# Oligopolies in Trade and Transportation: Implications for the Gains from Trade

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The views expressed here do not necessarily reflect those of the Bank of Italy or the Euro-System.

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# Introduction

- Transportation sector is crucial and indispensable for global trade and economic growth:
  - Recent events: Suez, Red Sea, Baltimore blockages; Panama Canal droughts; port congestion due to Covid.

- Mostly overlooked in trade/IO literature despite its importance.
  - Standard assumption: iceberg trade costs.
  - Ignore market structure and price negotiations in transportation.

- We study how imperfect competition and carrier-importer relationships shape transportation costs.
  1. New stylized facts on the presence of bilateral bargaining within a two-sided market power structure.
  2. Estimate relative bargaining power, decompose bilateral prices into markups and markdown.
  3. Embed these features in a quantitative trade model to quantify the welfare effects of trade shocks.

# Stylized Facts

# Data

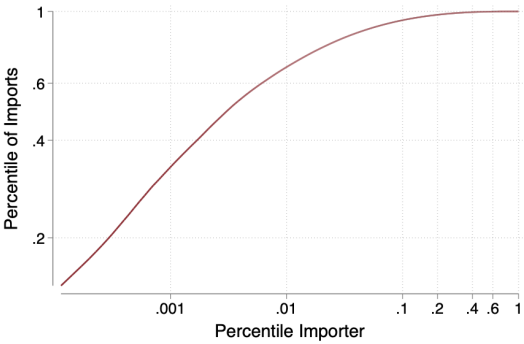
We use official Chilean Custom Data on imports from 2007 to 2022:

- 12mil daily transactions reporting:
  - Total value, quantity, and weight;
  - Product category (8-digit);
  - Country of origin;
  - Importer (numerical ID);
  - **Freight charges** $\rightarrow$ Freight per unit of value, kg, or quantity;
  - **Mode used** (sea vs air vs road);
  - **Shipper company** (string name and/or ID);
  - **Incoterms information** (party responsible for the delivery).

- We aggregate at importer-transporter-market-time observations:
  - Time: quarterly frequency;
  - Market: Mode-Origin-HS2 triplet;
  - Unit values are expressed per KG

# I. Concentration in Trade and Transportation

- 10% of importers account for 95% of total imports
- Average market HHI » 0.4 (green line) → strong concentration among freight carriers



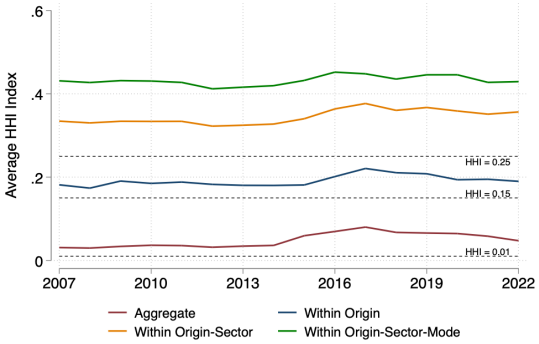




**Figure 1:** Concentration among Importers and Freight Carriers

# II. Variation in Bilateral Freight Prices

- Mean CoV across markets is $\approx 0.9$
- Uniform pricing $\rightarrow$ CoV $\leq 0.01$

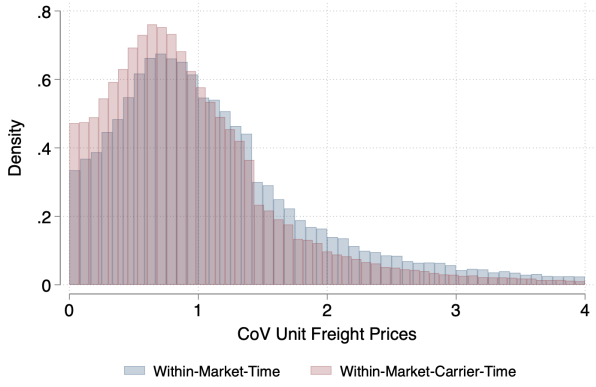



**Figure 2:** Freight Price Dispersion

- Statistical accounting of variation in unit freight prices (AKM, 1999):

$$\log \tau_{ijmt} = \text{FE}_i + \text{FE}_j + \text{FE}_{mt} + \beta \mathbf{X}_{ijmt} + \varepsilon_{ijmt}$$

| | (1) | (2) |
|---|---|---|
| **Panel A: Share of price dispersion explained by:** | | |
| Observables | . | 0.023 |
| Buyer FE | 0.049 | 0.051 |
| Transport Company FE | 0.041 | 0.041 |
| Market x Time | 0.626 | 0.606 |
| Match Residual | 0.283 | 0.279 |
| **Panel B - Within Carrier-Market-Time:** | | |
| Observables | . | 0.024 |
| Buyer FE | 0.112 | 0.111 |
| Match Residual | 0.888 | 0.865 |

**Table 1:** Fixed-effect Decomposition of Freight Price Dispersion

# III. Bargaining in Unit Freight Prices

- Carrier market power: carrier $j$'s share in importer $i$'s total purchases
- Importer market power: importer $i$'s share in carrier $j$'s total sales IV Construction

$$\log p_{ijmt} = \alpha + \beta_s \log s_{ijmt} + \beta_x \log x_{ijmt} + \beta \mathbf{X}_{ijmt} + FE_i + FE_j + FE_{mt} + \varepsilon_{ijmt}$$

| | (1) OLS | (2) OLS | (3) OLS | (4) IV |
|---|---|---|---|---|
| Log Carrier Share | 0.053 | 0.053 | 0.448 | 0.209 |
| | (0.002) | (0.002) | (0.004) | (0.059) |
| Log Importer Share | -0.201 | -0.201 | -0.549 | -0.302 |
| | (0.002) | (0.002) | (0.003) | (0.055) |
| Controls | No | Yes | Yes | Yes |
| $FE_j + FE_i + FE_{mt}$ | Yes | Yes | No | No |
| $FE_{jmt} + FE_{imt}$ | No | No | Yes | Yes |
| F-stat | | | | 74.605 |
| $N$ | 1,505,273 | 1,505,273 | 1,335,604 | 1,321,917 |

