China, Ports, and Trade

Pamina Koenig [1]   Sandra Poncet [2]   Mathieu Sanch-Maritan [3]

SPLOTT seminar, Université Gustave Eiffel

January 13, 2025

1. U. of Rouen, U Paris I, & PSE
2. U. of Paris I & PSE
3. U. of Saint-Etienne

International trade and transport firms

- Container shipping is the 3rd largest transported category in volume with 2 billion tons transported in containers.
  details
- Goods are transported by a few large firms.
- These firms not only carry containers, but also invest in terminals and ports
  details

Top 20 Operators — Existing Fleet / Orderbook

Rank	Operator	TEU	Share (%)
1	Mediterranean Shg Co	5,467,805	19.7
2	Maersk	4,120,528	14.8
3	CMA CGM Group	3,494,135	12.6
4	COSCO Group	3,042,939	10.9
5	Hapag-Lloyd	1,929,726	6.9
6	ONE (Ocean Network Exp...	1,697,634	6.1
7	Evergreen Line	1,649,763	5.9
8	HMM Co Ltd	790,342	2.8
9	Yang Ming Marine Transp...	705,614	2.
10	Zim	579,700	2.
11	Wan Hai Lines	473,820	1
12	PIL (Pacific Int. Line)	292,282	
13	SITC	157,357	
14	KMTC	153,758	
15	X-Press Feeders Group	148,736	
16	IRISL Group	135,724	
17	UniFeeder	125,669	
18	Zhonggu Logistics Corp.	121,754	
19	Sinokor Merchant Marine	112,583	
20	Sea Lead Shipping	110,810	

Transport firms and terminal ownership

TRADE | **CHINA**

In Greece's largest port of Piraeus, China is the boss

Kaki Bali
10/30/2022

Since 2016, the Chinese shipping company Cosco has been the majority stakeholder in the port of Piraeus. This means a foreign power controls Greece's main port.

- These investments participate in lowering the costs of trade
- Chinese State-owned carrier acquired control of a container terminal in the Greek port of Piraeus (2009)
- ... and purchased controlling shares of the port authority (2016). details

Transport firms and port ownership

- Investing in Piraeus may have facilitated trade flows
  - Faber (2014), Duflo-Banerjee (2020), Duranton et al (2014 Restud)
  - Allen-Arkolakis (2022, Restud)
  - Ducruet, Juhász, Nagy, Steinwender (2024, JIE)
  - Heiland, Moxnes, Ulltveit-Moe and Zi (2023, rev. Restat)
- Infrastructure takeover may bias the decrease in trade costs towards Cosco, and hence increase only Cosco-operated traffic
  - Pascali (2014)
  - Coşar, Demir (2018, JIE)
- Geopolitical tensions could affect operator-specific global supply chains
  - Felbermayr (2021)
  - Baldwin-Freeman (2022, ARE)

→ Role of operators ?

Details on port governance

Roadmap

⇒ Investment in a port may affect vessels' traffic, through a decrease in shipping costs.

1. We investigate the effects of this investment on traffic, by operator.
   Data : AIS vessels tracking data

⇒ Changes in traffic flows may imply changes in trade

2. We estimate the effect of the purchase of Piraeus on bilateral trade flows
   Data : bilateral trade flows, 2015-2020

⇒ Local changes in traffic may impact global trade flows

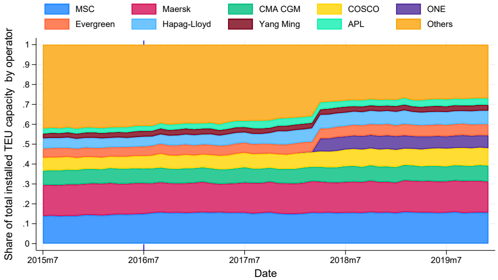
3. We compute the General Equilibrium effect of the purchase on trade flows.

Data

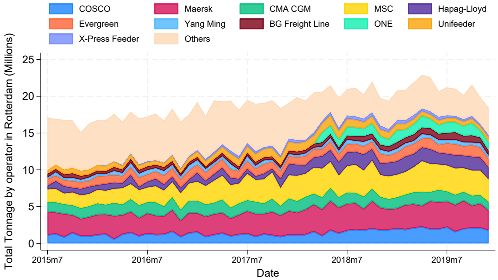
- **AIS data** : Alphaliner. Real-time positions of ships emitted by the mandatory device carried on board. Info on ships as they enter or leave each polygon mapping the planet :
  - a polygon is a port or a terminal (non selected : shipyards, waypoints, zones)
  - info on their name, IMO, timed-position, and draught (theoretical and at entry).
  - 478 ports, 1366 container terminals (131 countries), 5444 container vessels. Singapore
  - Cleaned data contains a maximum of one port call in a specific port for a given IMO in a particular day.
- **Operator** information : IHS Markit. Name of carrier for each ship.
- **Trade data** : BACI. Yearly. 2015-2020.

