The Price of Delays: Supply Chain Disruptions and Pricing Dynamics

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International Seminar on Trade, May 2025

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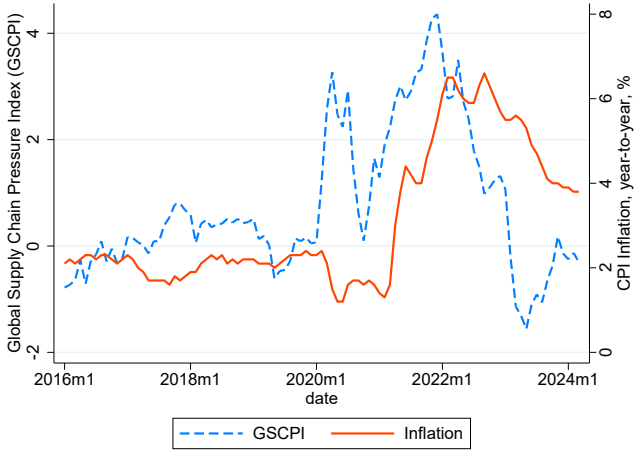

Figure: GSCPI vs. core CPI ex-food & energy

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  - Cost shocks
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- Little micro-evidence on delay→price pass-through or on strategic spillovers across firms.
- Our contribution:
  - Merge firm-level shipment data & consumer prices
  - Estimate delay vs. cost pass-through & competitor amplification
  - Quantify aggregate inflation decomposition

This Paper

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  - Monopolist optimizes price & inventory to manage delay-driven stock-outs
  - Pricing equation in terms of delays and cost changes as well as strategic interactions

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  - 1 B receipts & 1 B shipments; 36.7 k stores, 120 M items
  - Builds monthly MA shortfalls from prepandemic baseline as a proxy for delays.
  - Additional data for IVs: Port dwells (Fuchs and Wong, 2025), Port/HS2 trade data.

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  - HS2 delay & unit cost exposure
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  - HS2 delay & unit cost exposure
  - Port dwell & freight cost exposure
- Quantification solving for perturbed new equilibrium given cost and delay shocks

Theory: Product Availability and Pricing

Theory overview:

- Simple inventory-pricing problem for a monopolist
  - Markups depend on demand (σ_i) and stock-in elasticities (κ_i).
- Pricing and inventory decisions with strategic interactions
  - Competitor behavior captured via price and delay indices

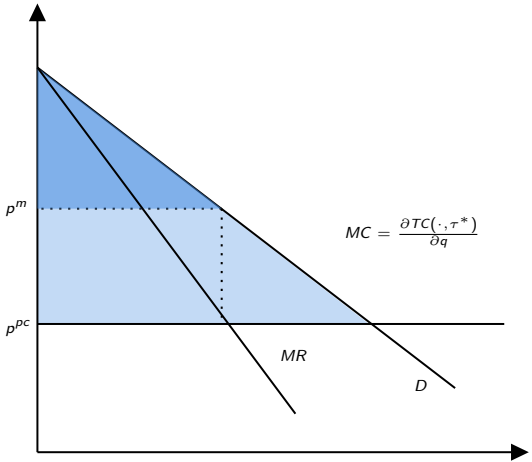
Monopolist Price

- **Objective:**

$$\max_{p_i} \Pi_i = R_i - TC_i$$

$$R_i = \exp\left\{p_i + q_i\left(p_i\right)\right\}$$

$$TC_i = TC_i\left(\exp\left\{q_i(\cdot)\right\}\right)$$



Monopolist Price

- **Objective:** Monopolist chooses p_i, given τ_i^* to maximize availability-adjusted profit:

