

Navigating Shocks: The Ripple Effects of Shipping Route Closures

RWTH Aachen Research Seminar — June 16, 2026

Carsten Brockhaus,^{1,2} **Julian Hinz**^{1,3}, Charles Serfaty⁴

¹ Kiel Institute for the World Economy

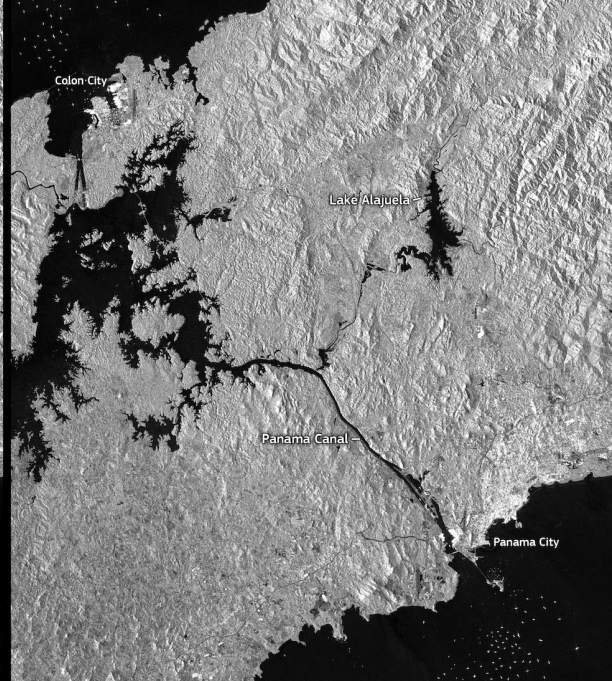
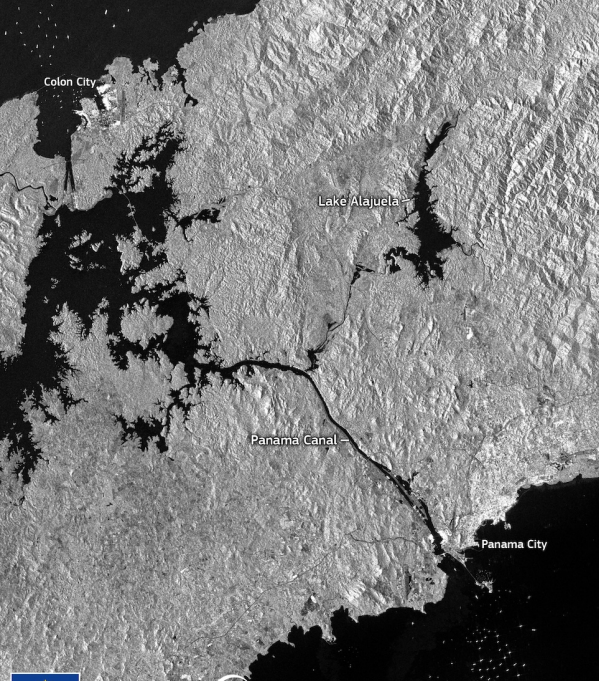
² Kiel University

