Foreign Ships in U.S. Waters

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Motivation

- The U.S. once dominated global shipbuilding and maintained a large U.S.-flag 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 fees) aimed at China-linked vessels
- Ownership matters not only for **efficiency**, but also for **resilience, leverage, and national security**

This paper:

Who owns and operates ships that carry U.S. imports — and what are the risks of foreign dependence?

Questions

1. How is the global fleet of containerships distributed across builder and operator countries?
2. How does U.S. dependence compare to the global distribution of fleets?
3. What are the consequences if access to China-linked ships is disrupted?
4. What is the incidence and desirability of policies (e.g., targeted port surcharges) to reduce vulnerability?

This Paper

Evidence

- Document the global distribution of ships across builder and operator countries
- Quantify U.S. exposure to foreign ships in this global context

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)

Quantitative analysis

- Assess the effect of losing access to foreign/Chinese-linked ships
- Evaluate the desirability and incidence of policies (e.g., targeted port surcharges) to reduce vulnerability

What We Find

- **Concentrated Supply, Rising China**
  - Global shipbuilding remains heavily concentrated in East Asia.
  - China's share is expanding fastest, especially among newer vessels.
- **High U.S. Exposure**
  - Most U.S. imports travel on foreign-built and foreign-operated fleets.
  - East Asian yards dominate vessels serving U.S. trade lanes.
- **Scale and Cost Efficiency**
  - Larger ships deliver strong per-TEU cost efficiencies.
  - Chinese-built vessels are generally cheaper for a given size and class.
- **Uneven Policy Impact**
  - Fees bite hardest on lanes and goods most reliant on Chinese fleets.
  - Re-routing and substitution soften—but do not eliminate—the effect.

Related Literature (Three Buckets)

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),

Evidence

Global Distribution of Ships

Questions

How is the global containership fleet distributed across builder countries?

How exposed are different regions to these global fleets?

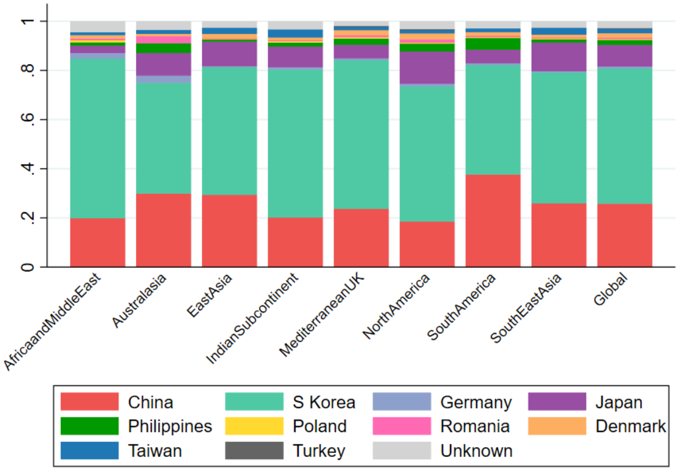
Data

- Clarksons vessel-level information on the global containership fleet (2025 cross-section)
- Variables: ship size, age (vintage), builder country, builder firm, and port rotation

Approach

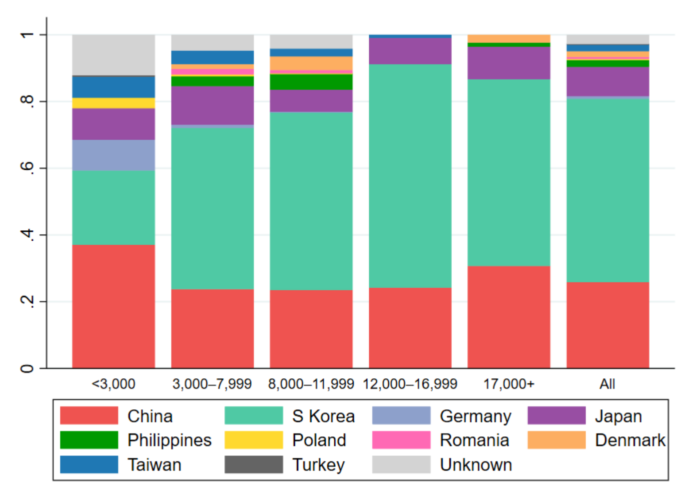
- Begin with the global distribution of ships by builder country
- Contrast the global fleet with the fleets serving different regions
- Examine how these patterns vary by ship size and by vintage
- Identify concentration patterns and regional differences

Global Distribution of Shipbuilding Countries



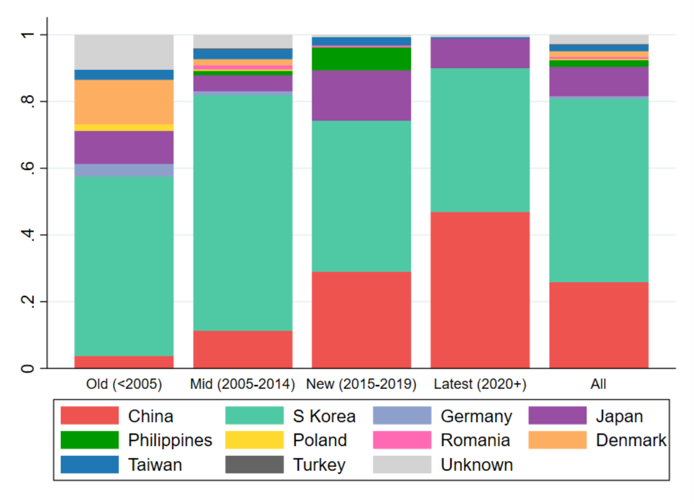
- South Korea (55%) and China (26%) account for more than 80% of the global containership fleet
- Shipbuilding is highly concentrated in these two countries, with only a small share built elsewhere