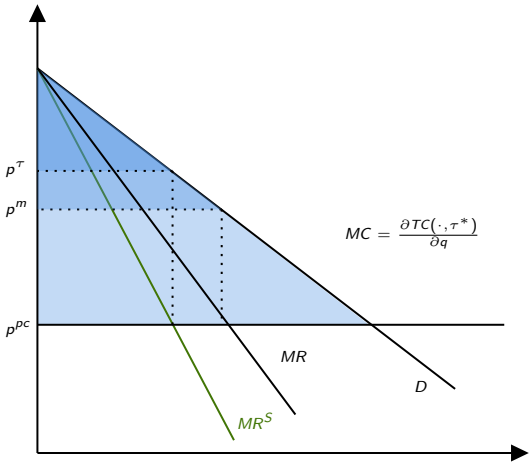
$$\max_{p_i} \Pi_i = R_i(p_i, s_i) - TC_i(q_i, s_i, \tau_i^*)$$

$$R_i = \exp\left\{p_i + q_i(p_i) + s_i\left(q_i(p_i), \tau_i^*, \zeta_i\right)\right\}$$

- **Availability:** Microfoundation: Inventory

$$s_i = s\left(q_i(p_i),\ \tau_i^*,\ \zeta_i\right)$$

  - $\partial s_i / \partial q_i < 0$ (sales deplete stock)
  - $\partial s_i / \partial \zeta_i < 0$ (delays tighten supply)

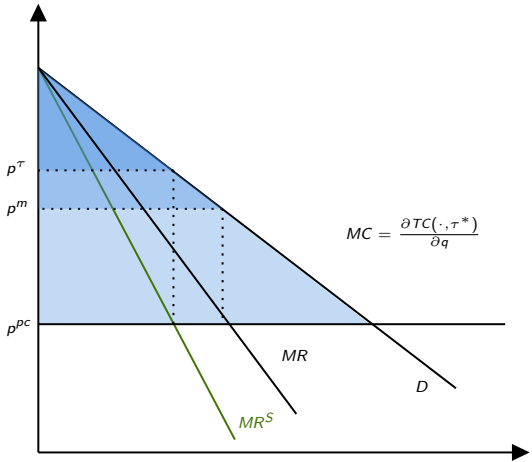


Monopolist Price

Optimal Price

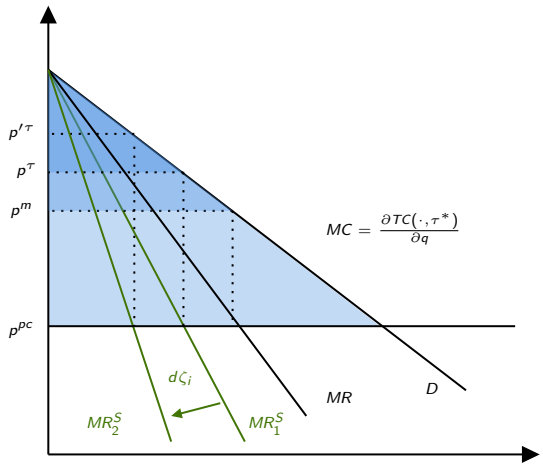
$$p_i = mc_i + \ln \frac{\sigma_i\left(1+\kappa_i\right)}{\sigma_i\left(1+\kappa_i\right)-1}$$

- Where $\sigma_i = -\frac{\partial q}{\partial p}$ is demand elasticity.
- Where $\kappa_i = \frac{\partial s}{\partial q} < 0$ is stock-in elasticity.



Monopolist Price

- Effect of a supply shock $d\zeta_i$ on price:
  - shift availability-adjusted revenue downward.