**Table 2:** Prices and Bilateral Concentration

# Robustness

Empirical results survive a series of robustness checks:

I. Concentration in Trade and Transportation Robustness
II. Variation in Bilateral Freight Prices Robustness
III. Bargaining in Unit Freight Prices Robustness

# Theoretical Framework

# Model Overview

- Firm-to-firm trade with two-sided market power.
  - Focus on relationship between importer *i* and carrier *j* in a single transportation market.
- Partial equilibrium and Nash-in-Nash bargaining.
  - Price of transportation services is bilateral, taking as given all other bilateral agreements.
- Functional form restrictions and simplifying assumptions, partially relaxed in quantitative analysis.
  - Framework used to estimate deep parameters of firm-to-firm trade in transportation.

# Importer Technology

- The domestic final demand for the good produced by importer $i$ is:

$$y_i = A_i p_i^{-\sigma}, \qquad \sigma > 1$$

- Technology: CRS in imported inputs $q_{iF}$ and domestic inputs $q_{iD}$:

$$y_i = \varphi_i q_{iD}^{1-\gamma} q_{iF}^{\gamma}$$

- Assumption: no buyer market power in input markets, common price taken as given.

# Importer Technology (cont'd)

- Each unit of imports requires one unit of transportation services → Leontief production.

$$q_{iF} = \min\{\overline{q_{iF}}, t_i\}$$

where $\overline{q_F}$ : physical imported input; $t_i$ : transportation service purchased by the importer.

- Transportation services: CES composite bundle of carrier-specific varieties. Logit

$$t_i = \left( \sum_{j \in J_i} t_{ij}^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \qquad \text{and } \tau_i = \left( \sum_{j \in J_i} \tau_{ij}^{1-\rho} \right)^{\frac{1}{1-\rho}},$$

where:

- $t_{ij}$: quantity of transportation services that importer $i$ purchases from carrier $j$.
- $\tau_{ij}$: corresponding bilateral price.
- $\rho > 1$: substitutability across carriers → Carrier market power.

→ Unit price of imported inputs is $p_{iF} = \overline{p_{iF}} + \tau_i \Leftrightarrow p_{iF}$ = factory-gate + transportation.

# Carrier Technology

- Each carrier sells a unique variety of transportation services.

- Technology:

$$t_j = \zeta_j l_j^{\theta},$$

  where:
  - $l$: input bundle, with price $p_l$ common and taken as given.
  - $\theta$: RTS parameter.

- $\theta \in (0, 1)$: upward-sloped supply with marginal cost increasing in quantity $\rightarrow$ **Importer market power.**
- Increasing marginal costs are the result of capacity constraint.

# Bargaining over Shipment Prices

- Bilateral prices $\tau_{ij}$ outcome of Nash-in-Nash Bargaining over joint surplus:

$$\max_{\tau_{ij}} \left(\pi_i(\tau_{ij}) - \widetilde{\pi_{i(-j)}}\right)^{\phi} \left(\pi_j(\tau_{ij}) - \widetilde{\pi_{j(-i)}}\right)^{1-\phi},$$

  where:
  - $\widetilde{\pi_{i(-j)}}$, $\widetilde{\pi_{j(-i)}}$: importer's and carrier's outside options (i.e. if $i-j$ pair breaks).
    - Outside options depends on how much $i$ and $j$ rely on each other.
  - $\phi$ captures importers' bargaining power.

- Assumption: taking as given other pairs, down- and up- stream markets.

# Bargaining over Shipment Prices (cont'd)

- The FOC for the bilateral price $\tau_{ij}$ is:

$$\tau_{ij} = \underbrace{c_j}_{\text{MC Carrier } j} \underbrace{\left(\omega_{ij}\mu_{ij}^{\mathcal{I}} + (1-\omega_{ij})\mu_{ij}^{\mathcal{J}}\right)}_{\text{Bilateral Markup } \mu_{ij}},$$

- Oligopolistic markup $\mu_{ij}^{\mathcal{J}} \geq 1$:

$$\mu_{ij}^{\mathcal{J}} = \frac{\epsilon_{ij}}{\epsilon_{ij}-1}, \qquad \frac{\partial \log \mu_{ij}^{\mathcal{J}}}{\partial \log s_{ij}} \geq 0, \qquad s_{ij} = \frac{\tau_{ij} t_{ij}}{\sum_{z \in J_i} \tau_{iz} t_{iz}},$$

- Oligopsonistic markdown $\mu_{ij}^{\mathcal{I}} \leq 1$:

$$\mu_{ij}^{\mathcal{I}} = \theta \frac{1-(1-x_{ij})^{\frac{1}{\theta}}}{x_{ij}}, \qquad \frac{\partial \log \mu_{ij}^{\mathcal{I}}}{\partial \log x_{ij}} \leq 0, \qquad x_{ij} = \frac{t_{ij}}{\sum_{z \in Z_j} t_{zj}},$$

- $\omega_{ij} \in (0,1)$: weighting factor increasing in importers' bargaining power.