Global Distribution of Shipbuilding Countries: by Size



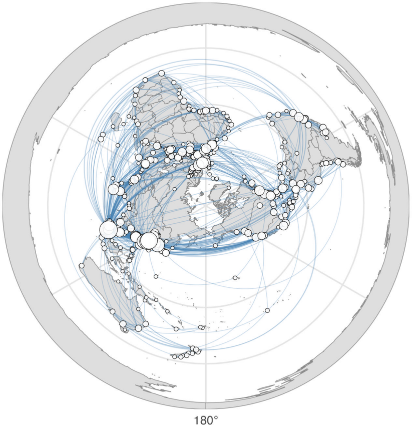
- China and South Korea built over 80% of large containerships
- For smaller vessels their share falls to about 60%, with production spread across a broader set of countries

Global Distribution of Shipbuilding Countries: by Age

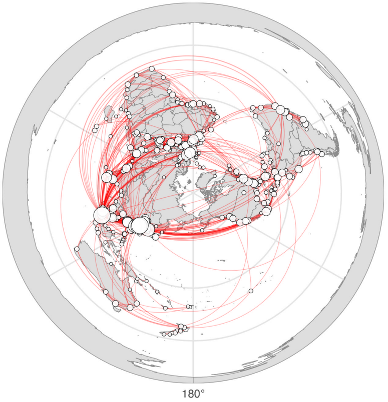


- Since 2020, China and South Korea have built about 90% of all new containerships (China 47%, SK 43%)
- China built fewer than 4% of older vessels, highlighting how abrupt and recent its rise has been

Global Distribution of Shipbuilding Countries: by Trade Lanes



Node volume (TEU, millions) 10.0M 20.0M 30.0M
Edge volume (TEU, millions) 5.0M 10.0M



Node volume (TEU, millions) 10.0M 20.0M 30.0M
Edge volume (TEU, millions) 5.0M 10.0M

- 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

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.

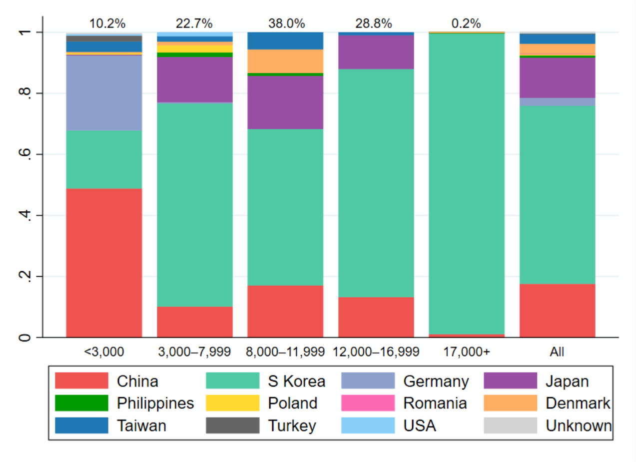
U.S. footprint in this global picture:

U.S. accounts for 12.7% of global container trade, with most traffic carried on mid-sized vessels (3K–12K TEU)

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

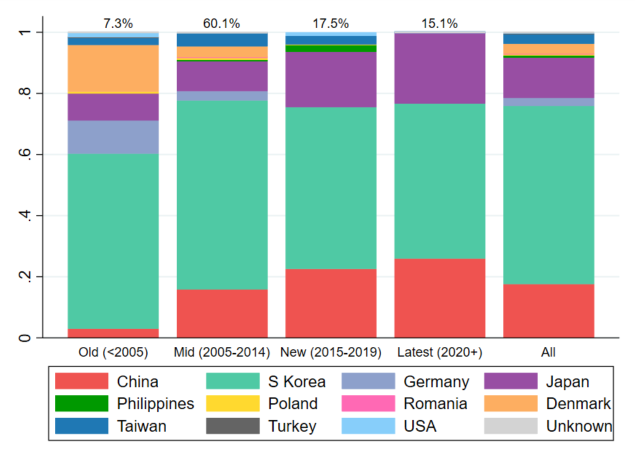
- Merge U.S. import shipments (Panjiva) with vessel registry data (Clarksons)
- Compute TEU-weighted exposure of U.S. imports by builder country and operator nationality
- Characterize patterns of reliance across ship types and sources to assess the extent of foreign dependence

U.S. Imports by Vessel Size



- U.S. imports mostly use East Asian-built ships (Korea, China, Japan) Levels Operators
- China builds 35% of feeders but only 15% of ultra-large vessels; Korea/Japan dominate the largest

U.S. Imports by Vessel Vintage



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

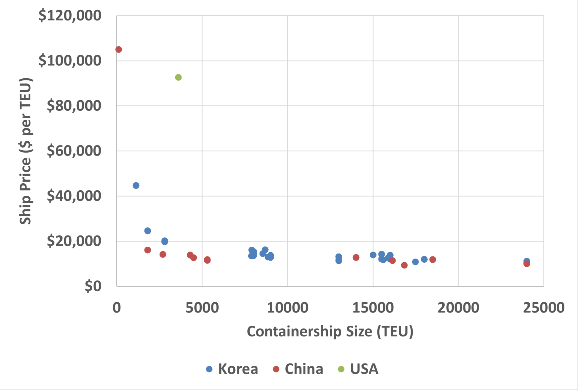
So far: The evidence highlights *exposure*—a concentrated dependence on a small set of shipbuilding countries.

