's marginal utility $\mathbb{E}[\Lambda]$
  - Risk premia enter through covariance: producers invest less if rentals are high in low-marginal-utility states

## Solution: Fleet Producer FOC under Alternative Preferences back

- **1) Risk-neutral owners (linear utility)** $\Lambda_{m(n)}(\Omega) \equiv 1$ (exact)

$$\mu_n f_n \;=\; \mathbb{E}_\Omega\Big[\rho_n(\Omega)\Big]$$

- **2) Quadratic (Mean–Variance) utility** $U_m = \mathbb{E}[C_m] - \frac{\lambda_m}{2}\mathrm{Var}(C_m)$

$$\mu_n f_n \;=\; \mathbb{E}[\rho_n] \;-\; \lambda_{m(n)}\,\mathrm{Cov}\Big(\rho_n, C_{m(n)}\Big)$$

*Note:* Linear SDF $\Lambda$ makes the covariance form *exact* (no approximation).

- **3) CRRA utility**

$$U(C) = \frac{C^{1-\gamma}}{1-\gamma}, \qquad \Lambda(\Omega) = C(\Omega)^{-\gamma} \;\Rightarrow\; \mu_n f_n \;=\; \mathbb{E}_\Omega\Big[C_{m(n)}(\Omega)^{-\gamma}\,\rho_n(\Omega)\Big]$$

# Solving the Model back

- The rest of decisions are not affected by risk: within any realized state $\Omega$, the solution is as in the baseline.
- **Algorithm:**
  1. Guess a vector of fleet investments $f = \{f_n\}$.
  2. For each possible state $\Omega$, solve the baseline GE (households, production, routing, operators).
  3. From these state-contingent solutions, compute expected fleet returns.
  4. Update fleet choices using producers' conditions.
  5. Iterate until fleets and state-contingent allocations are consistent.

# Network, routing & recursive equilibrium back

**Links**: directed $(k \to l)$, ad valorem cost $t_{kl} \geq 1$.

**Multimodal**: $t_{kl} = (\sum_m t_{kl,m}^{\eta})^{1/\eta}$ (cross-mode elasticity $\eta > 0$).

**Congestion (optional)**: $t_{kl} = \bar{t}_{kl}\, \Xi_{kl}^{\lambda}$ (or by mode $\lambda_m$).

**Routing (soft-min)**:

$$\tau_{ij}^{1-\sigma} = \mathbf{1}\{i = j\} + \sum_{k \in \mathcal{N}(i)} t_{ik}^{1-\sigma}\, \tau_{kj}^{1-\sigma}.$$

**Recursive equilibrium (local)**:

$$A_i^{1-\sigma} w_i^{\sigma} L_i = W^{1-\sigma} u_i^{\sigma-1} w_i^{\sigma} L_i + \sum_{k \in \mathcal{N}(i)} \kappa_{ik}^{1-\sigma}\, A_k^{1-\sigma} w_k^{\sigma} L_k,$$

$$w_i^{1-\sigma} u_i^{1-\sigma} = W^{1-\sigma} A_i^{\sigma-1} w_i^{1-\sigma} + \sum_{k \in \mathcal{N}(i)} \kappa_{ki}^{1-\sigma}\, w_k^{1-\sigma} u_k^{1-\sigma}.$$

# Risky Routing (CARA + Normal) & Soft-Min back

**Routing (Soft-Min Bellman)**

- Recursion:

$$\tau_{ij}^{1-\sigma} = \mathbf{1}\{i=j\} + \sum_{k\in N(i)} \kappa_{ik}^{1-\sigma}\,\tau_{kj}^{1-\sigma}, \quad \sigma > 1.$$

**CARA + Normal motivation**

- Edge log-costs: $X_{ik} = \ln T_{ik} \sim \mathcal{N}(\mu_{ik}, s_{ik}^2)$.
- Path log-cost: $Y_{\mathcal{P}} = \sum_{e\in\mathcal{P}} X_e$.
- CARA on log-cost: $U(Y) = -e^{\eta Y}$; log-CE:

$$Y_{\mathcal{P}}^{\mathrm{CE}} = \frac{1}{\eta}\ln \mathbb{E}[e^{\eta Y_{\mathcal{P}}}] = \sum_{e}\left(\mu_e + \frac{\eta}{2}s_e^2\right).$$

- Edge CE (multiplicative): $\kappa_{ik}^{\mathrm{CARA}}(\eta) = \exp\left(\mu_{ik} + \frac{\eta}{2}s_{ik}^2\right)$.