Data : heterogeneity, by port and operator

Figure – 1



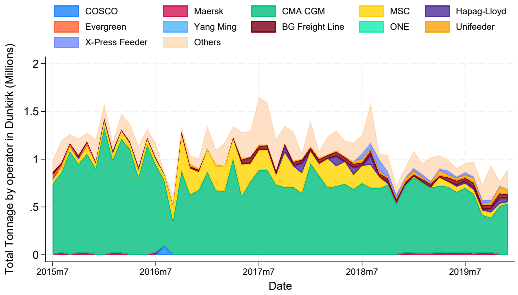
World total TEU



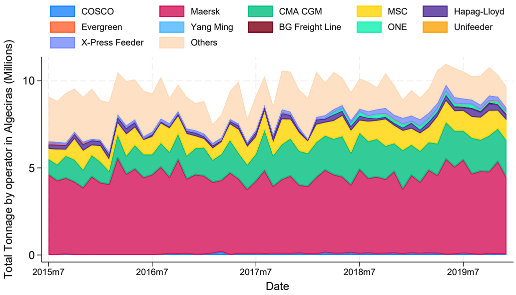
Port of Rotterdam, cargo by operator

Data : port attendance, by operator (1/2)

Figure – 2 - Cargo in port, by operator



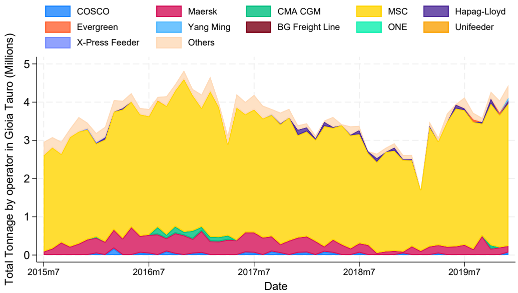
Port of Dunkirk
CMA-CGM dominates



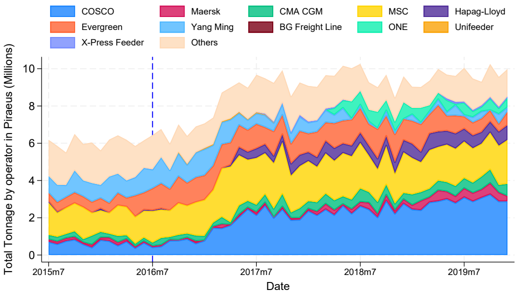
Port of Algericas
Maersk dominates

Data : port attendance, by operator (2/2)

Figure – 3 - Cargo in port, by operator



Port of Gioia Tauro
MSC dominates

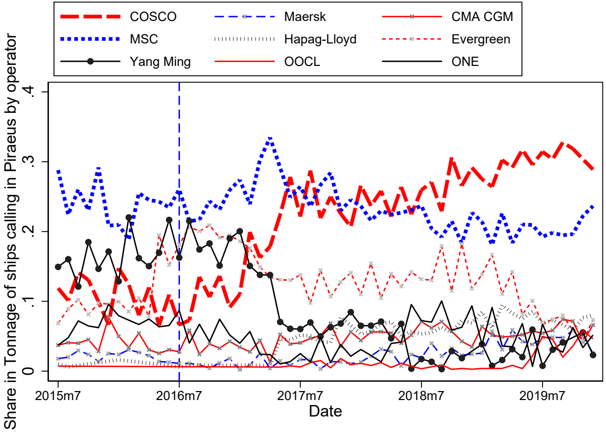


Port of Piraeus
Cosco rises

Absolute size of Piraeus increases after 2016. Cosco rises, MSC and CMA-CGM stable.

Background : Piraeus and Cosco

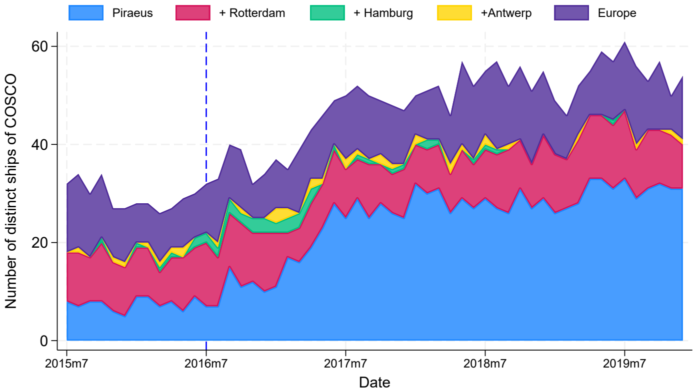
Figure – 4 - Share of operators in the port of Piraeus



Share of Cosco in Piraeus triples.

Background : Cosco in Europe

Figure – 5 - Number of active Cosco ships



Number of active Cosco ships doesn't change after 2016.
Ships now stop in Piraeus also.

Take away from descriptives

- Traffic increased in Piraeus after purchase by Cosco.
- Increase in traffic : mostly Cosco stopping more.
- International trade perspective : increase in attractivity $\approx$ **a decrease in trade costs**.

  Not clear yet whether trade costs decreased
  - for all users of Piraeus port
  - or specifically for trade flows channeled by Cosco,

$\Rightarrow$ We investigate the channels of a decrease in trade costs.

$\Rightarrow$ We introduce a trade model and use trade data to estimate whether **trade flows increased** following the investment, according to the transporter.

A model for trade flows

- Which trade model? We observe
  - bilateral trade flows, but not the exact routes
  - vessels departing and arriving in ports on the segments of the routes
  - Trade is mostly indirect (Ganapati et al., 2024).

- Allen and Arkolakis (2022) introduce indirect routes in an EK trade, geography and migration model.
- Heiland et al (2023) use the trade model (no migration) and apply it to shipping.
- We use the same model and allow trade costs on the segments to vary according to shipping operators.

Set up

- N Locations $i \in \{1, \ldots, N\}$.
- L_i workers, CES preferences over the varieties ν.
- Price of good ν sent from i to j along route r is

$$p_{ij,r} = \frac{w_i \prod_{k=1}^{K} t_{r_{k-1},r_k}}{\epsilon_{ij,r}(\nu)},$$

  - t_{kl} is ad valorem cost between k and l.
- Production and shipping face idiosyncratic productivity shocks $\epsilon_{ij,r}(\nu)$.
- Consumers in j purchase good ν from the cheapest source (location-route).
- $\epsilon_{ij,r}(\nu)$ follows a Fréchet (A_i, θ) distribution across routes and goods.