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.
- 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: Setup

- Directed transport network $G = (\mathcal{N}, \mathcal{E})$
  - Nodes $i \in \mathcal{N}$: production/consumption locations
  - Edges $e = (i \to j) \in \mathcal{E}$: directed transport links
- Countries: nodes are partitioned into sets $\{\mathcal{N}_m\}_{m=1}^{M}$, each corresponding to one country
  - Labor mobile within a country m, immobile across countries
- Each node i produces a unique variety with local labor
- Households consume CES bundles; mobility equalizes welfare within each country

$\Rightarrow$ Spatial GE model of trade across countries on a risky network

Model: Households

- Country m has labor endowment $\bar{L}_m$
  - Labor immobile across countries, mobile across nodes $i \in \mathcal{N}_m$
  - Allocation satisfies $\sum_{i \in \mathcal{N}_m} L_i = \bar{L}_m$

- Households at node j consume a CES aggregate of varieties from all nodes

$$C_j = \left(\sum_{i \in \mathcal{N}} \phi_{ij}^{1/\sigma} \, q_i^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)}$$

  with elasticity $\sigma > 1$

- Local amenity: $u_j = \bar{u}_j \, L_j^{\beta_{m(j)}}$

- Free mobility within a country equalizes welfare across nodes

Model: Production

- Each node i produces a unique variety using local labor
- Technology: $Y_i = A_i L_i$
- Productivity depends on fundamentals and scale externalities

$$A_i = \bar{A}_i L_i^{\alpha_{m(i)}}$$

  where...
  - $\alpha_{m(i)} > 0$: agglomeration
  - $\alpha_{m(i)} < 0$: congestion

Model: Shipping

- Trade flows over network edges (e.g. Shanghai $\rightarrow$ Los Angeles)
- Edge operators rent fleet capacity and assemble shipping services, facing congestion
- Fleet availability is stochastic (e.g. sanctions, conflict), limiting usable capacity
- Shippers route goods across edges; routing adapts flexibly ex-post to realized costs
- Fleet producers (owned in different countries) invest in shipping capacity ex-ante, then rent it out

Model: States and Timing

- At the start of each period, a *state* Ω is realized:

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

- Interpretation:
  - $\Omega_{e,n} = 1$: fleet n is available to operate on edge e
  - $\Omega_{e,n} = 0$: fleet n cannot serve edge e (e.g. war, sanctions, embargo)
- Timing:
  - Ex-ante: fleet producers invest f_n
  - Ex-post: Ω is realized, then households, firms, and operators choose

Model: Operators and Shipping Services

- Edge operators rent fleet capacity $s_{e,n}$ from different producers n

- Operators combine these inputs into shipping services on edge e:

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

- Congestion raises the cost of operating services on edge e:

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

- Capacity usable by operators depends on realized fleet availability $\Omega_{e,n}$

Model: Shipping Costs

- Each edge $e = (i \to j)$ has a generalized iceberg cost $\kappa_e(\Omega)$
  - One unit shipped at i delivers $1/\kappa_e(\Omega)$ at j

- Operator price index on edge e:

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

where prices depend on (i) which fleets are available, (ii) their rental rates, and (iii) congestion

- Costs combine first-nature frictions and operator user prices:

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

where $\frac{p_e(\Omega)}{v_e}$ represents the *ad-valorem shipping cost* implied by the per-unit shipping price $p_e(\Omega)$ and the average shipment value v_e

Model: Shipping Routing

- Goods must be delivered from origin i to destination j by selecting a route across network edges

- Shippers face idiosyncratic shocks across routes (logit/Fréchet structure)

- Effective iceberg cost from i to j in state Ω:

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

- Routing share $\theta_{(k \to \ell)}(i \to j; \Omega)$ gives the probability a shipment uses edge $(k \to \ell)$:

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

- Interpretation: routing is probabilistic; cheaper routes get higher weight but all feasible routes may be used

Model: Fleet Producers

- Fleet producers are a subset of countries $\mathcal{F} \subseteq \{1, \ldots, M\}$
- Timing:
  - Ex-ante: each producer n chooses fleet investment f_n before shocks are realized
  - Ex-post: shocks Ω determine which edges can use n's fleet; all available capacity is rented at rate $\rho_n(\Omega)$
- Technology: supplying f_n is costly

$$\tfrac{1}{2}\mu_n f_n^2$$

- Problem of producer n (owned by country $m(n)$):

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

- Definition: $\Lambda_{m(n)}(\Omega)$ is the marginal utility of profits for households in country $m(n)$ in state Ω (i.e. the household's stochastic discount factor).

Model: Competitive Equilibrium

A competitive equilibrium of the world economy (in state Ω) 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 $\rho_n(\Omega)$

- Markets clear in each state Ω:

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

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

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

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

Solution: Fleet Producer

- 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

- **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 Λ 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

- The rest of decisions are not affected by risk: within any realized state Ω, the solution is as in the baseline.
- **Algorithm:**
  1. Guess a vector of fleet investments $f = \{f_n\}$.
  2. For each possible state Ω, 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.