³ Bielefeld University

⁴ Banque de France



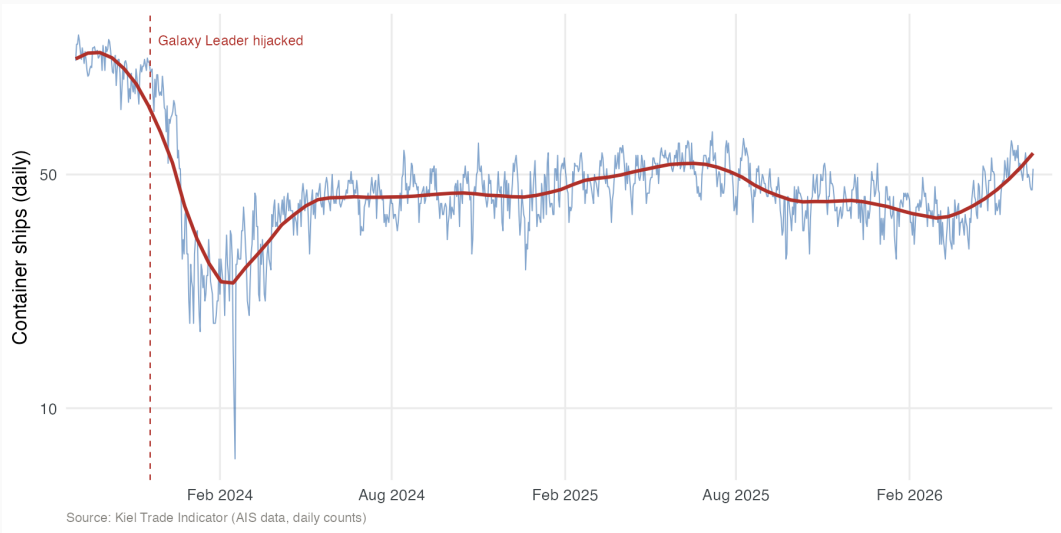




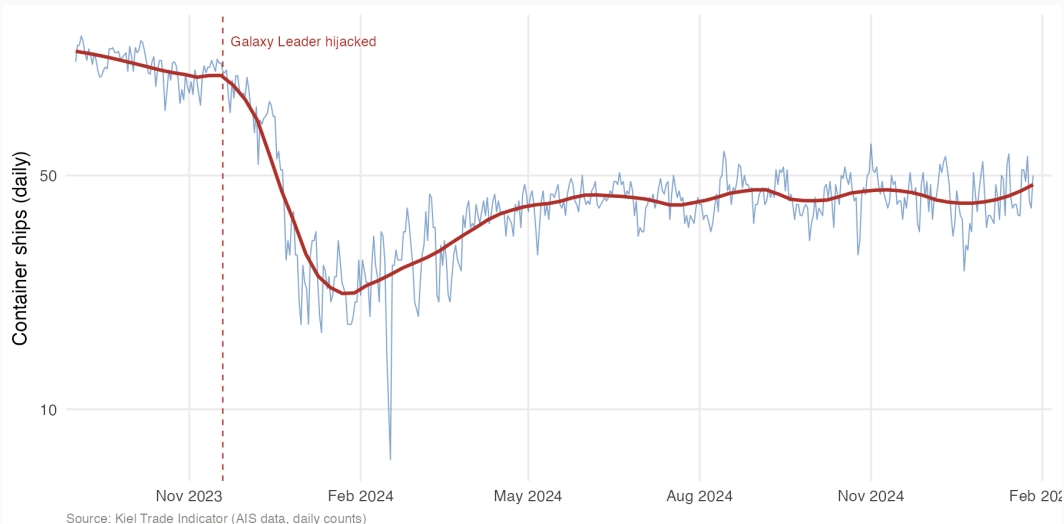




Vessel traffic: Red Sea



Vessel traffic: Red Sea

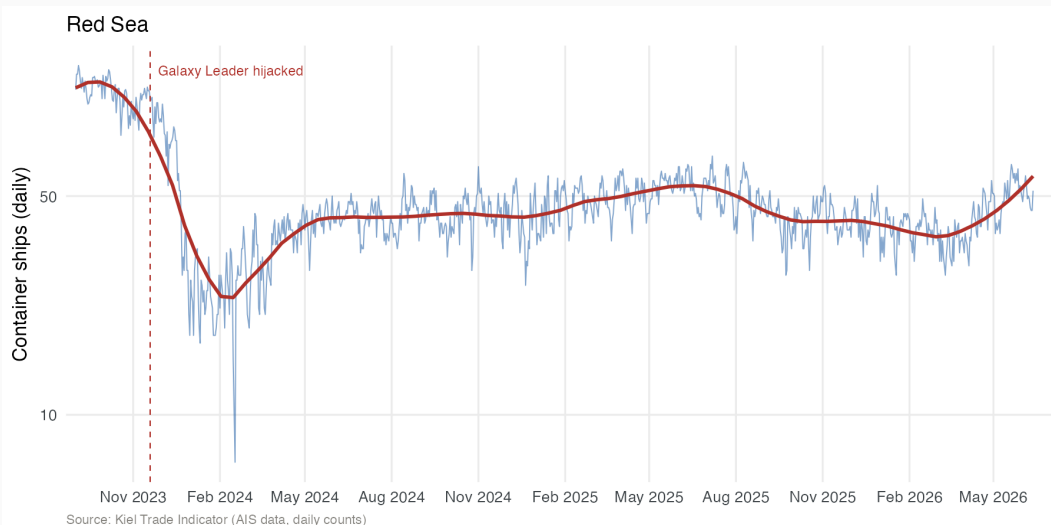


Freight rates

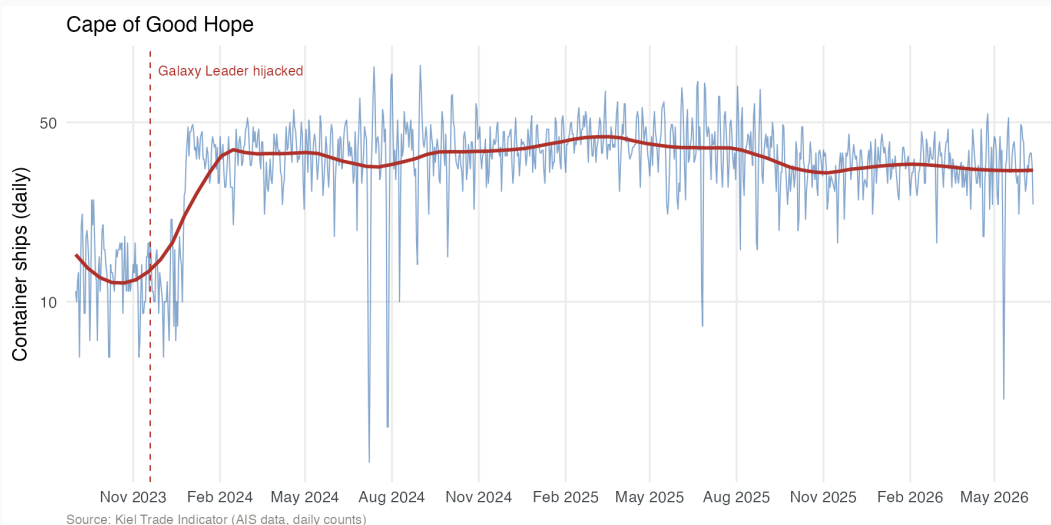


Source: Freightos Baltic Index via Kiel Trade Indicator

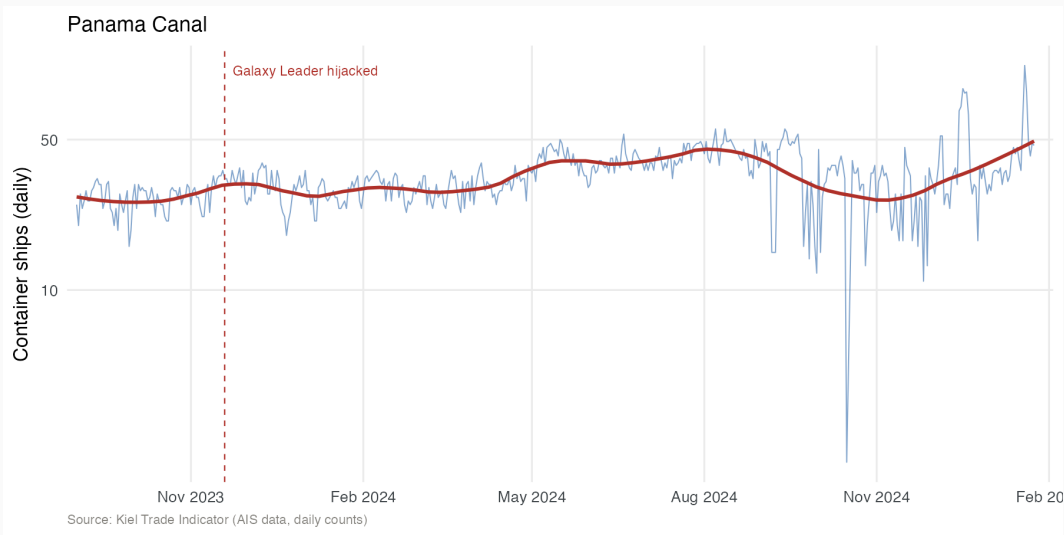
Vessel traffic: Red Sea



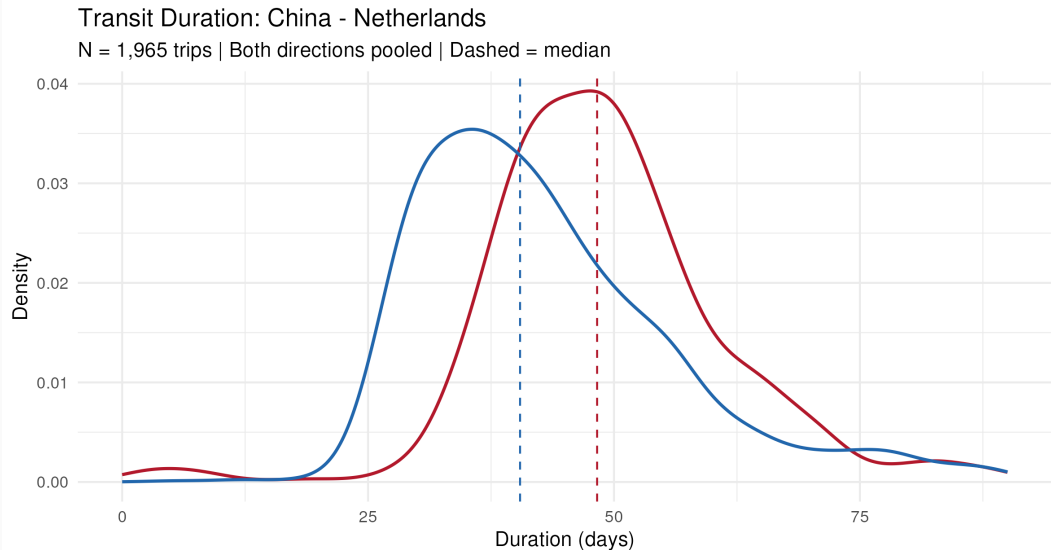
Vessel traffic: Cape of Good Hope



Vessel traffic: Panama Canal



Travel duration: China → Netherlands



What this paper is about

- 80% of trade volume and 70% of trade value moved by ship
- Disruptions to shipping routes seemingly more frequently
 - do they matter economically?
- Suez transits collapsed by $\sim 2/3$ within days, Asia–Europe freight rates roughly double
 - What are the welfare costs?
 - Who bears them?

What this paper is about

1. Document how the global container network reroutes around chokepoint shocks
 - AIS-based reconstruction, port-level network
2. Quantify trade response: Macro and micro-level (work-in-progress)
3. Build a structural shipping model nesting rich transport-cost mechanisms
 - Congestion, global capacity, monopoly toll-setting at canals
 - Embedded in Caliendo–Parro / Baqaee–Farhi production network
4. Counterfactuals on Red Sea disruption

Related works

Shipping networks:

ganapati_entrepot_nodate, heiland_trade_2022, wong_round_2022, tsiotas_measuring_2021, allen_welfare_2022, fuchs2022multimodal, Tolva (2024), Koenig, Poncet & Sanch-Maritan (2024)

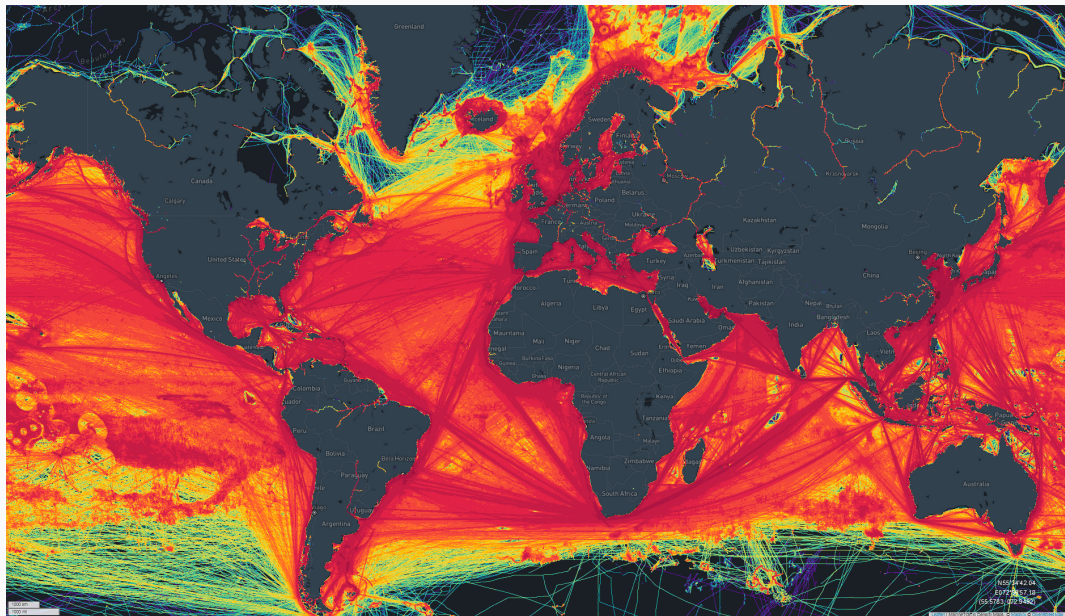
Resilience of shipping networks:

peng_fine-grained_2018, cremaschini_shipping_nodate, pratson_assessing_2023, mei_structural_2024, wu_vulnerability_2019

AIS data:

svanberg_ais_2019, yang_how_2019

Empirical facts about the shipping network