Equilibrium trade flows

- Total value of goods shipped from i to j :

$$X_{ij} = \frac{\tau_{ij}^{-\theta}(w_i/A_i)^{-\theta}}{\sum_k \tau_{kj}^{-\theta}(w_k/A_k)^{-\theta}} E_j.$$

Incorporating the market clearing conditions allows to write

- Gravity for trade flows :

$$X_{ij} = \frac{Y_i}{\Pi_i^{-\theta}} \frac{X_j}{P_j^{-\theta}} \tau_{ij}^{-\theta},$$

with $\quad \tau_{ij} = \left(\sum_{r \in R_{ij}} \prod_{k=1}^{K} t_{r_{k-1},r_k}^{-\theta} \right)^{-\frac{1}{\theta}}$

Roadmap

1. **Descriptives** on changes in port-calls following the purchase of Piraeus :
   - Show heterogeneity in port attendance by operator.
   - Characterize changes in time.

2. **Reduced-form estimation** of the trade effect of a shock on trade costs in Piraeus :
   - Which countries are exposed to the trade costs decrease ? Identify the pairs of countries (+ operator) which shortest route features Piraeus : POR_{ij}.
   - Empirical estimates using double-difference PPML gravity.

3. **General Equilibrium Trade Impact** of reduced trade costs in Piraeus
   - Estimate the effect of reduced trade costs in Piraeus on traffic Ξ_{kl}, Piraeus being k or l
   - Use the effect on traffic + traffic matrix and simulate world real incomes after shock.

Reduced-form estimation

The Routes of Trade ?

We don't observe the exact routes and ports through which countries trade.

- Ideally : track goods within containers, from country to country.
- Instead, make assumptions on how shipping companies choose their route :
  - lowest cost / shortest / least changes for containers route/...

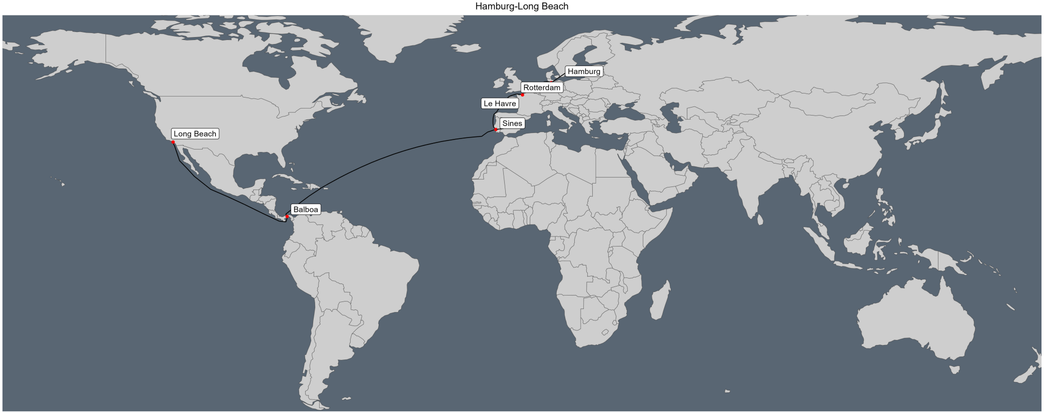
$\Rightarrow$ AIS data allow to reconstruct the routes taken by the ships linking two countries, assuming they chose the shortest one in time.

The **shortest path algorithm** identifies for each date the shortest direct and indirect links between ports separated by given travel times

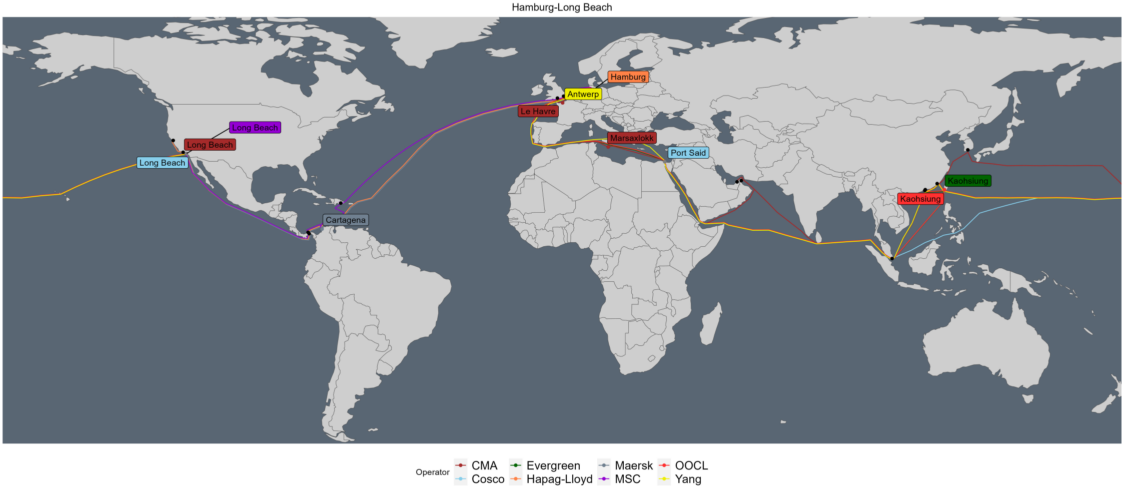
- It relies on the actual ex-post departure and arrival times of vessels observed in our AIS data.
- Output : one shortest route for each port pair and date.
- Here we can identify whether Piraeus is within the sequence of ports on the shortest route.
- Select the most frequently-used shortest route between two ports.

Shortest path across all operators

How does a box move from Hamburg to Long Beach ?



Shortest path by operator



The Routes of Trade

- The shortest-paths are at the port-to-port (od) level.
- Compute Piraeus port-to-port dummy, $Piraeus_{od} = 1$ when Piraeus is on the port-to-port shortest-path route.