**Soft-Min compatibility**

- Choose $\underline{\eta = 1-\sigma < 0}$ so that

$$\left(\kappa_{ik}^{\mathrm{CARA}}\right)^{1-\sigma} = \exp\left((1-\sigma)\mu_{ik} + \frac{(1-\sigma)^2}{2}s_{ik}^2\right) = \mathbb{E}\left[T_{ik}^{1-\sigma}\right].$$

- Result: risk-averse path choice (CARA+Normal) aligns with soft-min edge powers.

# Correlated Edges & Abridged Equilibrium back

**Correlated edges (path-level risk)**

- Exact CE adds covariances $\Rightarrow$ not edge-local.
- Edge-local factor allocation with factors $Z_f$ (var $\sigma_f^2$) and weights $\alpha_{ik,f} \geq 0$:

$$K_{ik} \equiv (\kappa_{ik}^{\mathrm{CARA}})^{1-\sigma} = \exp\left((1-\sigma)\mu_{ik} + \frac{(1-\sigma)^2}{2} s_{ik}^2 + \frac{(1-\sigma)^2}{2} \sum_f \alpha_{ik,f}\sigma_f^2\right).$$

- Intuition: $\mu_{ik} \uparrow \Rightarrow K_{ik} \downarrow$; $s_{ik}^2, \sigma_f^2 \uparrow \Rightarrow K_{ik} \uparrow$.

**Abridged equilibrium (risk-adjusted kernels)**

- Origin-side mass $F_i = A_i^{1-\sigma} w_i^{\sigma} L_i$, local $D_i = W^{1-\sigma} u_i^{\sigma-1} w_i^{\sigma} L_i$:

$$F_i = D_i + \sum_{k \in N(i)} K_{ik} F_k.$$

- Destination-side mass $G_i = w_i^{1-\sigma} u_i^{1-\sigma}$, local $H_i = W^{1-\sigma} A_i^{\sigma-1} w_i^{1-\sigma}$:

$$G_i = H_i + \sum_{k \in N(i)} K_{ki} G_k.$$

**Edge-level comparative statics**

- $\dfrac{\partial \ln K_{ik}}{\partial \mu_{ik}} = 1 - \sigma < 0, \quad \dfrac{\partial \ln K_{ik}}{\partial s_{ik}^2} = \dfrac{(1-\sigma)^2}{2} > 0, \quad \dfrac{\partial \ln K_{ik}}{\partial \sigma_f^2} = \dfrac{(1-\sigma)^2}{2}\alpha_{ik,f} > 0.$

# Extended approach & local multipliers (formal) back

**Extended social-savings (welfare elasticity).** For any edge–mode $(k, l, m)$,

$$\frac{d \ln W}{d \ln \kappa_{kl,m}} = \rho \, \Xi_{kl,m} \left( M_k^{\mathrm{in}} + M_l^{\mathrm{out}} \right), \qquad \rho = \frac{1 + \alpha + \beta}{1 + \beta(\sigma - 1) + \alpha\sigma}.$$

**Local multipliers (definition).** Let $G(\ln x, \ln y) = 0$ be the $2N$-eq. log-recursive system obtained from the two market-access balance conditions, with Jacobian $DG$ (see Appendix). Then, writing population weights $L_i / \bar{L}$,

$$M_k^{\mathrm{in}} = \frac{1}{\Xi_k} \sum_i \frac{L_i}{\bar{L}} \left[ (1 - \sigma) \, (DG)^{-1}_{x, ik, 1} + \sigma \, (DG)^{-1}_{y, ik, 1} \right],$$

$$M_l^{\mathrm{out}} = \frac{1}{\Xi_l} \sum_i \frac{L_i}{\bar{L}} \left[ (1 - \sigma) \, (DG)^{-1}_{x, il, 2} + \sigma \, (DG)^{-1}_{y, il, 2} \right],$$

where the columns indexed "$k, 1$" and "$l, 2$" correspond to unit perturbations in the $(k \to \cdot)$ and $(\cdot \to l)$ balance equations, respectively. Intuition: $M_k^{\mathrm{in}}$ and $M_l^{\mathrm{out}}$ capture *local propagation* of a link shock through the recursive market-access system at the tail/head of the link, including congestion and externality feedback.