Exposure to Foreign Fleets and Implications

Import Composition

- Each importer country m's trade depends on the composition of fleets serving its routes
- Key question: what share of m's imports is carried by fleets from country n?
- This share depends jointly on:
  - Technology and costs: fleet rental rates ρ_n, substitutability η, and weights $\omega_{e,n}$
  - Network and routing: which edges m's shipments use ($\theta_e(i \to j)$), and how much traffic flows through each edge ($\Xi_e(m)$)

$\Rightarrow$ Import composition links fundamentals (fleet efficiency, network structure) to exposure (share of trade carried by foreign fleets)

Import Composition by Supplier

- Fleet cost share on edge e from producer country $n \in \mathcal{F}$

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

- Edge traffic used by importer country m

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

- Import composition share of m served by 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
    - $a_{e,n}$ from technology/prices $(\omega_{e,n}, \rho_n, \eta)$
    - $\Xi_e(m)$ from demand/routing $(X_{ij}, \theta_e, \sigma)$ and network costs (κ_e)

Removing a Shipping Supplier

- Suppose a fleet producer n_0 becomes unavailable on some routes (e.g., sanctions or conflict):

$$\Omega_{e,n_0} = 0 \quad \Rightarrow \quad a'_{e,n_0} = 0$$

- This change propagates through the model via three layers:
  1. **Shipping equilibrium:** Higher effective fleet rental prices ρ_n and shipping costs $\kappa_e(\Omega)$ on affected edges.
  2. **Routing equilibrium:** Reallocation of trade flows X_{ij} and routing shares $\theta_e(i \to j)$ across alternative paths.
  3. **Spatial equilibrium:** Adj. prices and quantities across nodes i, j, feeding into welfare W_m for each country m.

- The overall welfare effect for importer m reflects:

$$\frac{d \ln W_m}{d \ln \Omega_{e,n_0}} = \underbrace{\frac{d \ln W_m}{d \ln \kappa_e}}_{\text{spatial equilibrium}} \times \underbrace{\frac{d \ln \kappa_e}{d \ln \Omega_{e,n_0}}}_{\text{shipping equilibrium}}$$

capturing how dependence on a foreign fleet translates into vulnerability through the network.

Evaluating U.S. Shipping Fees on Chinese Ships

Exclusive: US to levy fees on China-linked ships, push allies to do likewise, draft executive order says

By **Jonathan Saul**

March 8, 2025 1:13 AM GMT+8 · Updated March 8, 2025

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

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Joanna Partridge *and agencies*

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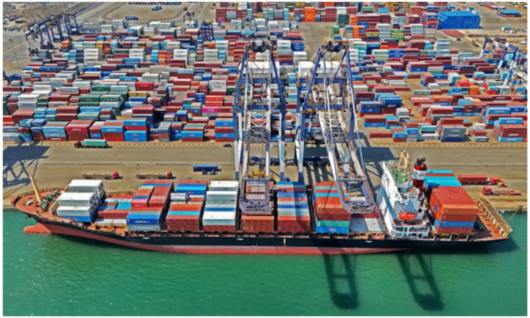

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LOGISTICS REPORT

U.S. Importers and Exporters Fret Over Port Fees on Chinese Ships

Worries come despite carriers' saying they don't plan to pass on the costs of levies set to take effect in October

By Paul Berger Follow

Sept. 17, 2025 5:30 am ET

U.S. Shipping Fees on Chinese Ships

- Section 301 introduces two fees, 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.

- In the model, we interpret these measures as per-container taxes on shipping services from affected fleets:
  - Each fee raises the effective user price ρ_n for the relevant fleets.
  - This increase maps into higher effective shipping costs κ_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.

From Policy to Quantification

Goal: Assess how U.S. fees on Chinese ships affect trade costs and welfare through the global shipping network.

- Policies raise effective price of shipping services provided by Chinese fleets on U.S. routes:

$$\rho_{\text{CHN}} \;\rightarrow\; \rho_{\text{CHN}} T_{e,\text{CHN}}, \quad T_{e,\text{CHN}} > 1.$$

- These higher prices propagate through:
  1. the **shipping equilibrium** — affecting route-level costs κ_e,
  2. the **spatial equilibrium** — reallocating trade flows and prices,
  3. and ultimately, countries' **welfare** W_m.

- Our focus today is on the (local) **welfare elasticity**:

$$\frac{d \ln W_m}{d \ln T_{e,\text{CHN}}},$$

  capturing the percent change in welfare from a 1% increase in the cost of Chinese fleets.
  - Can be expressed in **equivalent variation** terms, linking directly to welfare losses from the policy.
  - Provides a transparent, general measure of exposure before solving full counterfactuals.

- **Next:** Full counterfactual analysis of the U.S.–China shipping policy in progress.

Welfare Elasticities of Shipping Fees: Spatial Equilibrium

Welfare elasticity (recap).

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

Spatial response (Allen-Fuchs-Wong, 2025) Details

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

- Ξ_e: baseline usage of edge e (routing weight). *Heavier-used links bite more.*
- $M^{\text{in}}_{o(e)}$, $M^{\text{out}}_{d(e)}$: node multipliers at origin/destination. *High-centrality nodes amplify impact.*
- ρ: model scaling from amenities/agglomeration (α) and crowding (β) with demand elasticity (σ).