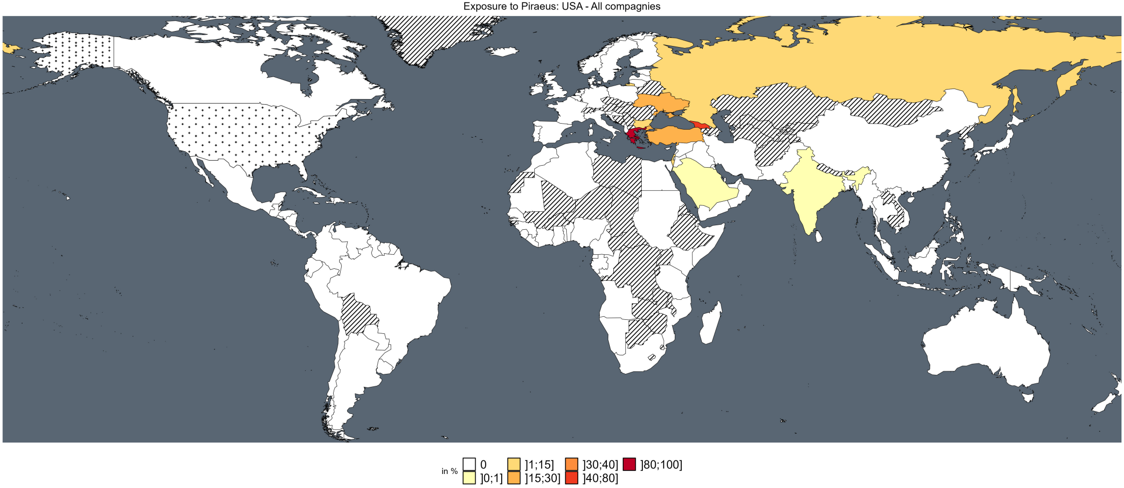
⇒ Aggregate at the ij level by weighting $Piraeus_{od}$ by shares of o and d ports in total 2016 tonnage :

$$POR_{ij} = \sum_{o \in i} \frac{size_o}{\sum_{o \in i} size_o} \sum_{d \in j} \frac{size_d}{\sum_{d \in j} size_d} Piraeus_{od}$$

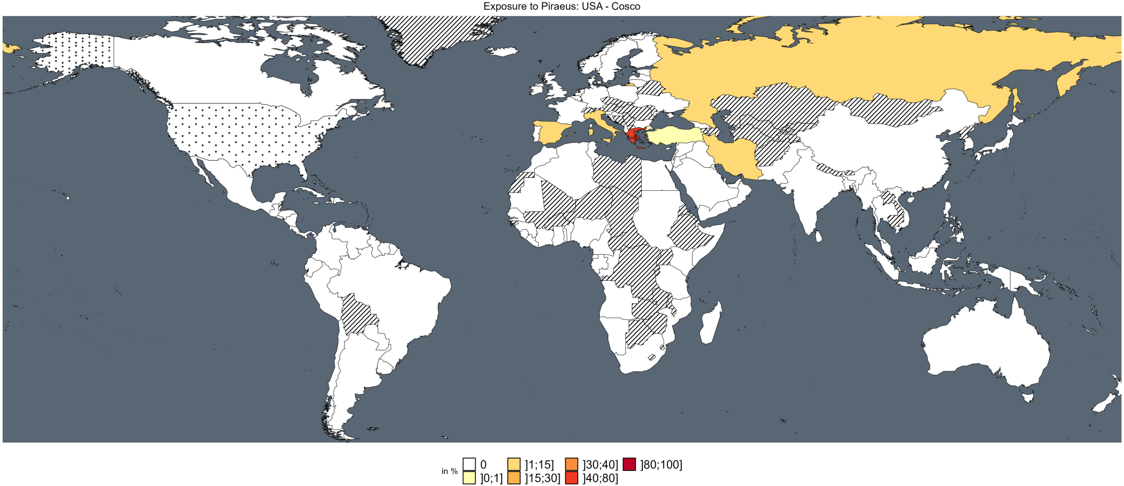
We compute :

1. POR_{ij} **for all shipments**.
2. POR_{ij}^{op} for **each operator**.

"Piraeus on trade route" from the US : POR_{USj}



"Piraeus on Cosco's trade route" from the US : POR^{Cosco}_{USj}



Takeaway on the routes of trade

- POR_{ij} variable indicates the probability with which Piraeus stands on the route between countries i and j
  $\approx$ probability of i and j having experienced a decline in trade costs on their trade route.
- 23.256 pairs of non-landlocked countries,
  - 1401 with $POR_{ij} > 0$, (6%).
  - 288 with $POR_{ij}^{Cosco} > 0$, (1.3%).
- Important heterogeneity in operator-level trade routes suggests operator-specific trade costs :

  Run trade estimations considering either POR_{ij} or POR_{ij}^{op}.