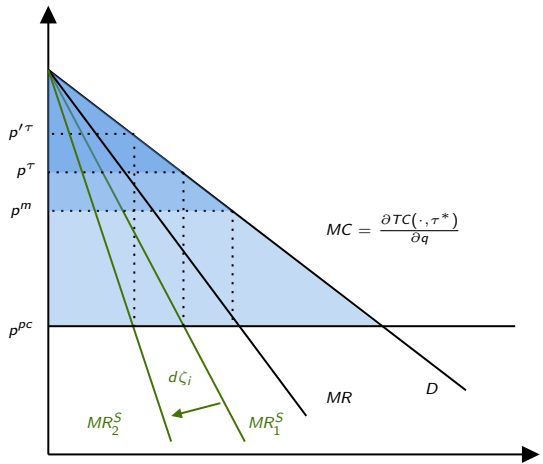
Monopolist Price

- Effect of a supply shock $d\zeta_i$ on price:
  - shift availability-adjusted revenue downward.

$$dp_i = dmc_i + d\mu(\sigma_i, \kappa_i)$$

$\rightarrow$ *Pass-through to price via growing markup.*

$$\underbrace{\partial\mu/\partial\kappa_i}_{<0} \cdot \underbrace{d\kappa_i/d\zeta_i}_{<0}$$



Adding strategic interactions

- Extends to strategic interaction across firms (Amiti, Itskhoki, and Konings 2019)

$$\max_{p_i, \tau_i} \Pi_i = R_i - TC_i \quad \text{s.t.} \quad h_{-i}(p_i, \boldsymbol{p}_{-i}; \tau_i, \tau_{-i}, \boldsymbol{\xi}) = 0$$

- **Proposition 1:** Existence of markup M_i and inventory function $\mathcal{T}_i$ characterizing best-response schedules via fixed-point conditions:

$$\tilde{p}_{it} = mc_{it} + \mathscr{M}_i(\tilde{p}_{it}, \tilde{\tau}_{it}, \boldsymbol{p}_{-it}, \tau_{-it}; \xi_t)$$
$$\tilde{\tau}_{it} = mc^{\tau}_{it} + \mathscr{T}_i(\tilde{p}_{it}, \tilde{\tau}_{it}, \boldsymbol{p}_{-it}, \tau_{-it}; \xi_t)$$

Price Change Decomposition

(Equilibrium) Price Change

$$dp_{it} = \frac{1}{1+\Gamma_{it}}\, dmc_{it} - \frac{\Lambda_{it}}{1+\Gamma_{it}}\, d\tau_{it} + \frac{\Gamma_{-it}}{1+\Gamma_{it}}\, dp_{-it} + \frac{\Lambda_{-it}}{1+\Gamma_{it}}\, d\tau_{-it} + \varepsilon_{it}.$$

- Decomposition shows how changes in price are driven by own cost, inventory adjustments, and competitors' actions.

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- Decomposition shows how changes in price are driven by own cost, inventory adjustments, and competitors' actions.

- Reduced-form coefficients depend on markup elasticities:
  - $\Gamma_{it} \equiv -\frac{\partial M_i}{\partial p_{it}}$ (own markup elasticity).
  - $\Lambda_{it} \equiv -\frac{\partial M_i}{\partial \tau_{it}}$ (own inventory elasticity).
  - $\Gamma_{-it} \equiv \sum_{j \neq i} \frac{\partial M_i}{\partial p_{jt}}$ (competitor price elasticity).
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- Competitor price index:

$$\Delta p_{-it} = \sum_{j \neq i} \frac{S_j}{1 - S_i}\, \Delta p_j$$

- Competitor delay index:

$$\Delta \tau_{-it} = \sum_{j \neq i} \frac{S_j}{1 - S_i}\, \Delta \tau_j$$

(Proposition 2)

Towards empirics: From delays to import shortfalls

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- Pricing equation:

$$dp_i = dmc_i + \frac{\partial \mu}{\partial \sigma_i} d\sigma_i + \underbrace{\frac{\partial \mu}{\partial \kappa_i} \frac{d\kappa_i}{d\tau_i} \frac{d\tau_i}{dd_i}}_{} \cdot \underbrace{\frac{dd_i}{dm_i}}_{\text{importshare}} \cdot \underbrace{\frac{dm_i}{d\zeta_i}}_{\text{shortfall}} d\zeta_i$$