Automatic Identification System (AIS):

- Tracking system for vessels with capacity above 300 gross tonnage
- Transmits: identifier, position, timestamp, bearing, speed, ...
- Port calls for each vessels: timestamp for arrival and departure, draft, ...

Our setting:

- Focus on container ships: universe of vessels (above weight threshold), 2015 until now
- Build network using port calls
 - 6,097 ships, 3.4 million journeys, 1,607 nodes (ports) and 26,971 edges (routes)

Automatic Identification System (AIS):

- Tracking system for vessels with capacity above 300 gross tonnage
- Transmits: identifier, position, timestamp, bearing, speed, ...
- Port calls for each vessels: timestamp for arrival and departure, draft, ...

Our setting:

- Focus on container ships: universe of vessels (above weight threshold), 2015 until now
- Build network using port calls
 - 6,097 ships, 3.4 million journeys, 1,607 nodes (ports) and 26,971 edges (routes)

How does the network react to removal of nodes (ports) and edges (routes)?

1. at **random**

→ natural disasters, accidents, etc.

2. **deliberate** based on importance metrics

→ war, geopolitical tensions, etc.

Iteratively remove nodes and edges until entire network collapses!

How does the network react to removal of nodes (ports) and edges (routes)?

1. at **random**

→ natural disasters, accidents, etc.

2. **deliberate** based on importance metrics

→ war, geopolitical tensions, etc.

Iteratively remove nodes and edges until entire network collapses!

Network complexity metrics

- **Average Clustering Coefficient:** average likelihood that two ports are connected
- **Global efficiency:** average inverse shortest path length between all pairs of nodes → efficiency of propagation through network
- **Diameter:** length of longest shortest path through network