Effect on trade through Piraeus

- Estimation runs PPML on yearly trade data for 2012-2020.

$$X_{ijt} = \exp(\beta POR_{ij} \times \text{Post}_t + \gamma Z_{ijt} + \lambda_{it} + \mu_{jt} + \nu_{ij} + \epsilon_{ijt}),$$

with :

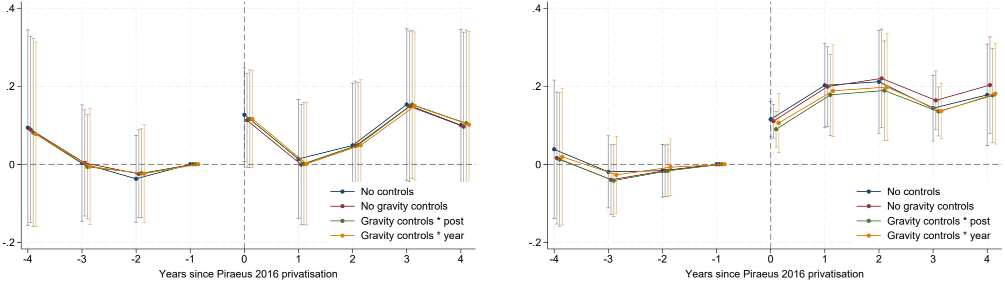
- POR_{ij} and alternatively POR_{ij}^{Cosco}
- X_{ijt} being total trade flows or containerizable trade flows,
- Z_{ijt} being gravity variables interacted with time,
- λ_{it} and μ_{jt} are FEs controlling for Multilateral Resistance terms,
- ν_{ij} are bilateral FEs controlling for constant frictions.

Table – Difference-in-Difference for export value by country pair *ij* : 2012-2020

	(1)	(2)	(3)	(4)
Piraeus On Route × Post	0.072			
	(0.089)			
Piraeus On Route^{COSCO} × Post		0.167^a		0.161^b
		(0.062)		(0.067)
Piraeus On Route^{NonCOSCO} × Post			0.089	0.055
			(0.081)	(0.088)
Observations	286,929	286,929	286,929	286,929
Fixed effects by				
Exporter-Year	Yes	Yes	Yes	Yes
Importer-Year	Yes	Yes	Yes	Yes
Exporter-Importer	Yes	Yes	Yes	Yes

Heteroskedasticity-robust standard errors two-way clustered at the origin country and at the destination country level appear in parentheses. ^{a}, ^{b} and ^{c} indicate significance at the 1%, 5%, and 10% confidence levels.

Figure – - PPML on Export value$_{ij}$



$POR_{ij}^{\text{All operators}}$ POR_{ij}^{COSCO}

- $\beta_p = 0.161$ implies that a country pair with $POR_{ij} = 1 \nearrow$ its trade by 17.4% post Cosco's purchase.
- Country pairs with $POR_{ij} > 0$ on average saw their trade flows multiplied by $\exp(0.161 \times POR_{ij})$.

$\Rightarrow$ Country pairs with $POR_{ij} = 0$ can still be impacted in a general equilibrium setting

Robustness on trade effect

1. Trade estimations using each operator's route : only $POR_{ij}^{\text{Cosco}} \times post_t$ impacts trade

   Robustness on other operators

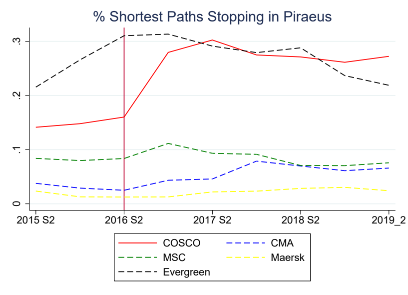
2. Adding controls for Cosco's other investments on shortest routes

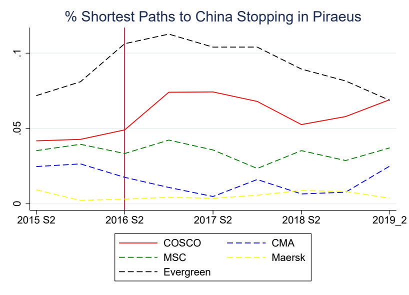
   Robustness with Cosco's investments

3. Removing Greece

Work in progress to understand the effect on trade...

Figure – - PPML on Export value$_{ij}$





Roadmap

1. **Descriptives** on changes in port-calls following the purchase of Piraeus :
   - Show heterogeneity in port attendance by operator.
   - Characterize changes in time.

2. **Reduced-form estimation** of the trade effect of a shock on trade costs in Piraeus :
   - Which countries are exposed to the trade costs decrease ? Identify the pairs of countries (+ operator) which shortest route features Piraeus : POR_{ij}.
   - Empirical estimates using double-difference PPML gravity.

3. **General Equilibrium Trade Impact** of reduced trade costs in Piraeus
   - Estimate the effect of reduced trade costs in Piraeus on traffic Ξ_{kl}, Piraeus being k or l
   - Use the effect on traffic + traffic matrix and simulate world real incomes after shock.

General Equilibrium Trade Impact

Roadmap for quantifications

- A shock in one of the segments of the network will have repercussions along all the routes.
- Traffic on each segment will be affected, reorganizing bilateral trade flows.
- We use the model to compute the **general equilibrium effect** of the shock in Piraeus :
  - This requires to compute the change in trade costs in Piraeus.
  - and use it to shock the traffic matrix in Piraeus.
  - The GETI through traffic is particularly adapted to study operator-specific effects.

Equilibrium equations

- Introduce a **matrix notation** for trade costs $\tau_{ij}^{-\theta}$:

  $\mathbf{A}$ is the $N \times N$ weighted adjacency matrix between all locations : $\tau_{ij}^{-\theta} = \sum_{K=0}^{\infty} \mathbf{A}^{\mathbf{K}}$
  which simplifies to : $\sum_{K=0}^{\infty} \mathbf{A}^{\mathbf{K}} = (\mathbf{I} - \mathbf{A})^{-1} \equiv \mathbf{B}$.
  $\tau_{ij}^{-\theta}$ can be expressed as the (i,j) element of the Leontief inverse of matrix $\mathbf{A}$:

$$\tau_{ij}^{-\theta} = b_{ij}$$

  .