Welfare Elasticities of Shipping Fees: Shipping Equilibrium

Shipping response (3 channels).

$$\frac{d\ln\kappa_{e'}}{d\ln T_{e,m}} = \underbrace{\mathbf{1}\{e'=e\}\,\chi_{e,m}}_{\textbf{(A) Direct on } e} + \underbrace{\psi_{e'}\sum_n a_{e',n}\,\phi_{n;\,e,m}}_{\textbf{(B) Fleet rentals}} + \underbrace{(1-\psi_{e'})\,\delta_{e'}\,g_{e'e}\,\chi_{e,m}}_{\textbf{(C) Routing/congestion}}.$$

- **(A) Direct (taxed edge):**

$$\chi_{e,m} = \frac{d\ln\kappa_e}{d\ln T_{e,m}} = \psi_e\,\beta_e\,s_{e|m}, \quad \beta_e = \left[1+\delta_e\,\varepsilon_e^Q(1-\psi_e)\right]^{-1}.$$

  Bigger when exposure $s_{e|m}$ and price share ψ_e are high; congestion lowers pass-through via β_e.

- **(B) Fleet rentals (market ripple):** $a_{e',n}$ = cost share of fleet n in e' (CES, $\eta > 1$), $\phi_{n;\,e,m} = \frac{d\ln\rho_n}{d\ln T_{e,m}}$. *Edges using fleets with rising rents see higher costs.*

- **(C) Routing/congestion (network ripple):** $g_{e'e} = \frac{d\ln\Xi_{e'}}{d\ln\kappa_e}$, $\delta_{e'}$ = congestion elasticity. *Detours toward e' (large $g_{e'e}$) + congestion sensitivity (large $\delta_{e'}$) amplify costs.*

Welfare Elasticities: Special Case

- Consider a special case with no spatial externalities ($\alpha = \beta = 0$) and no congestion in the shipping market ($\delta = 0$).

- In this environment, the welfare elasticity simplifies to:

$$\frac{d \ln W_m}{d \ln T_{e,\mathsf{CHN}}} = \underbrace{\Xi_e \, s_{e|\mathsf{CHN}}}_{\text{(A) Direct exposure on taxed routes}} + \underbrace{\sum_{e'} \Xi_{e'} \, \psi_{e'} \sum_n a_{e',n} \, \phi_{n;e,\mathsf{CHN}}}_{\text{(B) Indirect spillovers through fleet linkages}} .$$

- **Interpretation:**
    - Term (A): direct exposure of importer m to Chinese fleets on the affected U.S.–China routes.
    - Term (B): indirect effects via higher rental prices and substitution across fleets serving other edges.

- **Inputs from the baseline:**
    - Edge traffic Ξ_e — routing-based trade flows.
    - Cost shares $a_{e,n}$ — from the CES fleet aggregator ($\eta > 1$).
    - Exposure share $s_{e|\mathsf{CHN}}$ — fraction of Chinese fleets on taxed routes.

From Model to Data: Equivalent Variation

Goal: Express the welfare effect of U.S. fees on Chinese fleets in data-based terms.

- Start from the model-implied welfare change:

$$\frac{\Delta \text{EV}_m}{Y_m} \approx -(\text{tax change}) \times (\text{impact on shipping costs}) \times (\text{impact on import prices}) \times (\text{impact on aggregate prices}).$$

- In data:

$$\frac{\Delta \text{EV}_m}{Y_m} \approx -\Delta T_{\text{CHN}} \times \underbrace{s_{\text{CHN}}^{\text{ship}}}_{s_{e|CHN}} \times \underbrace{s_{\text{ship}}^{\text{imp}} \times s_{\text{imp}}^{\text{GDP}}}_{\Xi},$$

where:

  - ΔT_{CHN}: ad-valorem increase in Chinese fleet costs (17%–32%)
  - $s_{\text{CHN}}^{\text{ship}}$: share of imports carried on Chinese fleets (18%)
  - $s_{\text{ship}}^{\text{imp}}$: share of shipping costs in import prices (5%)
  - $s_{\text{imp}}^{\text{GDP}}$: share of imports in GDP (14%).

- Each component is directly observable from trade, freight, and national accounts data.

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 (%)
October 2025	17.26	$11.09	0.03%
April 2026	22.05	$14.17	0.05%
April 2027	26.84	$17.25	0.06%
April 2028	31.64	$20.34	0.07%

- **Gradual escalation:** Welfare losses increase from about $11 bn to $20 bn as the fee rises from 17% to 32%.
- **Aggregate scale:** By 2028, the loss reaches roughly 0.07% of U.S. GDP.

U.S. Shipping Fees on Chinese Ships: General Equilibrium and Next Steps

- **So far:** Local incidence and efficiency-based welfare effects.
  - Quantified equivalent variation from observed exposure margins.
  - Focused on the direct and partial-equilibrium transmission of U.S. fees.

- **Next: Full general-equilibrium analysis.**
  - Implement full *hat algebra* version of the model.
  - Calibrate using global data on the role of Chinese fleets across all trade lanes.
  - Evaluate reallocation of trade and shipping flows worldwide.

- **Beyond efficiency: Resilience and strategic behavior.**
  - Introduce *risky routing* and disaggregated spatial risk.
  - Study geoeconomic interactions—taxes and subsidies as non-cooperative instruments on shared global infrastructure (Lindahl-type games).