*Special case.* If $\alpha = \beta = 0$ and all $\lambda_m = 0$, then $\rho = 1$ and $M_k^{\mathrm{in}} = M_l^{\mathrm{out}} = 1$, recovering the traditional result $-\frac{\partial \ln W}{\partial \ln \kappa_{kl,m}} = \Xi_{kl,m}$.

# Incidence Roadmap: Mean Distortions vs. Risk (Transition)

**Goal.** Decompose the welfare effect of policies that change the *distribution* of shipping costs into (i) first-moment efficiency losses and (ii) second-order gains from stabilization (resilience).

**Broad decomposition (local, small changes):**

$$\Delta \ln W_m \;\approx\; \underbrace{-\sum_e \mathcal{W}_e\, \Delta\mu_e}_{\text{First-moment (efficiency) loss}} \;+\; \underbrace{\frac{\gamma_m}{2}\sum_e \mathcal{W}_e\, \Delta s_e^2}_{\text{Second-order (risk) gain}},$$

$$\mu_e \equiv \mathbb{E}[\ln \kappa_e], \qquad s_e^2 \equiv \mathrm{Var}(\ln \kappa_e), \qquad \mathcal{W}_e \equiv \rho\, \Xi_e\Big(M^{\mathrm{in}}_{o(e)} + M^{\mathrm{out}}_{d(e)}\Big).$$

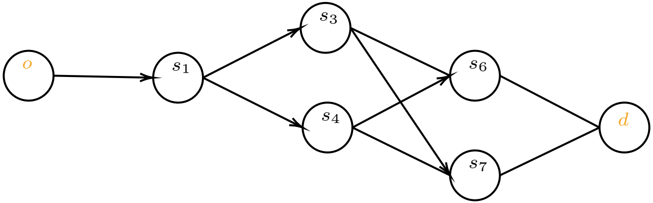
**Interpretation.**

- *Mean cost* increases ($\Delta\mu_e > 0$) bite **first order**, scaled by the spatial weight $\mathcal{W}_e$.
- *Pure stabilization* with unchanged mean ($\Delta\mu_e = 0$, $\Delta s_e^2 < 0$) yields **second-order** gains $\propto \gamma_m |\Delta s_e^2|$.
- $\mathcal{W}_e$ is exactly the edge weight that appears on the next slide: $\dfrac{d\ln W}{d\ln \kappa_e} = \rho\, \Xi_e\Big(M^{\mathrm{in}}_{o(e)} + M^{\mathrm{out}}_{d(e)}\Big)$.

*Classic insight:* Mean-preserving reductions in price/cost volatility deliver second-order welfare gains; mean distortions are first-order (Newbery & Stiglitz, 1981). See also World Bank derivation: $B/Y_0 = \overline{Y}/Y_0 - \frac{R}{2}\,\overline{(\mathrm{CV})^2}$.

# Recursive Routing from $o$ to $d$

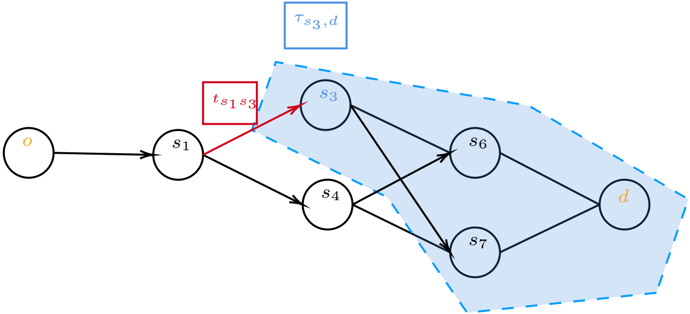
- Transportation from city $o$ to city $d$ requires choosing a route $r$