- Equilibrium price indices

$$\Pi_i^{-\theta} = \frac{E_i}{p_i^{-\theta}} + \sum_j t_{ij}^{-\theta} \Pi_j^{-\theta} \quad (1)$$

$$P_i^{-\theta} = \frac{Y_i}{\Pi_i^{-\theta}} + \sum_j t_{ji}^{-\theta} P_j^{-\theta}, \quad (2)$$

GETI using traffic flows 1/2

- **Gravity for traffic**

$$\Xi_{kl} = t_{kl}^{-\theta} \times P_k^{-\theta} \times \Pi_l^{-\theta},$$

the value of all cargo passing on the segment kl.

- **Price indices in changes**

$$\hat{\Pi}_i^{-\theta} = \frac{Y_i}{Y_i + \sum_j \Xi_{ij}} \frac{\hat{\Pi}_i^{-\theta/(\theta+1)}}{\hat{P}_i^{-\theta}} + \sum_j \left(\frac{\Xi_{ij}}{Y_i + \sum_j \Xi_{ij}} \right) \hat{t}_{ij}^{-\theta} \hat{\Pi}_j^{-\theta}, \quad (3)$$

$$\hat{P}_i^{-\theta} = \frac{Y_i}{Y_i + \sum_j \Xi_{ji}} \frac{\hat{\Pi}_i^{-\theta/(\theta+1)}}{\hat{\Pi}_i^{-\theta}} + \sum_j \left(\frac{\Xi_{ji}}{Y_i + \sum_j \Xi_{ji}} \right) \hat{t}_{ji}^{-\theta} \hat{P}_j^{-\theta}, \quad (4)$$

See predictive power of model on trade flows : here

GETI using traffic flows 2/2

Inputs for iteration :

1. initial matrix of traffic in value between all ports Ξ_{kl}
2. initial revenues in ports (Y_i)
3. trade elasticity θ
4. shock on trade costs $\hat{t}_{kl}^{-\theta}$ $\rightarrow$ estimated now

Volume of traffic :

$$\Xi_{kl} = t_{kl}^{-\theta} P_k^{-\theta} \Pi_l^{-\theta}$$

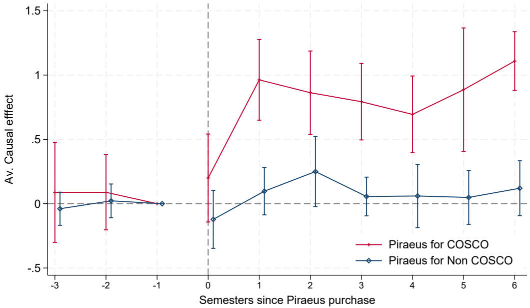
We assume that trade costs are a function of the shock in Piraeus, and are operator specific :

$$t_{kl}^{\text{Cosco}} = \exp\left(\alpha Piraeus_{kl}^{\text{Cosco}}\right) \nu_{kl} \tag{5}$$

- We estimate the effect of the shock on trade costs on traffic $\Xi_{kl,t}$: Details on traffic measure

$$\begin{aligned}\Delta \ln \Xi^{Operator}_{kl,t} &= \alpha_1 \theta \text{ Piraeus}_{k \text{ or } l} \times \text{Post}_t \times \text{COSCO} \\ &+ \alpha_2 \theta \text{ Piraeus}_{k \text{ or } l} \times \text{Post}_t \times \text{No COSCO} \\ &+ \lambda_{kl} + \nu^{Operator}_t + Z_{kl,t} + \epsilon_{kl,t} \end{aligned} \tag{6}$$

Figure – Total Traffic Volume COSCO vs Non COSCO : Ln Ξ_{kl} for port-pair *kl*



- We compute the change in trade costs :

$$\Delta \ln t_{kl}^{Cosco} = -\frac{\hat{\alpha_1 \theta}}{\theta} Piraeus_{k \text{ or } l} \quad (7)$$

$$\Delta \ln t_{kl}^{NonCosco} = -\frac{\hat{\alpha_2 \theta}}{\theta} Piraeus_{k \text{ or } l} \quad (8)$$

- The shock is specific to each operator. We iterate with
  1. two initial matrices of traffic in value between all ports Ξ_{kl}^{Cosco} and $\Xi_{kl}^{NonCosco}$
  2. initial revenues in ports (Y_i)
  3. trade elasticity θ
  4. shocks on trade costs $\hat{t}_{kl}^{Cosco^{-\theta}}$ and $\hat{t}_{kl}^{NonCosco^{-\theta}}$

- Price index in i for Cosco

$$\hat{\Pi}_{\text{Cosco},i}^{-\theta} = \frac{Y_{\text{Cosco},i}}{Y_{\text{Cosco},i} + \sum_j \Xi_{\text{Cosco},ij}} \cdot \frac{\Pi_{\text{Cosco},i}^{-\theta/(\theta+1)}}{\hat{P}_{\text{Cosco},i}^{-\theta}} + \sum_j \frac{\Xi_{\text{Cosco},ij}}{Y_{\text{Cosco},i} + \sum_j \Xi_{\text{Cosco},ij}} \cdot \hat{t}_{ij}^{Cosco^{-\theta}} \hat{\Pi}_{\text{Cosco},j}, \tag{9}$$