# Empirical Analysis

# Estimation of Key Parameters

- Estimate primitive parameters $\{\phi, \theta, \rho\}$:
  1. Leveraging demand for transportation services $\rightarrow$ estimate substitutability across carriers $\rho$.
  2. Given $\rho$, joint estimation of $\phi$ and $\theta$ leveraging price FOC.
- Goal: decompose bilateral prices in oligopolistic markup and oligopsonistic markdown.

# Estimation of $\rho$

- Identification of $\rho$ relies on demand equation for transportation service

$$\log s_{ijt}^m = -(\rho - 1)\left(\log \tau_{ijt}^m - \log \tau_{it}^m\right) + \nu_{ijt}^m$$

- We estimate the following:

$$\underbrace{\Delta \log s_{ijk,t}^m}_{\substack{\Delta \text{ in Importer } i\text{'s Share} \\ \text{with Carrier } j \text{ and another Carrier } k}} = -(\rho - 1) \underbrace{\Delta \log \tau_{ijk,t}^m}_{\substack{\Delta \text{ in Importer } i\text{'s Price} \\ \text{with Carrier } j \text{ and another Carrier } k}} + \Delta \nu_{ijkt}^m$$

Details

- Endogeneity of prices:
  - Hausman IVs, price charged by the *same* carrier $j$ to *other* importers in *other* markets.
  - Intuition: exploiting common carrier-level cost shocks across markets for identification.
  - Exogeneity assumption: importers' demand shocks not correlated across markets, $cov(\nu_{ijt}^m, \nu_{i'jt}^{m'}) = 0$.

# Joint Estimation of $\phi$ and $\theta$

- Identification of $\phi$ and $\theta$ relies on FOC for bilateral price $\tau_{ij}$:

$$\log \tau_{ijt} = \log \mu_{ijt} + \log c_{jt} + \nu_{ijt}$$

- Moment conditions identified by the $\Delta$ in price carrier $j$ charges to two importers $i$ and $z$:

$$g(\phi, \theta, \Lambda_{ijt}) \equiv \mathbb{E}_u[\nu_{ijt} - \nu_{zjt} | \Lambda_{izj,t}] \equiv \mathbb{E}_u[(\log \tau_{ijt} - \log \mu_{ijt}) - (\log \tau_{zjt} - \log \mu_{zjt}) | \Lambda_{izj,t} = 0 \quad \forall i, z, j, t,$$

Details

- Endogeneity: $\nu_{jit} - \nu_{jkt}$ reflects unobserved (cost) heterogeneity across buyers.
- IV: mean (median) bilateral shares in $m$ excluding involved pairs i – j and z – j.
- Correlated with endogenous explanatory variables through level of competition in the market.

# Results - $\widehat{\rho}$, $\widehat{\phi}$ and $\widehat{\theta}$

- Low substitutability across carriers $\rightarrow \widehat{\rho} \approx 3$
- Importers have two times more bargaining power than carriers $\rightarrow \frac{\widehat{\phi}}{1-\widehat{\phi}} \approx 2.3$
- Carriers have decreasing return to scale $\rightarrow \widehat{\theta} \approx 0.56$

| | $\widehat{\beta}$ | $\frac{\widehat{\phi}}{1-\widehat{\phi}}$ | $\widehat{\theta}$ |
|---|---|---|---|
| | -2.073 | 2.330 | 0.562 |
| | (0.418) | (0.159) | (0.101) |
| Implied $\rho$ | 3.073 | | |
| Implied $\phi$ | | 0.700 | |
| $FE_j \times FE_m$ | Y | N | N |
| N | 202196 | 11664641 | 11664641 |

**Table 3:** Estimated Model Parameters

Robustness

# Results - Bilateral Markup Distribution

- Carriers charge relatively higher markups compared to importers
- Implied bilateral markups over carrier's marginal cost of $\approx$ 12%

| | Mean | p10 | p50 | p90 |
|---|---|---|---|---|
| Oligopolistic Markup | 2.305 | 1.670 | 2.144 | 3.100 |
| Oligopsonistic Markdown | 0.911 | 0.793 | 0.927 | 0.985 |
| Bargaining Weight | 0.777 | 0.739 | 0.773 | 0.814 |
| Bilateral Markup | 1.118 | 1.032 | 1.129 | 1.176 |

**Table 4:** Bilateral Markups

# Quantitative Analysis

# Quantitative Model Overview

- Quantitative trade model of importing. Blaum et al. (2019), Halpern et al. (2015)
  Trade-off: importing reduces marginal cost vs fixed cost of importing.
- Single imported good from a representative foreign market (ROW) $\rightarrow$ One transportation market.
- Depart from iceberg trade cost, embed dual market power and bargaining in transportation industry.
- Estimate using combination of firm-level and customs data and SMM.
- Goal: counterfactual exercises to gauge the role of dual market power for GFT.

Small open economy, populated by unit measure of consumers:

- Supply $L$ units of labor inelastically.
- Consume bundle $C$ of a fixed and exogenous number of domestic products $N$:

$$C = \left( \sum_{i}^{N} c_i^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}},$$

  subject to budget constraint: $\sum_i^N p_i c_i \leq wL + \sum_i^N \pi_i$.