Concluding Remarks

Concluding Remarks

- **Concentrated Dependence**
  - Global shipbuilding remains centered in East Asia.
  - China's role is growing rapidly, though still behind Korea.
- **Efficiency vs. Exposure**
  - Concentration brings strong scale and cost advantages.
  - But it raises exposure to geopolitical and policy shocks.
- **Policy Implications**
  - U.S. fees on Chinese ships affect global trade through network linkages.
  - Even targeted measures can generate broad spillovers.
- **Next Steps**
  - Extend incidence analysis into full GE quantification.
  - Study efficiency, resilience, and strategic responses.

Appendix

Extended approach & local multipliers (formal) back

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

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

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 $L_i/\bar{L}$,

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

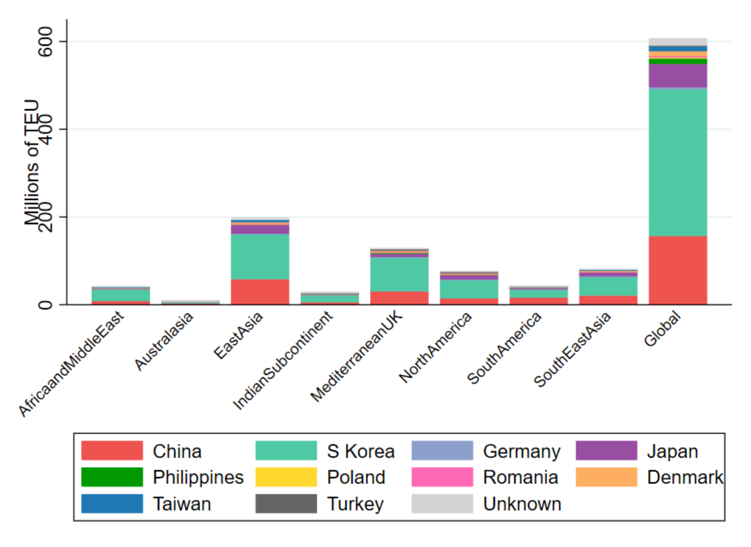
$$M_l^{\text{out}} = \frac{1}{\Xi_l} \sum_i \frac{L_i}{\bar{L}} \Big[(1-\sigma)\,(DG)^{-1}_{x,il,2} + \sigma\,(DG)^{-1}_{y,il,2} \Big],$$

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^{in} and M_l^{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 $M_k^{\text{in}} = M_l^{\text{out}} = 1$, recovering the traditional result $-\frac{\partial \ln W}{\partial \ln \kappa_{kl,m}} = \Xi_{kl,m}$.

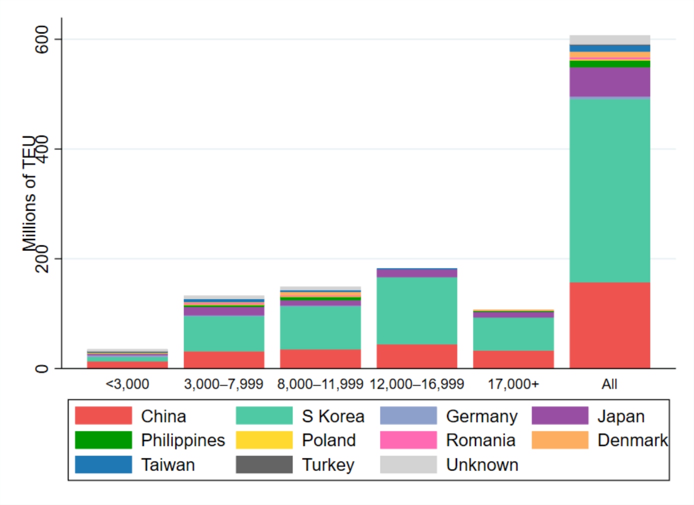
Global Distribution of Shipbuilding Countries

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



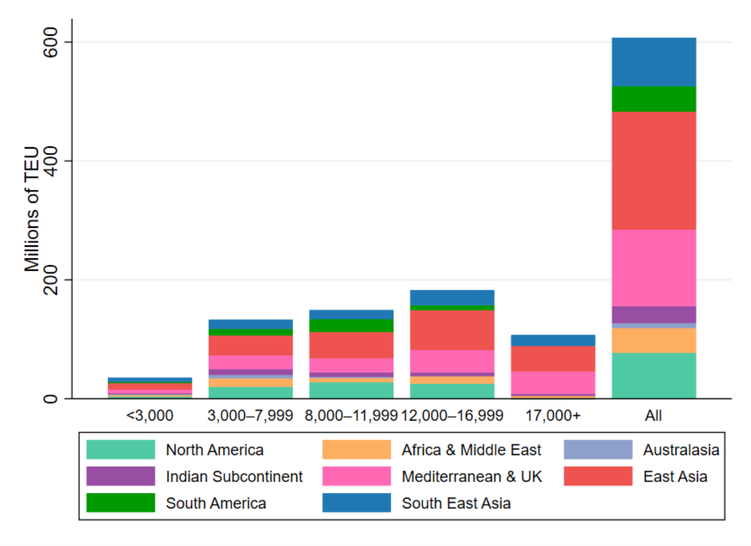
Global Distribution of Shipbuilding Countries: by Size