Likelihood that two ports are connected

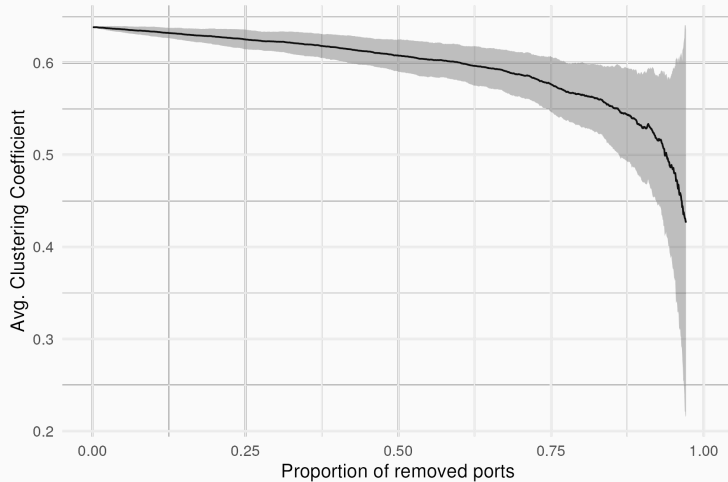


Figure 1: Random attacks on ports - 100 simulations

Likelihood that two ports are connected

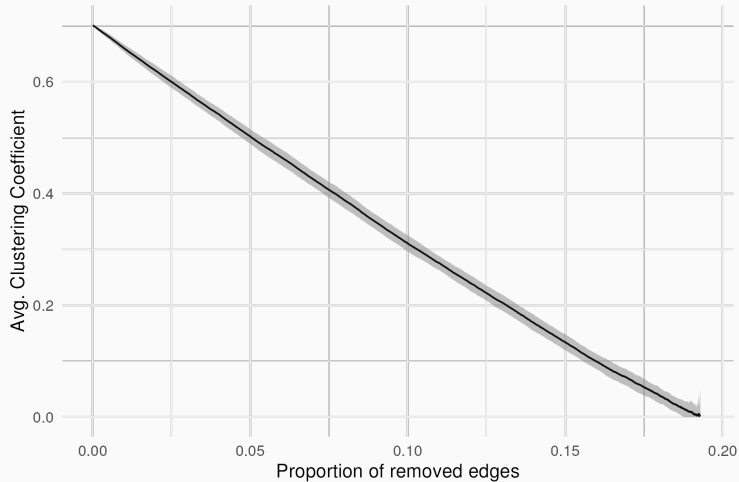


Figure 2: Random attacks on route - 100 simulations

Average inverse shortest path length between all pairs of nodes

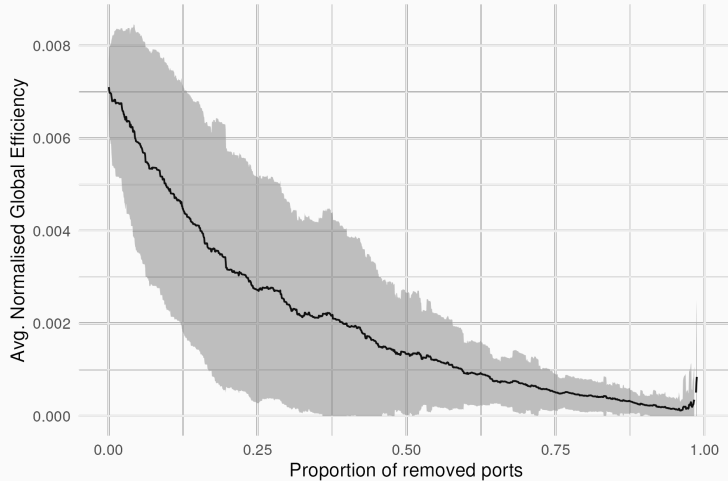


Figure 3: Random attacks on ports - 100 simulations

Average inverse shortest path length between all pairs of nodes

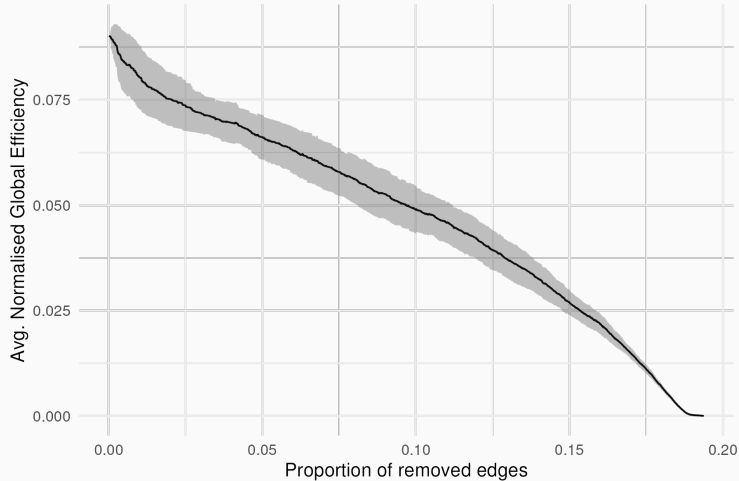


Figure 4: Random attacks on routes - 100 simulations

Length of longest shortest path through network

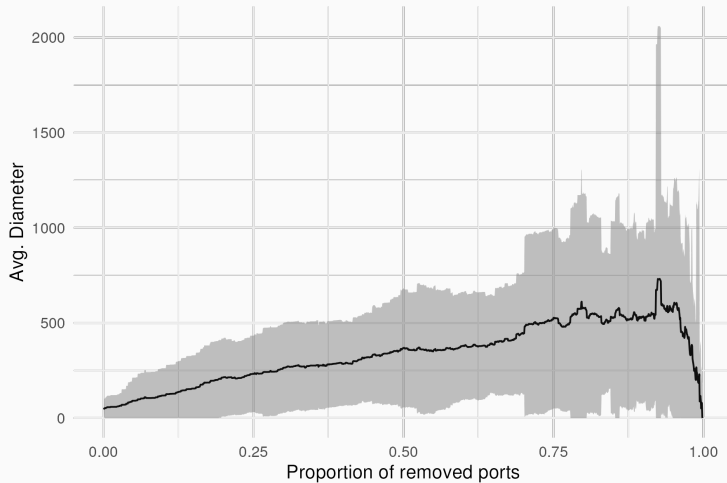


Figure 5: Random attacks on ports - 100 simulations

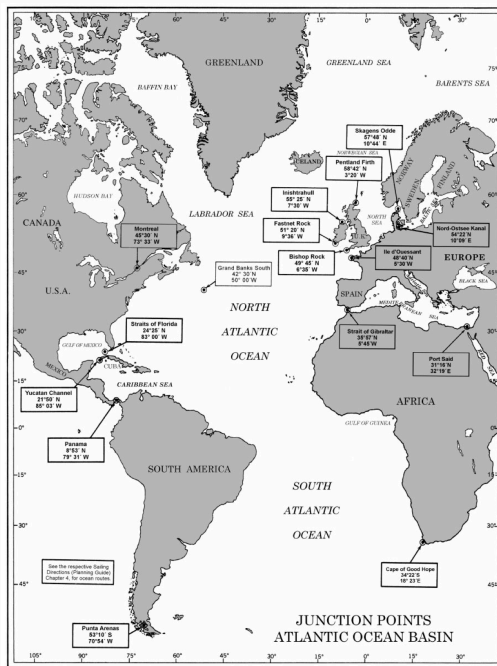
PUB. NO. 151
(Formerly No. 117)