  $\rightarrow$ Demand for each product $i \in N$: $c_i = p_i^{-\sigma} P^{\sigma} Y$

- CRS Cobb-Douglas technology :

$$y_i = \varphi_i l_i^{1-\beta_i} x_i^{\beta_i}$$

- Intermediate input:

$$x_i = \left( \eta_i q_{iD}^{\frac{\gamma-1}{\gamma}} + (1-\eta_i) q_{iF}^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}}$$

Firm $i$ imports

$$x_i = \eta_i^{\frac{\gamma}{\gamma-1}} q_{iD}$$

Firm $i$ does not import

- Roundabout production : $q_{iD} = \left( \sum_v^N y_{iv}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$
- Access to foreign inputs after paying a fixed cost of $f$ units of domestic labor

- Transportation sector is modeled as in PE

- Balanced trade between the domestic economy and the rest of the world:

$$\sum_{i}^{N} p_i y_i^{ROW} = \sum_{i}^{N} (1 - s_{iD}) m_i,$$

- Definition of equilibrium: set of (bilateral) prices $\{w, [p_i], [\tau_{ij}]\}$, labor demands for production and fixed costs, demand for services $[t_{ij}]$, production and consumption $\{[y_i], [c_i], [y_i^{ROW}]\}$, and input demands $\{[q_{iD}], [q_{iF}]\}$ such that firms maximize profits, consumers maximize utility, trade is balanced and labor and good markets clear.

# Calibration & Estimation

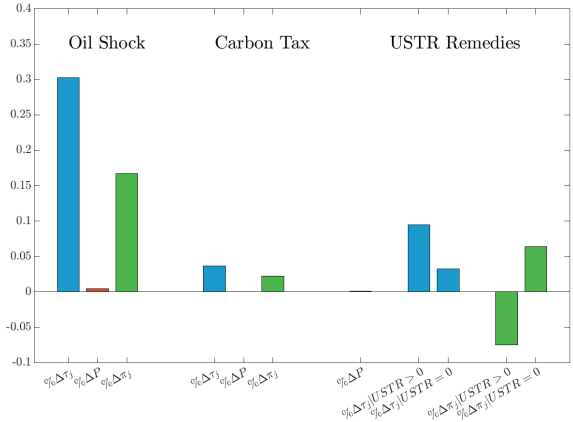
- Calibrate a set of parameters following previous literature and using additional firm-level data.
  Calibrated Parameters
- Importer are on average more productive than carriers
- Importers productivity distribution is more dispersed than those of carriers Estimated Parameters

**Table 5:** Pass-through of Tariffs

| Tariff Increase by | Iceberg Trade Costs (1) | Bilateral - No Entry/Exit (2) | Bilateral (3) |
|---|---|---|---|
| 5 % | 0.65 | 0.41 | 0.46 |
| 10 % | 1.30 | 0.79 | 0.84 |
| 20 % | 2.61 | 1.48 | 1.62 |
| 30 % | 3.91 | 2.08 | 2.35 |

**Notes**: The Table reports the percentage change in the aggregate price index after the introduction of an ad valorem tariff on imported goods. Column (1) reports the results from a model where transportation costs are iceberg. Column (2) reports the results from our model, fixing the number of importers to the original equilibrium. Column (3) reports the results from our model accounting for entry and exit.

**Figure 3:** Oil Shock, Carbon Tax, and USTR remedies




**Notes**: This figure reports the changes in transport costs (blue), domestic prices (red), and carriers' profits (green) across three counterfactual scenarios: on the left, a symmetric increase in fuel prices due to an oil shock; in the center, a carbon tax; and on the right, an asymmetric increase in costs due to port fees. We abstract from the effects of the entry/exit margin.

# Conclusion

# Conclusion and Next Steps

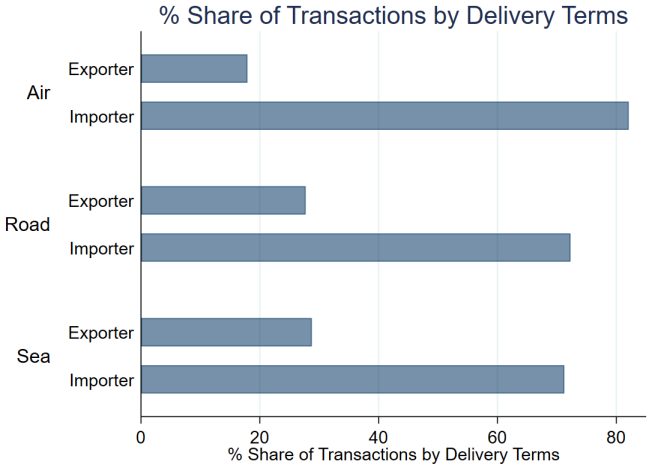
- Document novel stylized facts on transportation industry:
  - The transport sector and the imports market are highly concentrated, and...
  - ... in fact, transportation prices are consistent with bilateral bargaining.
- Propose and estimate model of dual market power and bargaining between carriers and importers.
  - Average bilateral markup of 11%.
  - Stronger bargaining power for importers. Economically reasonable heterogeneity.
- Endogenous response of transportation prices makes the domestic economy more resilient to shocks.

# Appendix: Data & Stylized Facts

# Data

- We keep air, sea, and land as mode of transport ($>$ 95% of total transactions).
  - We exclude observation with unreasonable origin-mode (e.g. road mode from different continent).
- We drop the following sectors:
  - Weapons (HS93)
  - Art items (HS97)
  - Non-categorised (HS99)
- We drop all the origin-code that do not correspond to a single country.
- Customs report the RUTs (Chilean tax identifier) of the carrier and a string with the name. We construct the id of the carrier in the following way:
  1. We keep RUTs if they belong to a carrier.
  2. If RUTs belong to a forwarder, we use the string to identify the carrier.
  3. We manually concord strings.
  4. We drop RUT that are not valid.

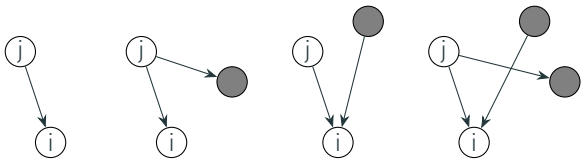
# Summary Statistics




**Notes**: The figure reports the share of transactions that is arranged by the importer across different transport modes. The party in charge of the transaction is reported in the variable Incoterms included in the Chilean custom data.