back

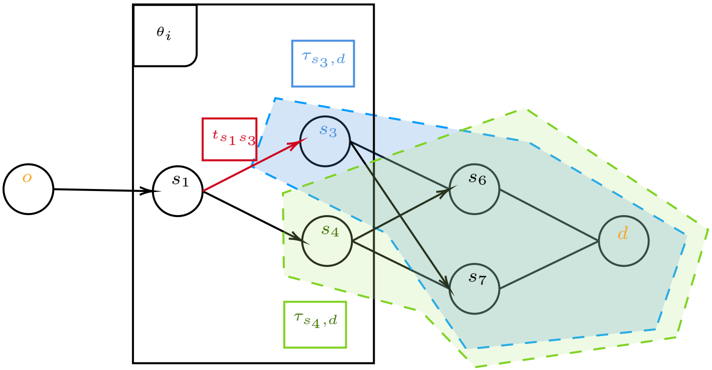
# Recursive Routing from $o$ to $d$

- Route is chosen recursively by comparing edge-specific costs $(t_{s_1,s_3})$ and continuation values $\tau_{s_3,d}$



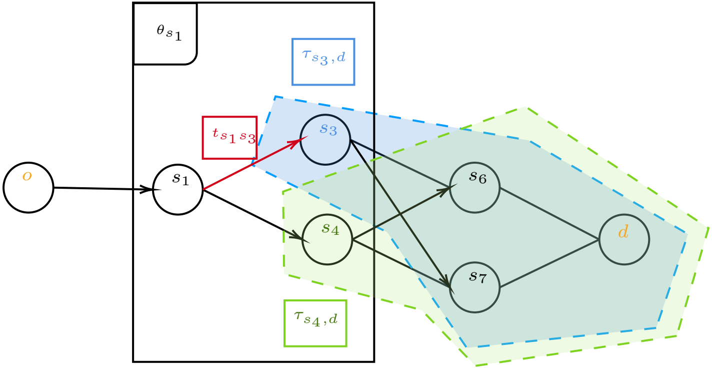
# Recursive Routing from $o$ to $d$

- Recursive choice is node-specific and compares neighboring options subject to a (possibly) node-specific elasticity of substitution.



# Recursive Routing from $o$ to $d$

- Gives rise to a closed-form (recursive) formula for transportation costs.




$$\tau_{s_1,d}^{-\theta_{s_1}} = \sum_{k\in\mathcal{F}(s_1)} t_{s_1 k}^{-\theta_{s_1}} \tau_{kd}^{-\theta_{s_1}}$$

back

# Constructing U.S. Foreign Ownership Exposure

Back

- **Data construction**
  1. Start from **Clarksons SIN**: vessel-level data on all active containerships worldwide
     $\rightarrow$ builder country, operator nationality, ship size, and vintage.
  2. Merge with **Panjiva U.S. imports**: shipment-level records with vessel identifiers and arrival ports
     $\rightarrow$ identify which ships serve U.S. trade and their cargo volumes.
  3. Match vessels using **IMO numbers** and port–date information.
  4. Aggregate to obtain **TEU-weighted exposure** of U.S. imports by builder and operator country.

- **Output**
  - First dataset linking global ship ownership and construction to U.S. import activity.
  - Enables systematic analysis of foreign dependence in shipping infrastructure.