- 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



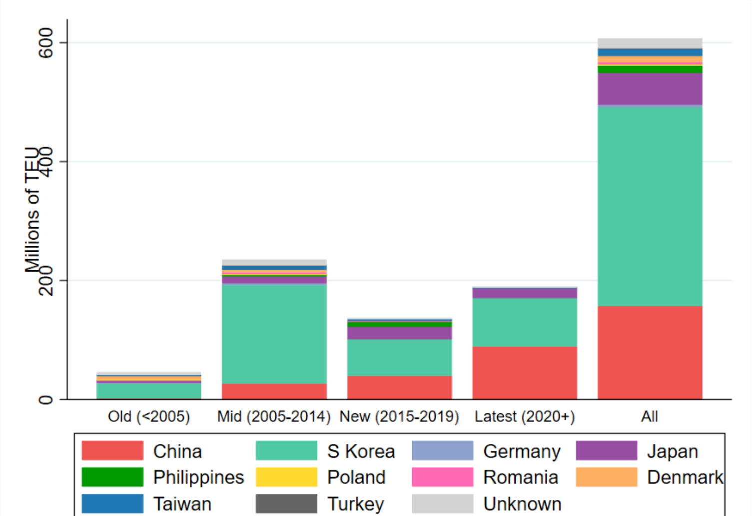
Global Distribution (levels)

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



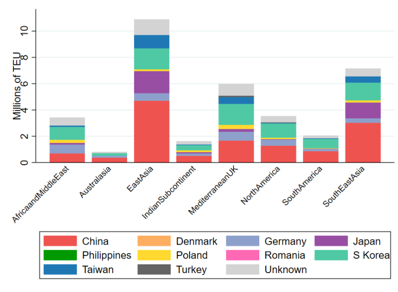
Global Distribution of Shipbuilding Countries: by Age

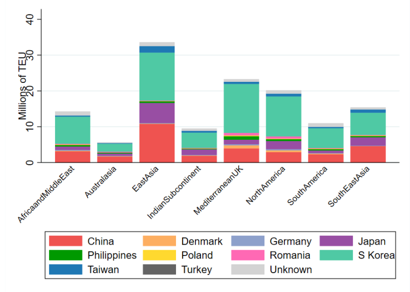
- By age: Both countries build 90% of most recent ships (2020 onwards), China 46.9% SK 43%
- China accounts for only 3.8% of old ships, show recent dominance in shipbuilding

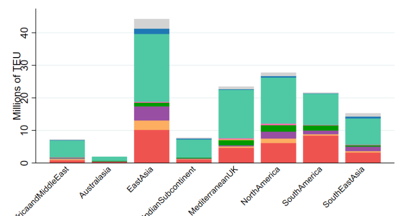


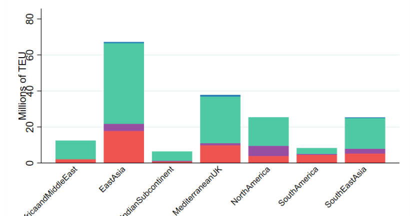
Global Distribution (I will combine the legends for these into one)

- By builder country and size: There are many more builder countries for smaller sized ships (maybe shares are in buttons?)



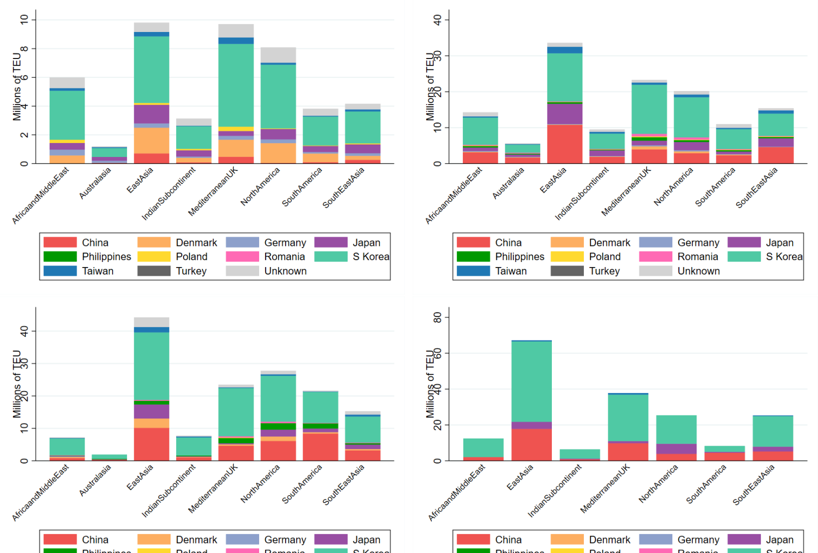






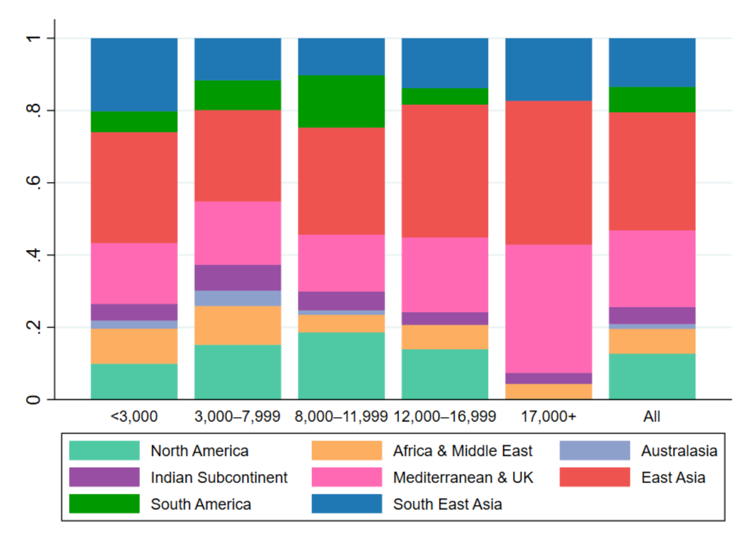
Global Distribution (I will combine the legends for these into one)