# Summary statistics

- Rich network structure:
  - Large share of import via multilateral links (many-to-many);
  - Multiple importers facing the same single shipper (1-to-many).

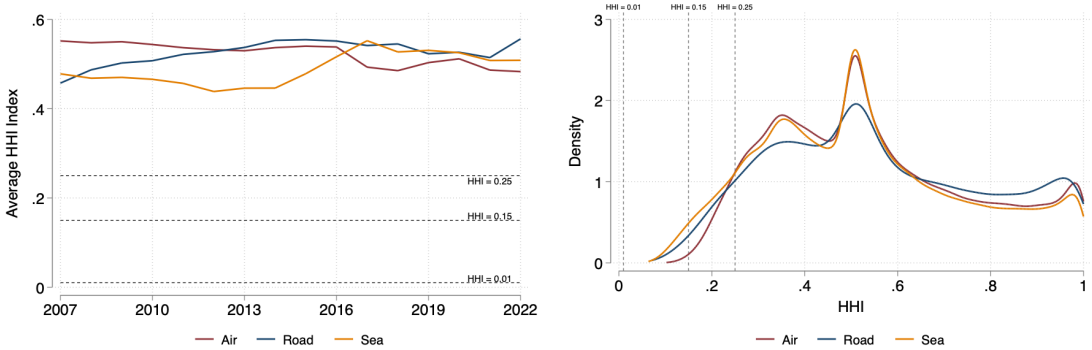



| | 1:1 | 1:m | m:1 | m:m |
|---|---|---|---|---|
| Fraction of links | 0.036 | 0.445 | 0.005 | 0.525 |
| | (0.386) | (0.242) | (0.162) | (0.248) |
| Fraction of import value | 0.017 | 0.338 | 0.007 | 0.593 |
| | (0.408) | (0.295) | (0.196) | (0.293) |

→ Variation we leverage to estimate the model.

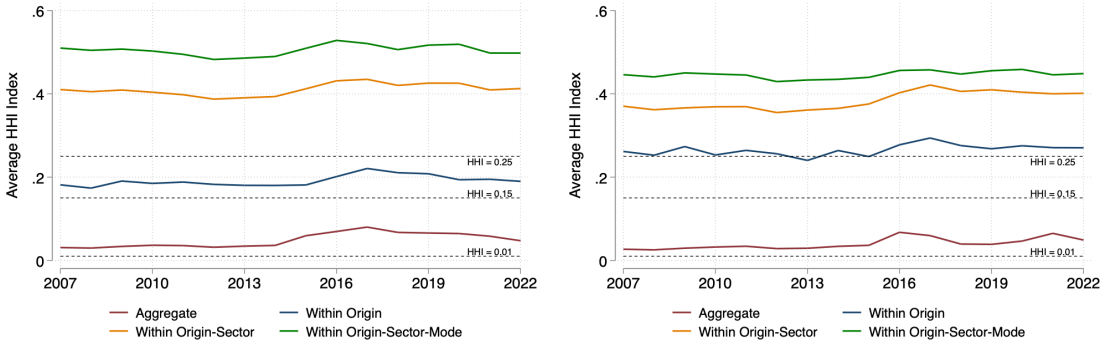
# Robustness: Concentration in Trade and Transportation

**Figure 4:** Concentration in International Transportation by Mode




**Notes**: The left panel plot the average HHI index across the different markets of the transportation sector over time. Markets are defined as a mode-origin-sector combination, where a sector is defined as a HS2 category. We compute the average distinguishing markets by their mode (sea vs air vs road freight). The left panel plots the distribution of HHI indices across the different markets, distinguishing markets by their mode (sea vs air vs road freight). Carriers' market share are computed in terms of value shipped.

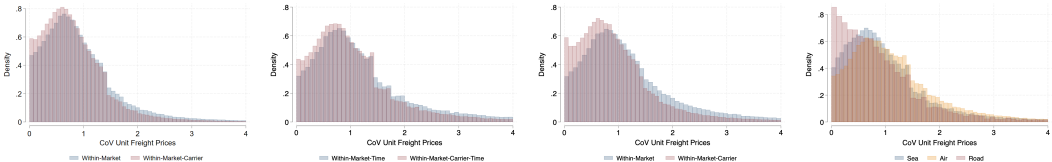
**Figure 5:** Concentration in International Transportation




**Notes**: The left panel reports the average HHI index across different markets of the transportation sector over time but with 4-digit products (HS4). The right panel instead uses 2-digit products but share are computed using the weight in kg transported. The blue line defines markets by the country of origin. The orange and green lines defines markets as a combination of origin-sector and mode-origin-sector, respectively. Back

# Robustness: Variation in Bilateral Freight Prices

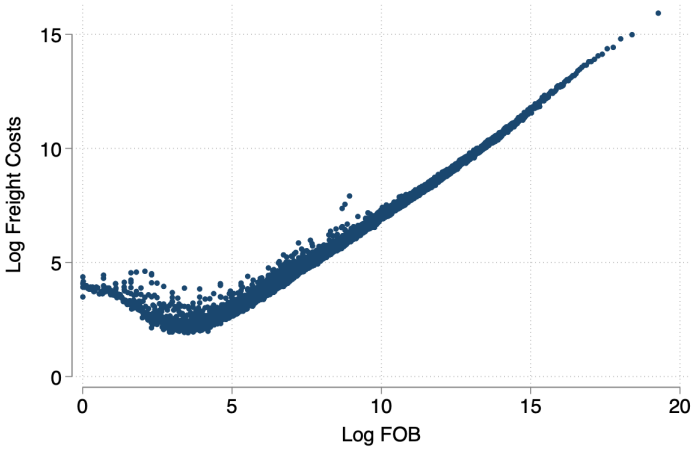
**Figure 6:** Freight Price Dispersion




**Notes**: The first panel plots the distribution of the coefficient of variation of unit freight prices within a market (and time). Markets are defined as a mode-origin-sector combination, where modes are sea, air, and road, and sectors are HS4 categories, respectively. In second panel, unit freight prices are computed by dividing total freight cost by the quantity transported. The third left panel plots the distribution of the coefficient of variation of unit freight prices within a market and within market-carrier pairs (and time) using the full sample of transaction. The last panel plots the distribution of the coefficient of variation of unit freight prices within a market (and time) distinguishing by the mode of transportation (sea, air, and road).