# Constructing Regional Exposure from Global Vessel Data

Back

## Data construction

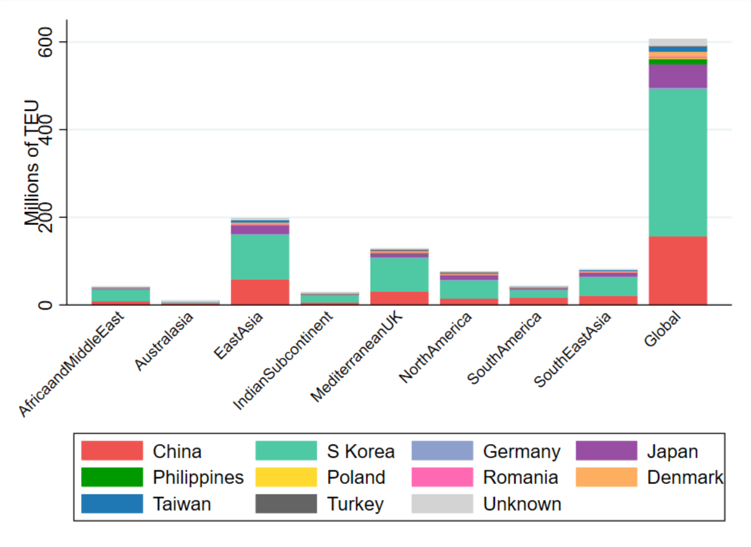
1. Start from **Clarksons SIN**: vessel-level registry of all active containerships in 2025 $\rightarrow$ builder country, operator nationality, ship size, vintage, and **port rotation**.
2. Use each vessel's port rotation to identify the ports, countries, and regions it serves. Each ship thus contributes exposure to all locations on its regular route.
3. For every port, country, and region:
   - Compute the share of total ship capacity (*TEUs*) arriving that was **built** in each builder country.
   - Compute the share **operated** by each operator nationality.
4. Aggregate these measures to characterize how regional exposure varies with ship size and vintage.

## Output

- Global map linking each region's incoming fleet composition to builder and operator origins.
- Foundation for contrasting global concentration patterns with the U.S. footprint in subsequent slides.

# Global Distribution of Shipbuilding Countries back

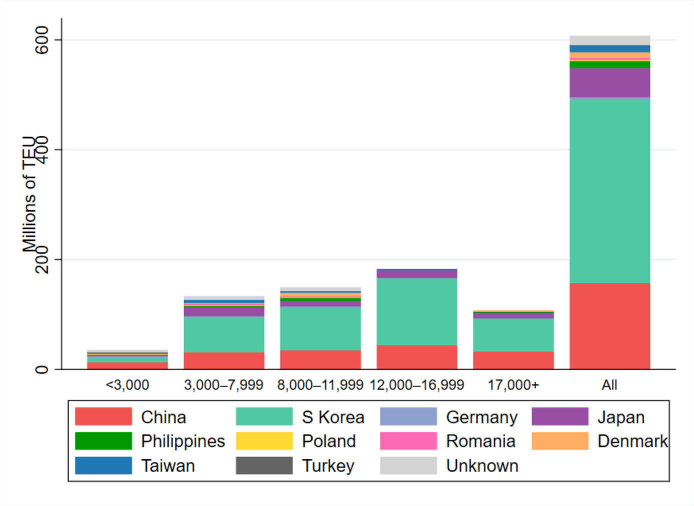
- By builder country: But this is very different in levels since some regions have low container trade volumes



# Global Distribution of Shipbuilding Countries: by Size

back

- By size: Both countries build >80% of larger ships, slightly less for smaller ships but still 60%
- Smaller ships are built by more diverse set of countries