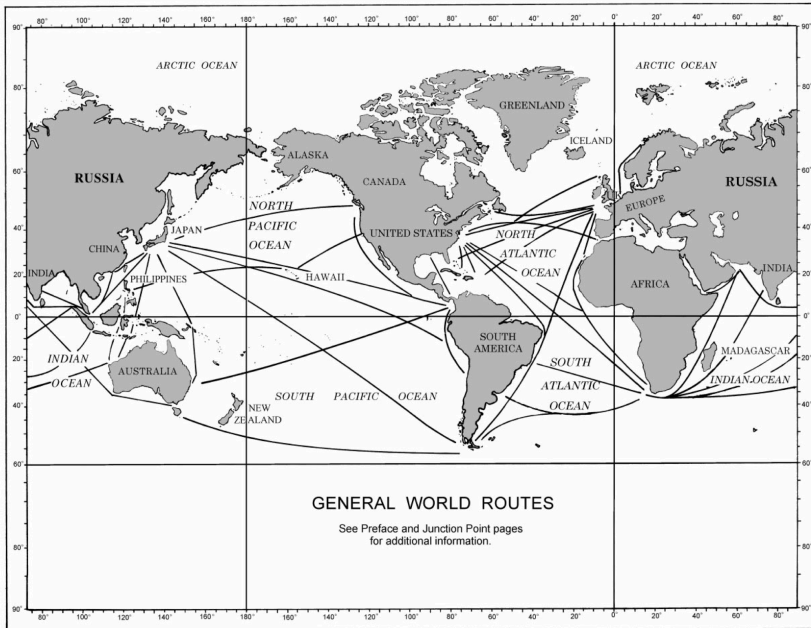
DISTANCES BETWEEN PORTS

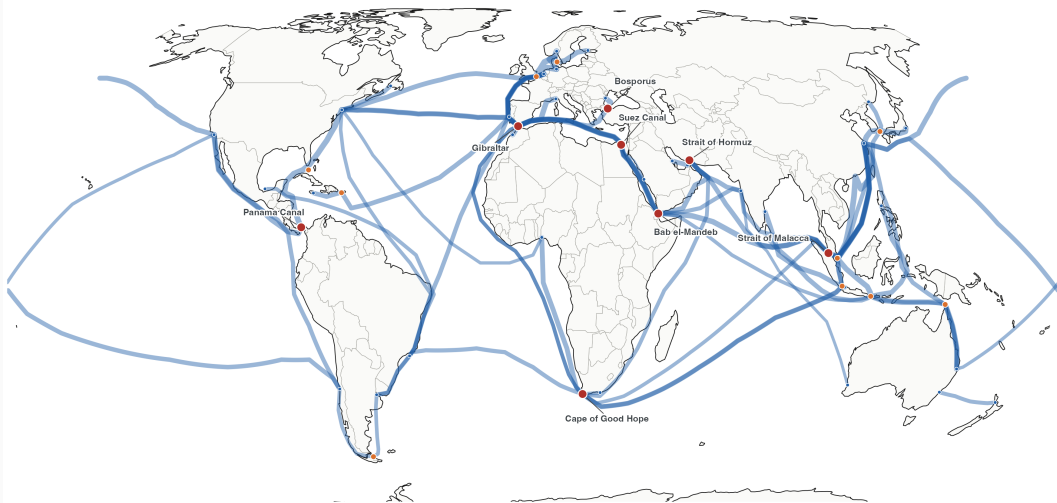
Published by the U.S. Naval Oceanographic Office
under the authority of the Secretary of the Navy



U.S. Government Printing Office
Washington : 1964







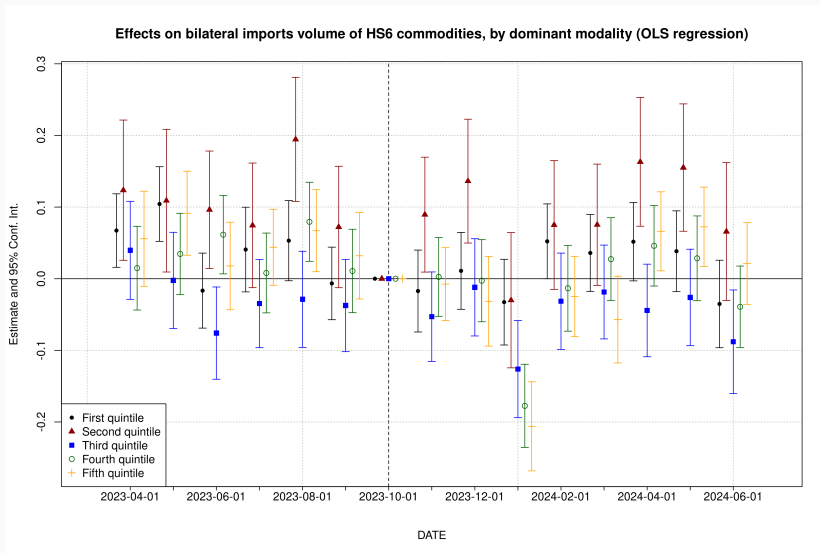
Trade response: macro and micro evidence

Sea-probability weighted DiD

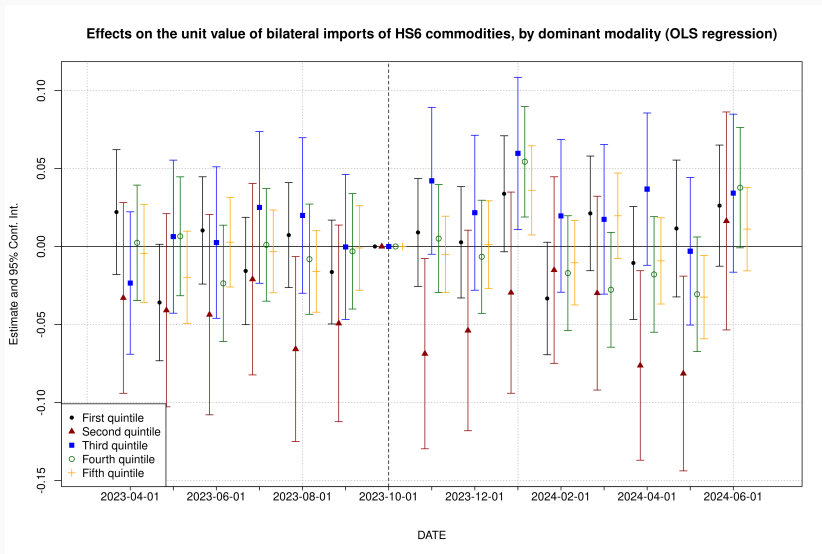
- HS6 product $\times$ bilateral monthly trade panel (Comext / Census)
- Treatment: *sea-probability* $s_{ij,k}$ – product- and route-specific likelihood the flow uses the Red Sea
 - Improvement over binary canal-closure dummies
- Identification:

$$\Delta \log y_{ijkt} = \beta \cdot s_{ij,k} \cdot \mathbf{1}[t \geq \text{Nov 2023}] + \dots$$