- By builder country and size: There are many more builder countries for smaller sized ships

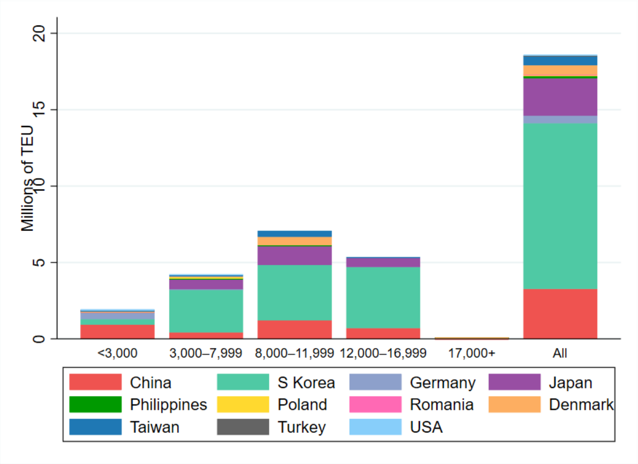


Global Distribution (shares)

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



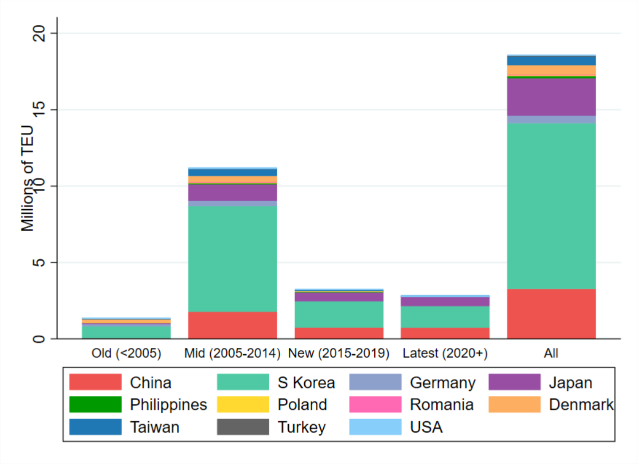
U.S. Imports by Vessel Size in Levels



- U.S. imports mostly use East Asian-built ships (Korea, China, Japan)
- China builds 35% of feeders but only 15% of ultra-large vessels; Korea/Japan dominate the largest

Back

U.S. Imports by Vessel Vintage in Levels



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

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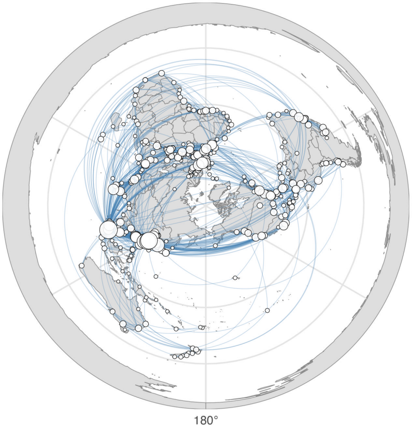
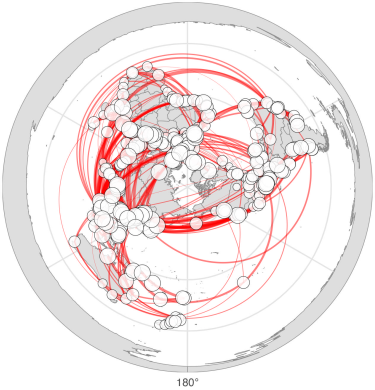
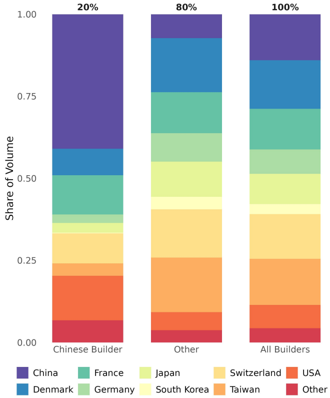
Global Distribution of Shipbuilding Countries: by Trade Lanes

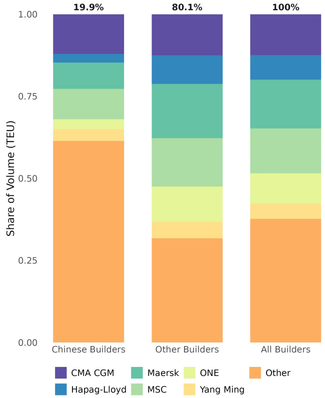




- Chinese shipping present across all major shipping lanes Shares
- Particularly prevalent in the most crucial lanes (Asia-Europe, Asia-North America) and most significant entrepots

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