# Rejecting Iceberg Assumption

- Dispersion and non-proportionality to transaction reject standard assumption.



# Robustness: Variation in Bilateral Freight Prices

**Table 6:** Fixed-effect Decomposition of Freight Price Dispersion - Alternative Measures

| | Value | | Quantities | | HS4 | | Full Sample | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| **Panel A - Share of price dispersion explained by:** | | | | | | | | |
| Observables | . | 0.048 | . | -0.000 | . | 0.011 | . | 0.038 |
| Buyer FE | 0.108 | 0.102 | 0.108 | 0.108 | 0.048 | 0.049 | 0.039 | 0.041 |
| Transport Company FE | 0.025 | 0.026 | 0.028 | 0.028 | 0.035 | 0.035 | 0.061 | 0.062 |
| Sector x Time x Origin x Mode | 0.327 | 0.306 | 0.476 | 0.477 | 0.629 | 0.618 | 0.634 | 0.601 |
| Match Residual | 0.540 | 0.518 | 0.388 | 0.388 | 0.288 | 0.287 | 0.265 | 0.258 |
| **Panel B - Within Carrier-Sector-Origin-Time-Mode:** | | | | | | | | |
| Observables | . | 0.054 | . | -0.000 | . | 0.008 | . | 0.044 |
| Buyer FE | 0.192 | 0.170 | 0.162 | 0.162 | 0.110 | 0.110 | 0.092 | 0.089 |
| Match Residual | 0.808 | 0.776 | 0.838 | 0.838 | 0.890 | 0.882 | 0.908 | 0.867 |

**Notes**: The table reports the results of the variance decomposition exercise for the freight price based on AKK, 1999. Unit freight prices are computed by dividing total freight cost by value, columns (1)-(2), or by quantities, columns (3)-(4). In columns (5)-(6) we use as market's definition an HS4-origin-mode triplet, while in columns (7)-(8) we do not restrict the analysis to transaction arranged by importers. For each set of regressions, the even column includes observable characteristics such as carrier's experience, age of relationship, size of transaction, while odd column includes only fixed effects.

Back

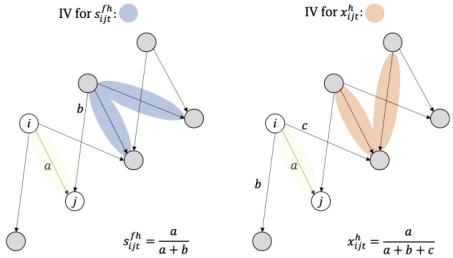
# Robustness: Bargaining in Unit Freight Prices

**Table 7:** Prices and Bilateral Concentration - Robustness

| | (1) Sea | (2) Air | (3) Quantity | (4) HS4 | (5) Full Sample |
|---|---|---|---|---|---|
| Log Carrier Share | 0.336 | 0.165 | 0.274 | 0.234 | 0.087 |
| | (0.115) | (0.067) | (0.170) | (0.057) | (0.037) |
| Log Importer Share | -0.399 | -0.274 | -0.288 | -0.330 | -0.189 |
| | (0.107) | (0.062) | (0.153) | (0.053) | (0.036) |
| Controls | Yes | Yes | Yes | Yes | Yes |
| $FE_{jmt} + FE_{imt}$ | Yes | Yes | Yes | Yes | Yes |
| F-stat | 21.903 | 52.676 | 61.728 | 92.137 | 135.143 |
| $N$ | 840,269 | 479,406 | 1,322,471 | 1,307,289 | 2,628,934 |

**Notes**: All Columns include the additional controls, and carrier-market and importer-market fixed effects. Columns (1) and (2) consider the subsample of sea and air freight, respectively. Column (3) measures unit freight prices per quantities shipped. Columns (4) reports the estimates using HS4 products rather than HS2. Column (5) uses the full sample of transactions. We exclude all importer-market-time and carrier-market-time singletons from the estimation. IV Estimates. Standard errors are clustered at the importer level. Back

- *i* seller; *j* is the buyer.

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# Appendix: Model

# Logit Microfoundation

- Importer purchases transportation services $t_i$ from one carrier only.
- Discrete choice problem: indirect utility of importer $i$ from choosing a specific $j$

$$V_{ij} = -\log \tau_{ij} + \frac{1}{1-\rho}\epsilon_{ij},$$

  where $\tau_{ij}$ is the bilateral price between $i$ and $j$.
- Assume $\epsilon_{ij}$ distributed according to Gumbel Extreme-Value type I.
- Expected demand of importer $i$ for carrier $j$ transportation services, $t_{ij}$, as

$$t_{ij} = \frac{\tau_{ij}^{1-\rho}}{\sum_{z \in Z_j} \tau_{iz}^{1-\rho}} t_i = \frac{\tau_{ij}^{1-\rho}}{\tau_i^{1-\rho}} t_i \quad \text{with } \tau_i = \left( \sum_{z \in Z_j} \tau_{iz}^{1-\rho} \right)^{\frac{1}{1-\rho}}.$$

  which is equivalent to the CES specification.