- Price index in i for Non Cosco

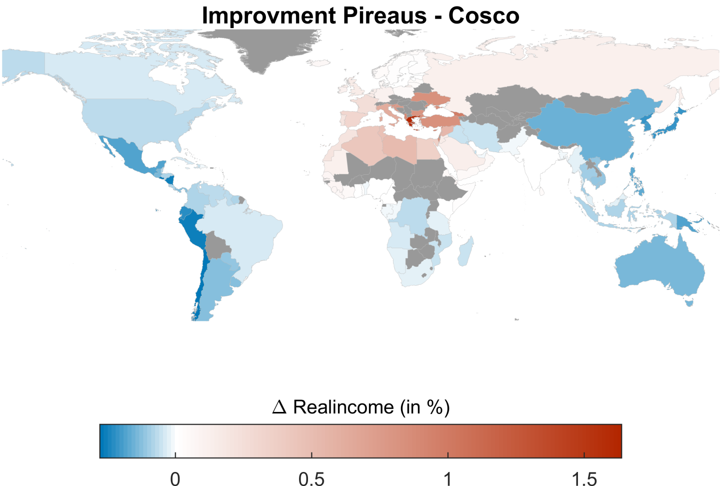
$$\hat{\Pi}_{\text{NoCosco},i}^{-\theta} = \frac{Y_{\text{NoCos},i}}{Y_{\text{NoCos},i} + \sum_j \Xi_{\text{NoCos},ij}} \cdot \frac{\Pi_{\text{NoCosco},i}^{-\theta/(\theta+1)}}{\hat{P}_{\text{NoCos},i}^{-\theta}} + \sum_j \frac{\Xi_{\text{NoCos},ij}}{Y_{\text{NoCos},i} + \sum_j \Xi_{\text{NoCos},ij}} \cdot \hat{t}_{ij}^{NoCos^{-\theta}} \hat{\Pi}_{\text{NoCo},j}, \tag{10}$$

- and reconstuct a price index for each port at every step

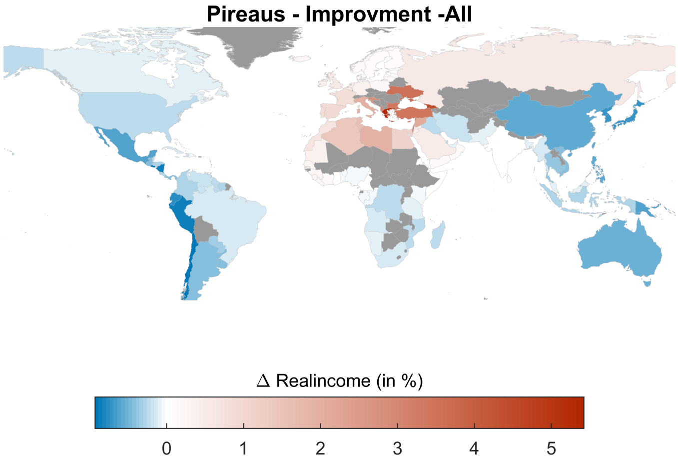
$$\hat{\Pi}_i = \text{share}_{\text{Cosco},i} \cdot \hat{\Pi}_{\text{Cosco},i} + \text{share}_{\text{no-Cosco},i} \cdot \hat{\Pi}_{\text{no-Cosco},i}. \tag{11}$$

Shocks propagate through ports shared among operators.

Decreasing trade costs for Cosco in Piraeus by 5%



Decreasing TC in Piraeus by 5% for Cosco and 1% for NonCosco



Work in progress...

- Introduce heterogeneity in shock to segments that arrive and depart from Piraeus.
- Build on Fuchs and Wong (2024) which model substitution between transport modes in a quantitative trade model with traffic.

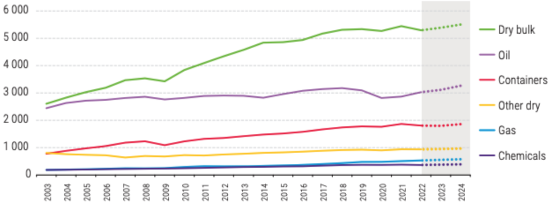
Thank you for your attention!

International trade and transport firms

- Total world trade in 2022 is $22.000 billion dollars in value and 15 billion tons in volume.
- 80% of those traded goods are transported by sea.
- After dry bulk and oil, container shipping is the 3rd largest category in volume with 2 billion tons transported in containers.

Back to Intro

Figure 1.1 International maritime trade, 2003–2024
(Million tons loaded)



Source: UNCTAD secretariat, based on Clarksons Research, Shipping Intelligence Network time series (July 2023).

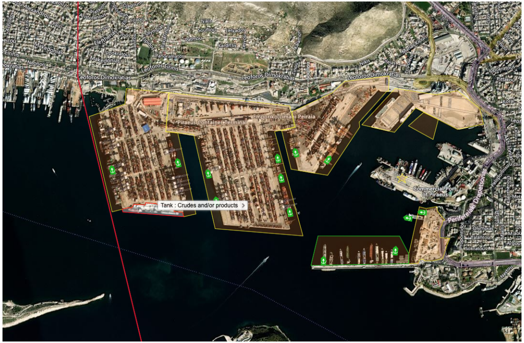
Transport firms and terminal ownership, details

- Port terminals have traditionally been publicly owned and operated
- Port governement reforms began in the 1980s
- Port ownership remained in majority public.
  Terminals allowed private ownership.
- Today there are three main terminal owners and operators :
  1. Pure stevedores
  2. Holdings
  3. Maritime shipping companies

Back to intro

Details about Cosco in Piraeus

- Greek ports reforms begin in 1999 (corporatizations), concessions contracts authorized in 2001.
- 2009 : Parliament ratifies concession of T2 + T3 + construction of T3 to/by **Cosco**.
- Greek crisis : 2014 decision to sell 67% of the port authorities' shares of Piraeus (PPA)+ Thess. (ThPA). Land remains to the State.
- July 2016, COSCO purchases 51% of Piraeus port authority and 67% in 2021.
- PPA still operates T1. Back to intro