Data: new dataset linking prices and shipments

1. Price Dynamics from Consumer Panel
2. Shortfalls from BoL Data
3. Port Dwell time from AIS data
4. Freight and Import Unit cost from Census

New Dataset on Consumption and Prices

Numerator Data

- **Source:** Digitized receipts (2019–23).
- **Coverage:** 1 B receipts, 2.5 M users (400 k static), 36.7 k stores, 120 M items
- **Levels:** Firm $\times$ Brand (85 k) $\times$ Category (3.8 k) (Dept, Sector)
- **Product:** firm $\times$ brand $\times$ category
- **Price:** Monthly median product-level price (within-product changes)

Sum Stats: Stores | Sum Stats: Expenditures | Sum Stats: Sectors | Validation: Flour | App

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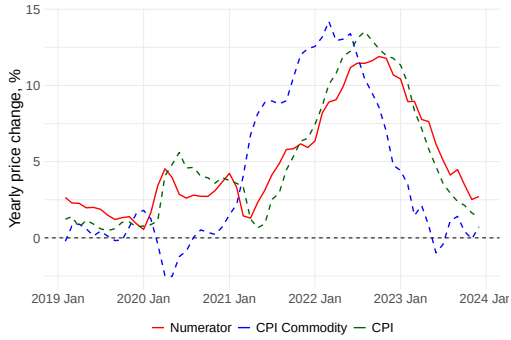
Figure: Numerator price growth vs CPI



Notes: The solid red line illustrates the 12-month aggregate price changes derived from Numerator data. We compute median product-level price changes within each category and then aggregate these category-level changes using product category sales weights.

US Shipments Data

US import shipments

- **Source:** Panjiva bills-of-lading (2007–23), >1 B shipments from 17 sourcing countries (issue redactions; Flaaen et al. 2023) Panjiva vs. Census
- **Classification:** HS6 codes via OCR of B/L
- **Fields:** Quantity; shipper & consignee names + locations; HS category; ports
- **Values:** No prices or values (imputed from Census data)

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Monthly firm-HS-code-level delivery shortfall

- % deviation of k-wk MA imports $D_{f,j,t}$ vs. 2019 (Davis, Haltiwanger and Schuh (1998))

$$DeliveryShortfall_{f,j,t(k)} = 2\frac{\sum_{m=t-k}^{t} D_{f,j,m} - \sum_{m=t-k,2019}^{t,2019} D_{f,j,m}}{\sum_{m=t-k}^{t} D_{f,j,m} + \sum_{m=t-k,2019}^{t,2019} D_{f,j,m}}.$$

- f: firm; j: HS2 code; t: month

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Firm-level delivery shortfall

$$DeliveryShortfall_{f,t(k)} = \sum_j s_{fj}^{2019} DeliveryShortfall_{f,j,t(k)}.$$

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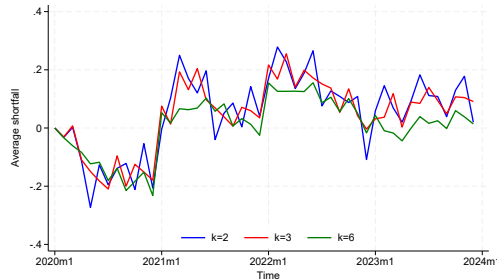
Figure: Average Delivery Shortfall Over Time



Notes: Weighted firm-level shortfalls over time. Panjiva sample. Weights are firm-level total annual imports.