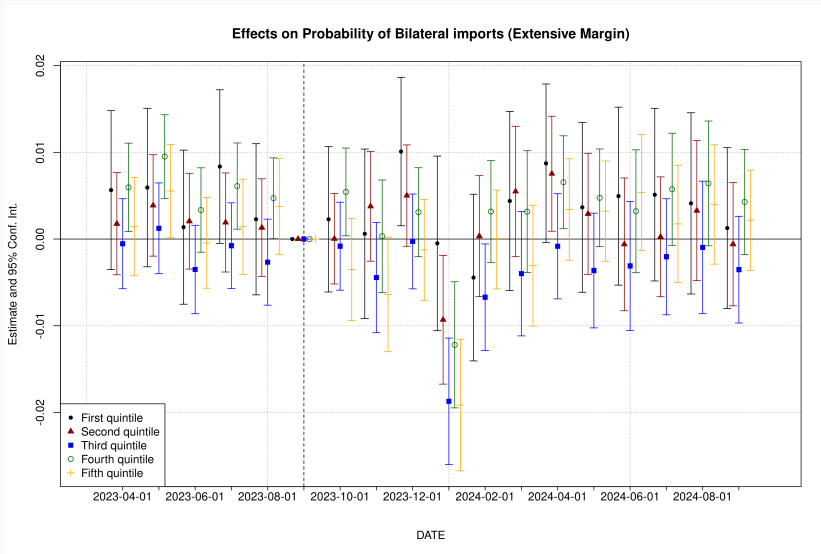
Quantity shock and rebound



Persistent unit-value effect



Supplier diversion (extensive margin)



Model and simulation

Model in one slide

- Eaton–Kortum structural gravity across sectors, route choice nested below source choice
 - Multinomial logit at the “ship level”, Poisson count at aggregation (Tolva 2025)
- “First-nature” geography δ_{odr} , transport-cost wedge per route has three components:
 - Local congestion Ξ_r
 - Global capacity Ψ
 - Endogenous *transit fee* ϕ_r at priced canals/chokepoints
- Embedded in Caliendo–Parro / Baqaee–Farhi I-O production network

Route choice

- Discrete choice problem like in Tolva (2025), but for route choice
- Price for importing goods from port o to port d written as

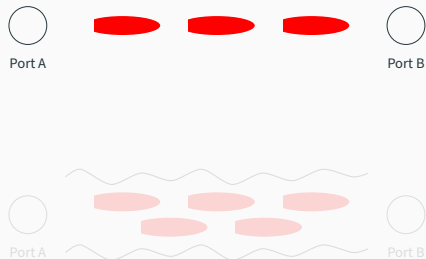
$$p_{od} = \left(\sum_r p_{odr}^{1-\eta} \right)^{\frac{1}{1-\eta}} = p_o \tau_{od} \left(\sum_r d_{odr}^{1-\eta} \right)^{\frac{1}{1-\eta}} = p_o \tau_{od} d_{od}$$

- Then share of trade between two ports by route

$$\pi_{odr} = \frac{X_{odr}}{X_{od}} = \frac{d_{odr}^{1-\eta}}{\sum_s d_{ods}^{1-\eta}}$$

Local congestion and global capacity

Local congestion:



→ Route usage ↑ → costs ↑

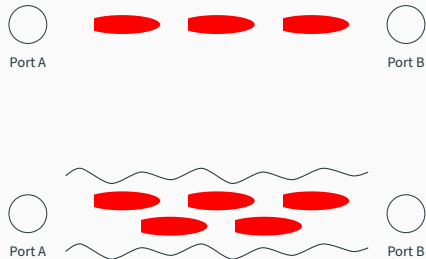
Global capacity constraints:



→ Route length ↑ → costs ↑

Local congestion and global capacity

Local congestion:



→ Route usage ↑ → costs ↑

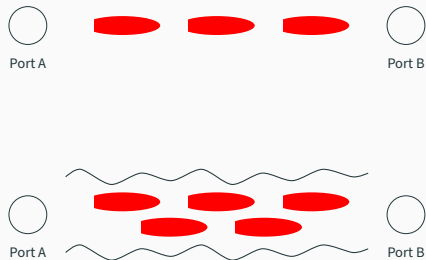
Global capacity constraints:



→ Route length ↑ → costs ↑

Local congestion and global capacity

Local congestion:



→ Route usage ↑ → costs ↑

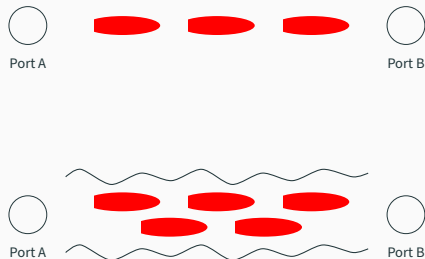
Global capacity constraints:



→ Route length ↑ → costs ↑

Local congestion and global capacity

Local congestion:



→ Route usage ↑ → costs ↑

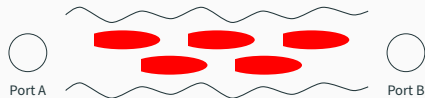
Global capacity constraints:



→ Route length ↑ → costs ↑

Local congestion and global capacity

Local congestion:



→ Route usage ↑ → costs ↑

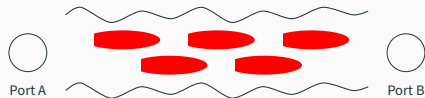
Global capacity constraints:



→ Route length ↑ → costs ↑

Local congestion and global capacity

Local congestion:



→ Route usage ↑ → costs ↑

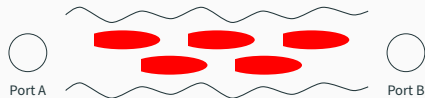
Global capacity constraints:



→ Route length ↑ → costs ↑

Local congestion and global capacity

Local congestion:



→ Route usage ↑ → costs ↑

Global capacity constraints:



→ Route length ↑ → costs ↑

Congestion and capacity constraints

- Transportation costs f_{odr} on a route be determined by three components:

→ Local congestion: $\Xi_r = \iota_r \left(\sum_{o',d'} X_{o'd'r} \right)^{\lambda_s}$

→ Global capacity: $\Psi = \left(\sum_{o',d',r'} X_{o'd'r'} \delta_{o'd'r'} \right)^{\gamma_s}$

→ Transit fee: ϕ_r

- Route-specific transport cost becomes

$$d_{odr,s} = \delta_{odr} \cdot \left(\Xi_r^{\lambda_s} \cdot \Psi^{\gamma_s} \cdot \phi_r \right)^{\chi_s}$$

Endogenous transit fees

- Canal authority on priced route r sets a fee ϕ_r multiplying the freight component
→ Suez canal, Panama canal, Strait of Hormuz now?
- Authority maximises revenue $\Pi_r = (\phi_r - 1) \sum_{o,d,s} \chi_s \cdot X_{odr,s}$
- Revenue accrues to the authority (e.g. Egypt, Panama, Iran?)