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# Appendix: Estimation PE

# Data Construction

- Same dataset used for stylized facts (customs from 2007-2022) with additional cleaning.
  - Trim unit transport price at the 5% level within each route and at the 1% level in the whole sample.

- Define market $m$ as an HS2 - country of origin - mode of transportation triplet.

- Additional steps for $\rho$:
  - Exclude markets with only one carrier operating (no variation in $s_{ijt}^m$);
  - Exclude carriers operating in only one market or selling only to one importer because (no Hausman IV)
  - Exclude importers that purchase transportation services from only one carrier within a market (no difference).

- Additional steps for $\phi$ and $\theta$:
  - Keep markets with $\geq 3$ carriers and importers transacting with $\geq 2$ carriers (no variation)
  - Exclude carriers transacting with only one importer within each market (moment condition not defined).
  - Calibrate $\rho = 3$ and other parameters $(\sigma, \gamma)$ consistently with data for quantitative analysis.
  - Drop all importer-carrier-market triplets that imply a carrier's perceived demand elasticity lower than one.
  - +80mil triplets, estimate by market $m$.

# Estimation of $\rho$

- Identification of $\rho$ relies on demand equation for transportation service (in log-log form):

$$s_{ijt}^m = \left(\frac{\tau_{ijt}^m}{\tau_{it}^m}\right)^{\rho-1} \qquad \longrightarrow \qquad \log s_{ijt}^m = -(\rho-1)\left(\log \tau_{ijt}^m - \log \tau_{it}^m\right) + \nu_{ijt}^m,$$

  where $m$ refers to a specific market; $\tau_{it}^m$: importer's price index; $\nu_{ijt}^m$: idiosyncratic demand shock.

- Translates into the following empirical specification:

$$\log s_{ijt}^m = \beta \log \tau_{ijt}^m + \alpha_{it}^m + \nu_{ijt}^m$$

- Endogeneity of prices:
  - Hausman IVs, price charged by the *same* carrier $j$ to *other* importers in *other* markets.
  - Intuition: exploiting common carrier-level cost shocks across markets for identification.
  - Exogeneity assumption: importers' demand shocks not correlated across markets, $cov(\nu_{ijt}^m, \nu_{i'jt}^{m'}) = 0$.

- We estimate it in difference to abstract away from importer-market-time fixed effects:

$$\Delta \log s_{ijj't}^m = -(\rho-1)\Delta \log \tau_{ijj't}^m + \Delta \nu_{ijj't}^m,$$

  where $\Delta \log x_{ijj't}^m \equiv \log x_{ijt}^m - \log x_{ij't}^m$.

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# Joint Estimation of $\phi$ and $\theta$

- Identification of $\phi$ and $\theta$ relies on equilibrium bilateral prices (in log form):

$$\tau_{ijt} = c_{jt}\mu_{ijt}(\phi, \theta, \rho, s_{ijt}, x_{ijt}) \qquad \longrightarrow \qquad \log \tau_{ijt} = \log \mu_{ijt}(\phi, \theta, \rho, s_{ijt}, x_{ijt}) + \log c_{jt} + \nu_{ijt}.$$

- Assumption: carriers' marginal cost is not importer specific. Alviarez et al. (2023)
  $\nu_{ijt}$: mean-zero i.i.d. capturing cost differences across the buyers of a given carrier.

- Moment condition: difference between the price carrier $j$ charges to any two distinct importers $i$ and $k$:

$$g(\phi, \theta, \Lambda_{jikt}) \equiv \mathbb{E}_u[\nu_{jit} - \nu_{jkt}|\Lambda_{jikt}] \equiv \mathbb{E}_u[\log \tau_{ijt} - \log \mu_{ijt} - (\log \tau_{kjt} - \log \mu_{kjt})|\Lambda_{jikt}] = 0 \quad \forall i, k, j, t,$$

  $\rightarrow$ No information on carrier's marginal cost is required.

- GMM collecting all moment condition across all i – k – j – t.

- Endogeneity: $\nu_{jit} - \nu_{jkt}$ reflects unobserved (cost) heterogeneity across buyers.
  IV: mean (median) bilateral shares in $m$ excluding involved pairs i – j and k – j.
  Correlated with endogenous explanatory variables through level of competition in the market.

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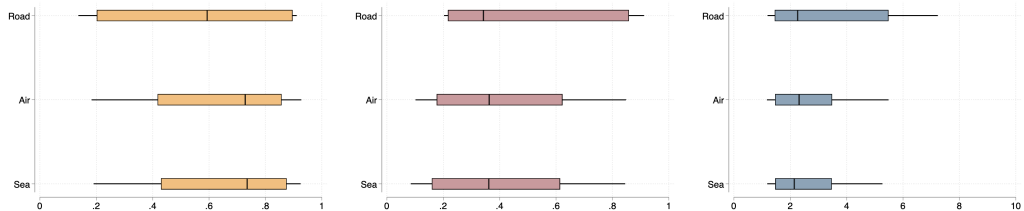
**Table 8:** Estimated $\widehat{\rho}$ - Robustness

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | OLS | IV | IV | IV | IV |
| $\widehat{\beta}$ | 0.021 | -2.352 | -1.877 | -1.564 | -2.023 |
| | (0.014) | (0.451) | (0.367) | (0.325) | (0.412) |
| Implied $\widehat{\rho}$ | | | | | |
| | | 3.352 | 2.877 | 2.564 | 3.023 |
| FEs | – | $FE_j + FE_m$ | $FE_j + FE_m + FE_t$ | $FE_j \times FE_m + FE_t$ | $FE_j \times FE_m$ |
| N | 203425 | 203087 | 203087 | 202196 | 202196 |

**Notes**: The table reports the estimated price elasticities. Column (1) is estimated via OLS without any fixed effect. Columns (2) to (4) saturate the specification in difference with different sets of fixed effects and the set of instruments from the main specification. The last column estimates using an alternative set of instruments including the log number of importers and carriers. All specifications are estimated in difference. Standard errors are clustered at the importer level. Implied $\widehat{\rho}$ reports the implied $\rho$, computed as $\widehat{\rho} = -\widehat{\beta} + 1$.