Details about port governance

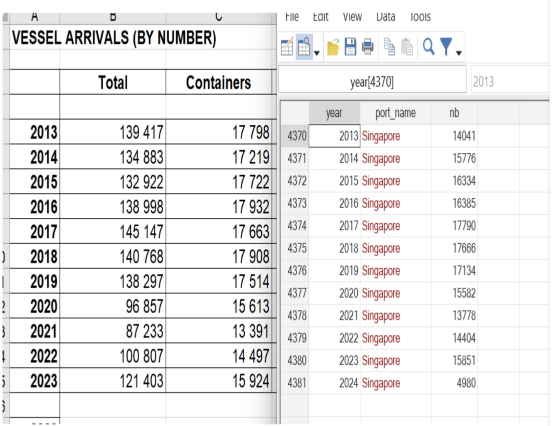
Decision making in ports involves

- **the port authority** : historically publicly-owned. Still mostly the case in Europe, the US. Some exceptions are the UK, (some) Australian ports, and Greek ports of Thessaloniki and Piraeus.
  The latter are corporatized + the State may hold a majority share (Thessaloniki)
  In charge of investments that benefit all users of the port (quays ..)
- **the terminals** : specialized in the handling of the traded commodity. May be publicly or privately-managed, in the latter case by private concessions.
  Investments are payed by the managing entity :
  gantry cranes, storage capacity, fleet gantries...

Back to roadmap

Singapore's port calls

Figure – Comparison of Singapore's official data with our data



	A	B	C
VESSEL ARRIVALS (BY NUMBER)			
		Total	Containers
	2013	139 417	17 798
	2014	134 883	17 219
	2015	132 922	17 722
	2016	138 998	17 932
	2017	145 147	17 663
	2018	140 768	17 908
	2019	138 297	17 514
	2020	96 857	15 613
	2021	87 233	13 391
	2022	100 807	14 497
	2023	121 403	15 924

	year	port_name	nb
4370	2013	Singapore	14041
4371	2014	Singapore	15776
4372	2015	Singapore	16334
4373	2016	Singapore	16385
4374	2017	Singapore	17790
4375	2018	Singapore	17666
4376	2019	Singapore	17134
4377	2020	Singapore	15582
4378	2021	Singapore	13778
4379	2022	Singapore	14404
4380	2023	Singapore	15851
4381	2024	Singapore	4980

Back to roadmap

Table – Robustness checks (3) for other individual operators

	(1)	(2)	(3)	(4)
	Total Export Value		Containerizable only	
	All sample		No Greece	
Piraeus On Route^{COSCO} × Post	0.148^{b}	0.171^{b}	0.151^{b}	0.178^{b}
	(0.070)	(0.083)	(0.069)	(0.084)
Piraeus On Route^{MSC} × Post	-0.061	-0.203^{b}	-0.067	-0.194^{c}
	(0.075)	(0.102)	(0.077)	(0.110)
Piraeus On Route^{Maersk} × Post t	-0.046	0.856	-0.035	0.895
	(0.069)	(0.991)	(0.082)	(0.973)
Piraeus On Route$^{Hapag-Lloyd}$ × Post	-0.116	0.218	-0.124	0.268
	(0.109)	(0.255)	(0.115)	(0.262)
Piraeus On Route$^{CMA-CGM}$ × Post	0.083	0.056	0.091	0.060
	(0.071)	(0.118)	(0.075)	(0.128)
Piraeus On Route^{Evergreen} × Post	0.068	0.067	0.070	0.067
	(0.074)	(0.081)	(0.075)	(0.083)
Piraeus On Route^{YangMing} × Post	0.022	0.023	0.031	0.034
	(0.098)	(0.104)	(0.099)	(0.106)
Observations	284,625	281,214	284,229	280,827
Gravity Controls ×Year	Yes	Yes	Yes	Yes
Fixed effects by				
Exporter-Year	Yes	Yes	Yes	Yes
Importer-Year	Yes	Yes	Yes	Yes
Exporter-Importer	Yes	Yes	Yes	Yes
Continent-pair-year	Yes	Yes	Yes	Yes

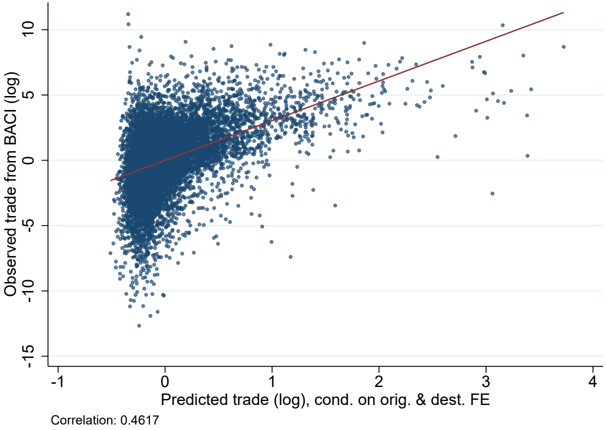
Heteroskedasticity-robust standard errors two-way clustered at the origin country and at the destination country level appear in parentheses. ^{a}, ^{b} and ^{c} indicate significance at the 1%, 5%, and 10% confidence levels.

Back to list of robustness

Predictions of trade

Allen and Arkolakis (2022) derive a mapping between traffic and trade :

$$X_{ij} = c_{ij}^X Y_i E_j$$



Traffic measure and operators' coefficients

- Traffic is defined as the number of boats multiplied by their cargo.
- Ξ_{kl}= Frequency$_{kl}$ $\times$ Carried Tonnage$_{kl}$, and where Carried Tonnage$_{kl}$ = Ship Size$_{kl}$ $\times$ Utilization$_{kl}$.
- Utilization$_{kl}$ is computed using the formula : (entry draught - ballast draught)/(scantling draught - ballast draught) where ballast draught corresponds to the draught when the ship is empty and scantling draught when fully loaded.
- The values of the estimated coefficients on the change of operator-specific traffic are : $\alpha_1 = 0.638$ and $\alpha_2 = 0.173$.

Back to GETI