Endogenous transit fees

- FOC: ϕ_r marks up over the effective demand elasticity

$$\eta_{\text{eff}} \approx \mu \cdot (1 - \pi_{odr})$$

→ High baseline share on the priced route $\Rightarrow$ low effective elasticity $\Rightarrow$ high optimal markup

→ We discipline this with $\phi_r \leq \bar{\phi}$ matching observed canal revenue

Embedding in the NQTM production network

- Route block above gives, for every OD pair and sector, a route-aggregated trade cost

$$d_{od,s} = \left(\sum_r d_{odr,s}^{1-\eta} \right)^{1/(1-\eta)}$$

- Plugged into NQTM with intermediates, factor markets, and final demand
- Counterfactual: shift δ_{odr} (closure $\rightarrow \infty$ on the closed route), and usual tariffs, NTBs, etc.

Response to a route-cost shock (hat algebra)

- Using exact hat algebra following Dekle et al. (2008), the change in route-aggregated trade cost in response to a first-nature shock $\hat{\delta}_{ods}$ is

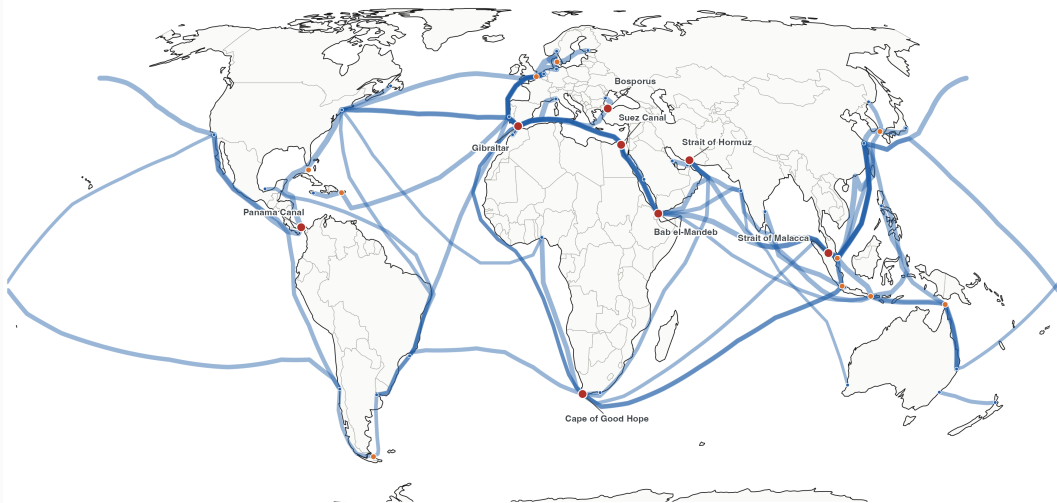
$$\hat{d}_{od} = \hat{\psi} \left[1 + \pi_{ods} \left((\hat{\delta}_{ods} \hat{\Xi}_{ods})^{1-\eta} - 1 \right) + \sum_{r \neq s} \pi_{odr} \left(\hat{\Xi}_{odr}^{1-\eta} - 1 \right) \right]^{\frac{1}{1-\eta}}$$

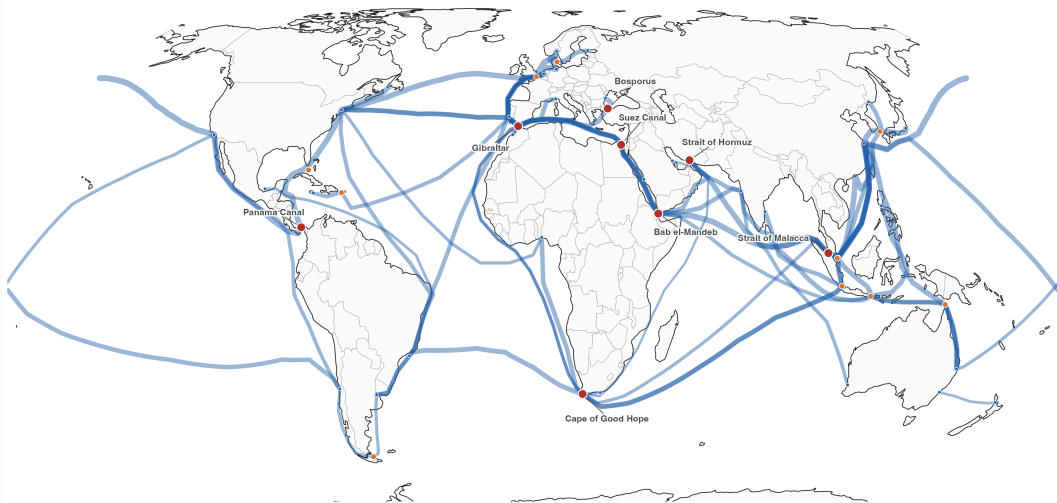
Calibration

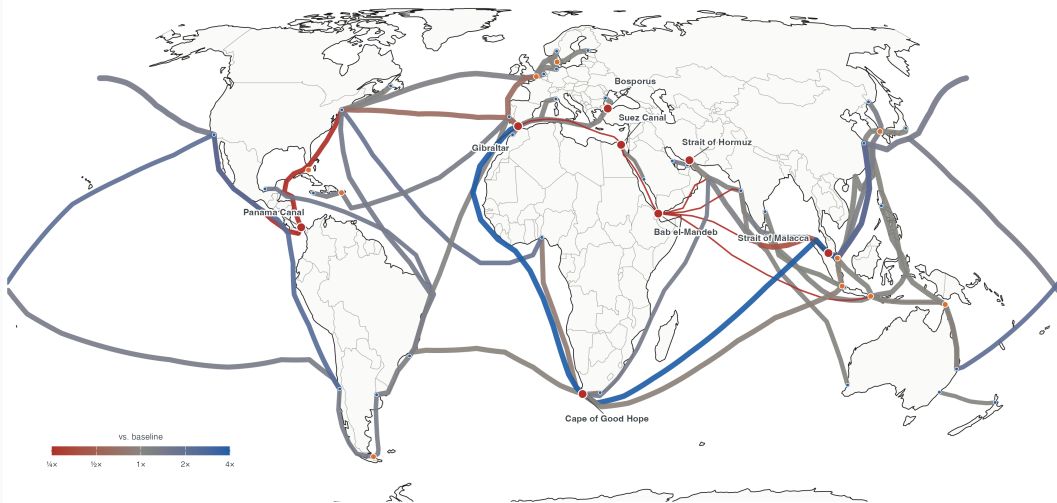
Parameter	Value	Source / method
μ (route choice)	7.535	GMM, 5,505 country pairs, 2023 (this paper)
γ^M (congestion)	0.135	Transit time $\times$ Freightos distance cost
γ^G (global capacity)	0.2	Gut-feel; IV pending
θ_{mode}	2.44	Tolva (2025); sectoral from Ko et al. (2025)
χ_s vector	$[0, 0.30]$, $\bar{\chi} \approx 0.06$	Best-guess / gravity by sector (Hummels 2007, OECD MA-TM)
$\bar{\phi}_r$	calibrated, ≈ 110	Match observed canal revenue