# Results - $\widehat{\rho}$, $\widehat{\phi}$ and $\widehat{\theta}$: Heterogeneity by Mode

**Figure 7:** Distribution Parameters by Mode of Transportation




**Notes**: The Figure plots the distribution of the estimated bargaining power parameter $\phi$ (left panel), return to scale parameter $\theta$ (center panel), and substitutability across carriers $\rho$, by mode of transportation, i.e. distinguishing sea, air, and road markets. The box delimits the interquartile range of the distribution, while the whiskers span from the 10th to the 90th percentiles. Values of $\rho$ larger than ten are trimmed.

# Results - $\widehat{\rho}$, $\widehat{\phi}$ and $\widehat{\theta}$: Heterogeneity by Market

**Table 9:** Heterogeneity across Markets

| | $\widehat{\rho}$ | $\widehat{\phi}$ | $\widehat{\theta}$ |
|---|---|---|---|
| Mean | 3.99 | 0.64 | 0.42 |
| Weighted Mean | 3.57 | 0.52 | 0.54 |
| Median | 2.35 | 0.73 | 0.36 |
| IQR | 2.42 | 0.45 | 0.45 |
| Number of Markets | 819 | 505 | 505 |

**Notes**: The table reports moments from the distribution of parameters $\rho$, $\phi$, and $\theta$, estimated at the market level. Markets are defined as a origin-product(HS2)-mode triplet. Price elasticities are estimated from the specification in Equation (**??**); bargaining power and scale elasticity $\theta$ from moment condition (**??**). In the second row, markets are weighted by the number of $i - j$ pairs in each market.

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# Appendix: Estimation GE

# Externally Calibrated Parameters

- Elasticity of substitution $\sigma$ from the firms' profit margin: $\frac{\text{Revenues}_i}{\text{Costs}_i} = \frac{\sigma}{\sigma-1}$, where costs is the sum of wage bill, material and electricity expenditure, and user cost of capital. Oberfield and Raval (2021)
- Share of material spending $\beta$: given a value for $\sigma$, we use $\frac{m_i}{p_i y_i} = \beta\frac{\sigma-1}{\sigma}$.
- Substitutability between domestic and imported inputs $\gamma$: firm output can be written as:

$$y_i = A\varphi_i l_i^{1-\beta} m_i^{\beta} s_{iD}^{-\frac{\beta}{\gamma-1}},$$

  Leverage variation in domestic expenditure shares, $s_{iD}$, holding $m_i$ constant. Blaum et al (2019), Zhang (2017)

  Standard structural production function estimation techniques. Olley and Pakes (1992), Ackerberg et al. (2015)

# Estimation

| A. Estimated parameters | Estimate | (Std. Error) |
|---|---|---|
| Std of domestic firm productivity, $\sigma_{\varphi}$ | 0.42 | (0.01) |
| Mean of domestic firm productivity, $\mu_{\varphi}$ | -0.81 | (0.03) |
| Std of carrier productivity, $\sigma_{\zeta}$ | 1.22 | (0.07) |
| Std idiosyncratic importer-carrier match shock, $\sigma_{\alpha_{ij}}$ | 0.45 | (0.01) |
| Factory-gate price of imports, $\overline{p_{iF}}$ | 1.48 | (0.06) |
| Fixed cost of importing, $f$ | 0.13 | (0.01) |
| **B. Targeted moments** | **Data** | **Model** |
| Std sales share in domestic economy | 0.03 | 0.04 |
| Aggregate domestic share | 0.89 | 0.82 |
| Correlation$(s_{ij}, x_{ij})$ | 0.10 | 0.12 |
| Average Max $x_{ij}$ | 0.43 | 0.39 |
| Average Std in $x_{ij}$ across carriers | 0.13 | 0.09 |
| Average Max $s_{ij}$ | 0.47 | 0.47 |
| Average Std in $s_{ij}$ across importers | 0.18 | 0.17 |
| Average $s_{i\tau}$ | 0.13 | 0.13 |
| Std aggregate shares across carriers | 0.20 | 0.20 |

**Table 10:** Parametrization Back

# Externally Calibrated Parameters

1. Calibrate a set of parameters following previous literature and using additional firm-level data.
   - Data: ENIA, representative survey of manufacturing industries from 1995-2018. Panel of 5k firms per year. Standard balance sheet information (e.g. revenues, cost, imports, exports, capital, etc).
   - Calibrated parameters:

| Panel A: Calibrated Parameters | | |
|---|---|---|
| Transportation Sector and Bargaining Process | | |
| $\rho$ | 3.5 | Estimated |
| $\theta$ | 0.5 | Estimated |
| $\phi$ | 0.7 | Estimated |
| $N_j$ | 4 | Average Number of Carrier per Market |
| $N_i$ | 19 | Average Number of Importers per Market |
| Domestic Economy | | |
| $\beta$ | 0.45 | Median Share of Materials |
| $\gamma$ | 4 | Estimated using Production Function |
| $\sigma$ | 6 | Median Markup |
| $N$ | 95 | Share of Importers |
| $\eta$ | 0.5 | Normalized |
| L | 1 | Normalized |

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