# Building a Linked Dataset of Global and U.S. Shipping Exposure

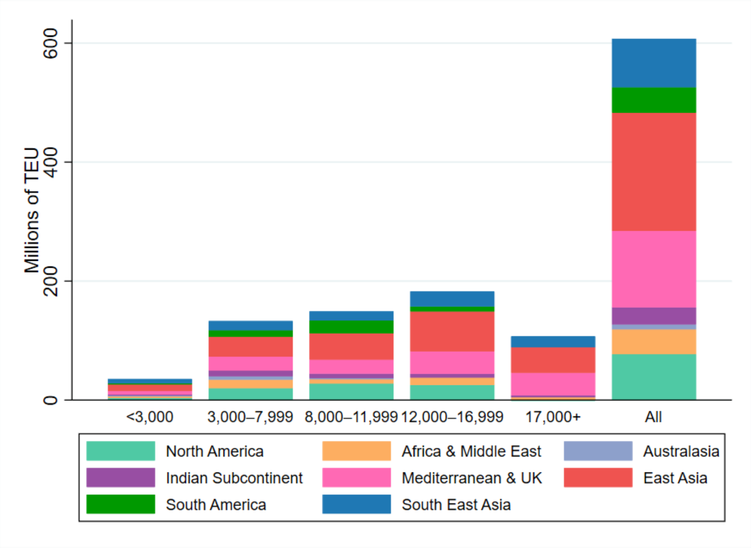
Back

- **Data construction**
  1. Start from **Clarksons SIN**: vessel-level data on all active containerships worldwide
     $\rightarrow$ builder country, operator nationality, ship size, and vintage.
  2. Merge with **Panjiva U.S. imports**: shipment-level records with vessel identifiers and arrival ports
     $\rightarrow$ identify which ships serve U.S. trade and their cargo volumes.
  3. Match vessels using **IMO numbers** and port–date information.
  4. Aggregate to obtain **TEU-weighted exposure** of U.S. imports by builder and operator country.

- **Output**
  - First dataset linking global ship ownership and construction to U.S. import activity.
  - Enables systematic analysis of foreign dependence in shipping infrastructure.

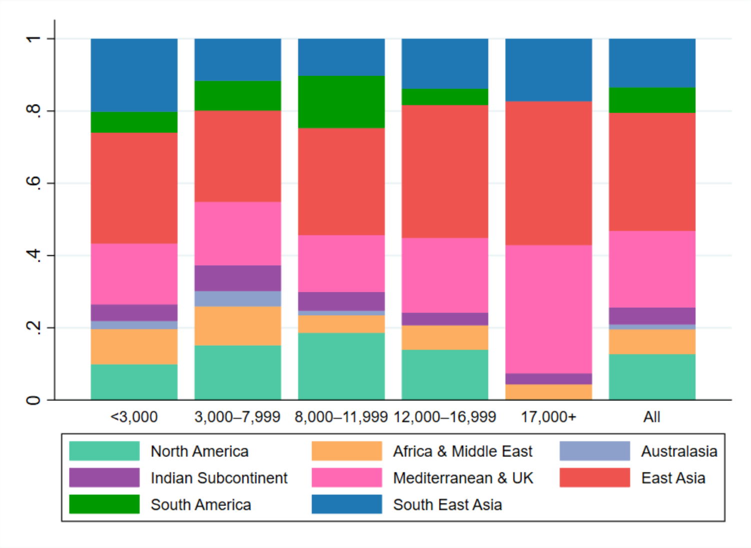
# Global Distribution (levels) back

- North America accounts for 12.7 % of global capacity, mostly in mid-size vessels