- OECD ICIO 2022 baseline: 81 countries, 50 sectors
- AIS route shares
 - X_{odr} number of ships (or TEUs) between ports o and d using route r
 - δ_{odr} time/distance between between ports o and d using route r

- Scenarios:
 - Red Sea closure: Suez route unavailable for Europe - Asia
 - Hormuz disruption: work in progress

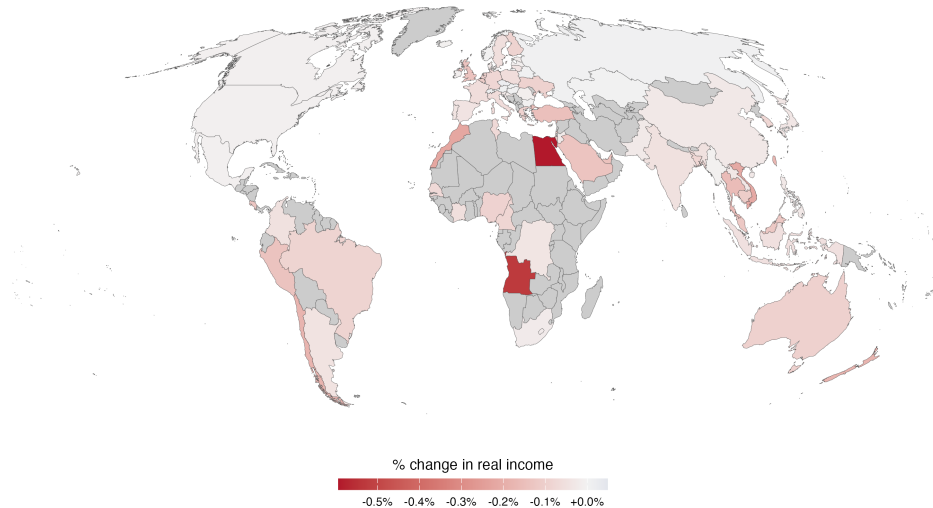




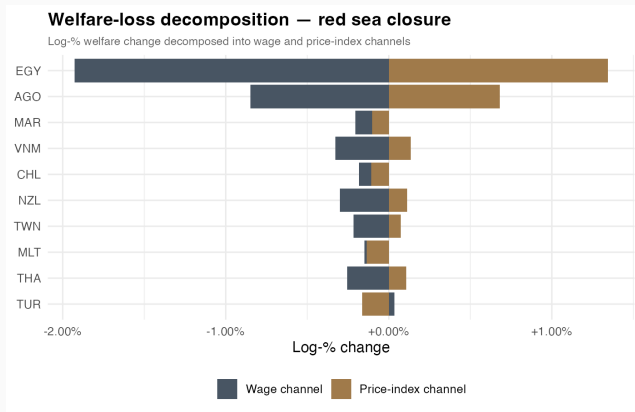


Welfare change under a Red Sea / Suez closure

% change in real income, ICIO 2022 baseline. AIS-derived route shares. BHS-2026 model.



Channel decomposition



- Top loser: Egypt ($\approx -0.59\%$)
 - Almost entirely wage channel
 - canal toll revenue is wage income for the authority; closure collapses it
- Other affected: Angola (?), Morocco, Turkey

Coming next: Strait of Hormuz

- Extend route taxonomy: Hormuz is a *dead-end* chokepoint — no maritime substitute for Persian Gulf trade
 - Different from Suez canal: priced detour
- Modal switch more important

Takeaways

- Maritime chokepoints are *very* important
- Global capacity constraint leads to strong price co-movement
- Transport model + NQTM embedding quantifies the trade response
 - Monopoly tolls + congestion + global capacity
 - Closing a priced chokepoint: wealth transfer *from* canal authority *to* ship operators and detour routes
- Strong GE additional effects, not a global welfare destruction event

Navigating Shocks: The Ripple Effects of Shipping Route Closures

RWTH Aachen Research Seminar — June 16, 2026

Carsten Brockhaus,^{1,2} **Julian Hinz**^{1,3}, Charles Serfaty⁴

¹ Kiel Institute for the World Economy

² Kiel University

³ Bielefeld University

⁴ Banque de France

Backup — Network resilience: longest shortest path

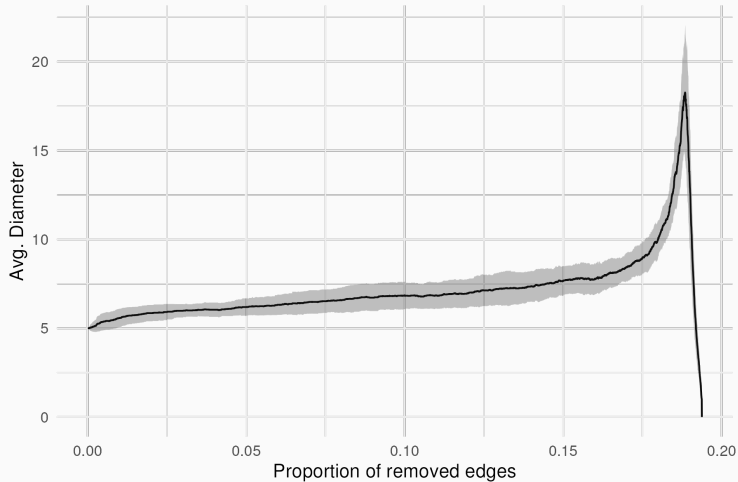


Figure 6: Random attacks on routes - 100 simulations

Backup — Panjiva firm-level (Turkey)

- Customs records, monthly firm $\times$ HS6
- DiD on Red Sea exposure (sea-share weighting at the firm level)
- Preliminary: importers reallocate within firm across suppliers; net trade roughly unchanged
- Extension under way to Sri Lanka, India, Pakistan

Backup — BACI mode-prediction nest

- HS6-level mode prediction (BACI 2022 harmonised)
- Currently *off*: `USE_MODE_NEST = FALSE`
 - Dimension bug in `compute_bhs_route_shipments` under mode-route nest
 - Route-only specification is the working configuration

Backup — additive χ form (Appendix B)

- Alternative decomposition: cargo and freight are Leontief

$$d = 1 + \chi(f - 1)$$

- Microfoundation: cargo value and freight cost are perfect complements in delivered goods
- Equivalent to multiplicative form at small $\chi(f - 1)$; deviates for large freight wedges
- Implemented in KITE.fw.bhs2026 (`freight_decomposition = "additive"`)