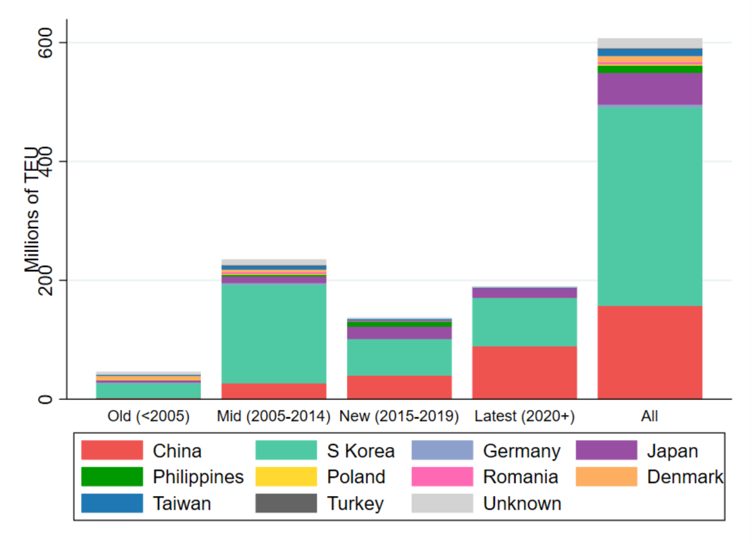
# Global Distribution (shares) back

- US accounts for 12.7 % of global container trade, mostly in mid-size vessels

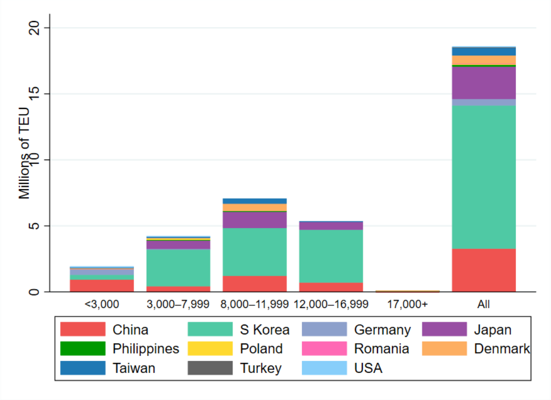


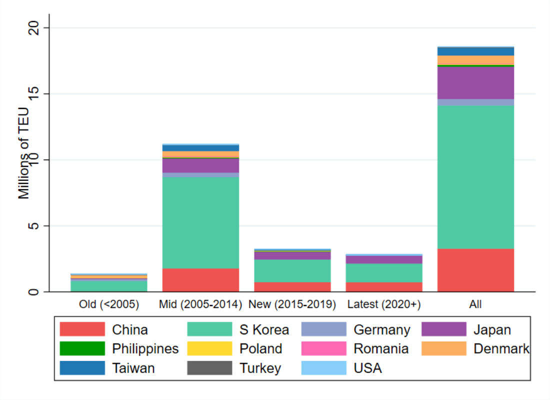
# Global Distribution of Shipbuilding Countries: by Age back

- By age: Both countries build 90% of most recent ships (2020 onwards), China 46.9% SK 43%
- China accounts for only 3.8% of old ships, show recent dominance in shipbuilding



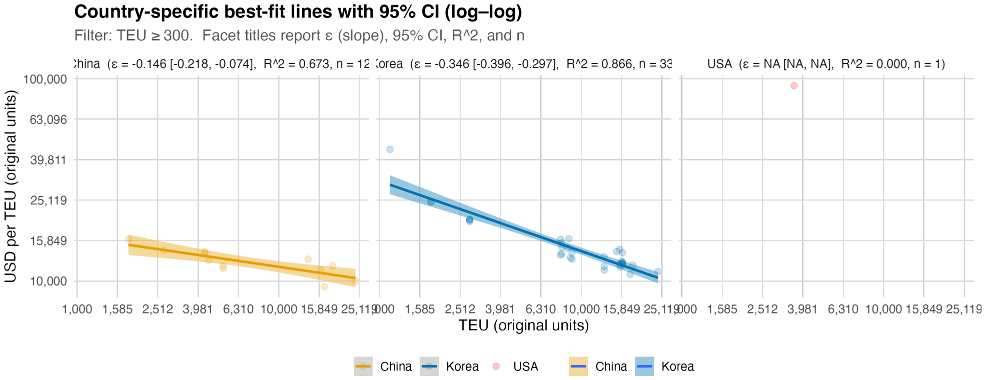
# U.S. Imports: by Vessel Size and Vintage Back



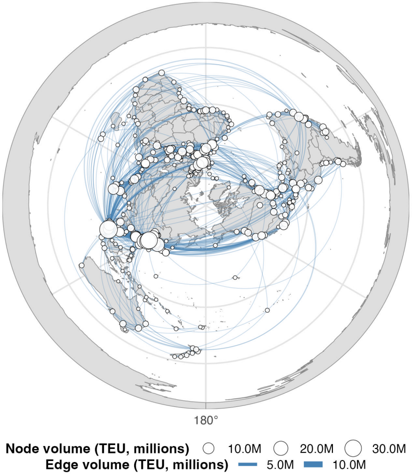

- U.S. imports mostly ride East Asian–built fleets (Korea, China, Japan).
- China builds ∼35% of feeders but ∼15% of ultra-large vessels; Korea/Japan dominate at the top end.
- Older vessels show little Chinese presence; Korea/Japan dominate.
- Nearly half of newest (2020+) ships serving U.S. trade are China-built.

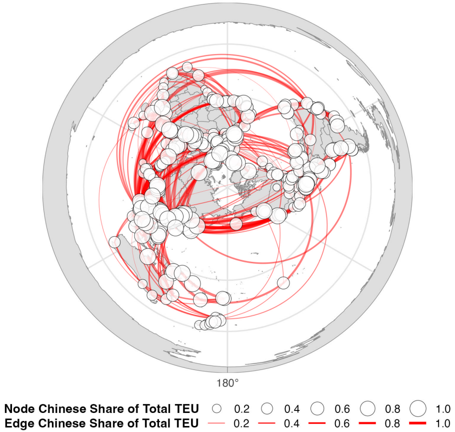
# Shipbuilding Efficiency by country




- **Korea vs. China:** Very similar size–efficiency profiles—$\$/\mathrm{TEU}$ falls with TEU at comparable rates; differences are mostly *levels* (intercepts), not slopes.
- **United States:** Extremely thin sample and much higher $\$/\mathrm{TEU}$; can't credibly estimate a slope; consistent with limited large-container build capacity and bespoke/regulatory premia.
- **Modeling takeaway:** Use a common size–cost elasticity for Korea/China with a country level shifter; treat the U.S. as capacity-constrained/high-intercept, and allow extra dispersion for small-TEU builds.

# Global Distribution of Shipbuilding Countries: by Trade Lanes

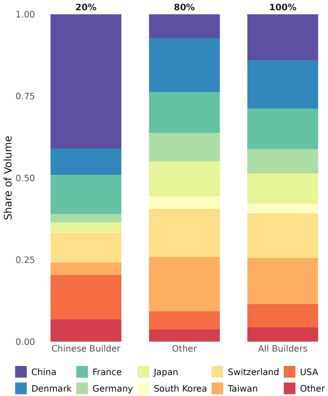


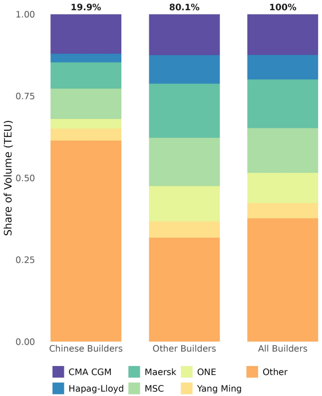




- Chinese shipping present across all major shipping lanes Shares
- Particularly prevalent in the most crucial lanes (Asia-Europe, Asia-North America) and most significant entrepots

Back

# Operators




- Chinese-built ships serving U.S. imports are largely operated by non-Chinese firms/countries, including major global carriers
- Reflects the integration of Chinese shipbuilding into international shipping networks, extending well beyond use by Chinese operators Back

# From U.S. Ship Fees to Ad-Valorem Rates back1 back2

**Goal:** Convert U.S. shipping fees (per NT or per TEU) into ad-valorem

**Step 1. Obtain fees by ship size**

- Use **Clarksons** data to obtain total fees (in $m per voyage) for ships of different sizes (6k, 10k, 14k TEU).
- The policy defines *two-tiered* fees (per NT and per TEU), with the **maximum applying**.

**Step 2. Express fees per container**

- Compute **fee per TEU** = total ship fee / ship capacity (TEU).
- Provides the effective cost per container under the new fee structure.

**Step 3. Convert to ad-valorem rates**

- Use literature-based shipping cost benchmarks by ship size (OECD/ITF, Drewry):
  6k TEU $\rightarrow$ 1.25 $\times$ baseline, 10k TEU $\rightarrow$ 1.00, 14k TEU $\rightarrow$ 0.85.
- Divide fee per TEU by adjusted baseline shipping cost per TEU:

$$\text{Ad-valorem rate} = \frac{\text{Fee per TEU}}{\text{Cost per TEU (size-adjusted)}}$$

- Result: effective tariff-equivalent shipping fee by vessel size.

# Size-Specific Ad Valorem Schedule

back

| Size bin | Midpoint (TEU) | Oct 2025 | Apr 2026 | Apr 2027 | Apr 2028 |
|---|---|---|---|---|---|
| $< 3000$ | 1,500 | 13.86% | 18.13% | 21.27% | 25.15% |
| $3000–8000$ | 5,500 | 12.57% | 16.56% | 19.56% | 23.15% |
| $8000–12000$ | 10,000 | 11.13% | 14.80% | 17.63% | 20.90% |
| $12000–17000$ | 14,500 | 9.68% | 13.03% | 15.71% | 18.66% |

Notes: Percentages are ad valorem fees applied to China-linked fleet services by ship-size bin and date.