Combining Panjiva and Numerator Datasets

Merged Data

- Merge: Panjiva consignees $\longleftrightarrow$ Numerator manufacturers/brands
  - Firm–month shortfalls + price changes
  - Covers 1/3 of firms & products (53% of sales) Sourcing partners

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Stylized Facts: 2020-2023

$\rightarrow$ Large heterogeneity in delivery shortfalls and price growth across:
- Product groups/sectors. here
- Firms. here

$\rightarrow$ Price increases larger for bigger firms. here

$\rightarrow$ Price increases smaller for firms with more diversified supply chains. here

Additional Data: Port dwell times and Marginal Cost Components

Additional Data

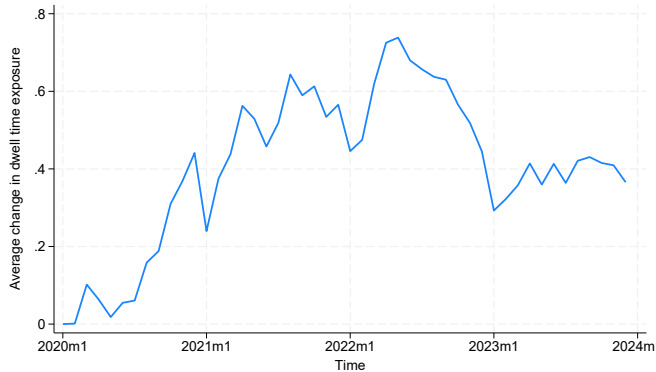
- Dwell time at US Ports
- Import cost across HS2
- Freight cost at US Ports

Additional Data: Port dwell times, and Census Data

Additional Data

- Dwell time at US Ports
  - Collected from vessel-location data (Fuchs and Wong, 2025) Details
- Import cost across HS2
- Freight cost at US Ports

Figure: Average Dwell Time Exposure Over Time



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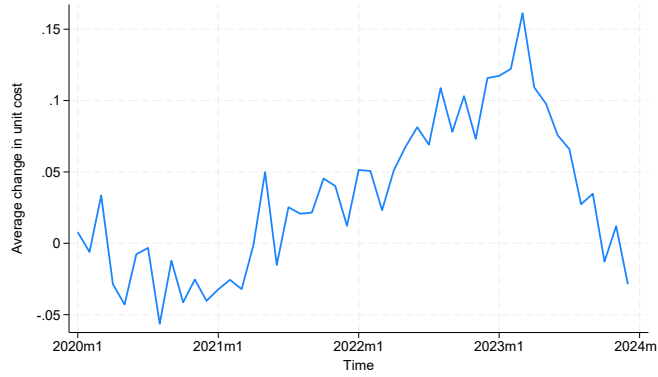
- Dwell time at US Ports
- Import cost across HS2
  - Unit costs from US Trade online (Census)
- Freight cost at US Ports

Figure: Marginal Cost Changes: Unit Values and Freight Cost Ratios

(A) Average unit value change



Notes: Weighted average of firm-level change in unit value and freight cost ratio over time.

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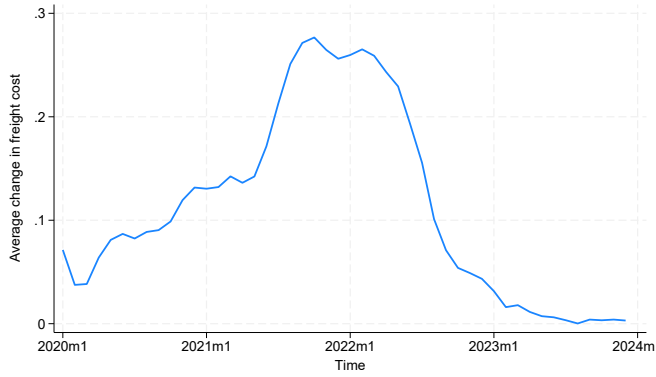
Additional Data

- Dwell time at US Ports
- Import Unit cost across HS2
- Freight cost at US Ports
  - $\frac{CIF}{FOB}$ calculated from US Trade online at port-district level.

Figure: Marginal Cost Changes: Unit Values and Freight Cost Ratios

(B) Average freight cost ratio change



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Empirics: estimating pass-throughs

Estimating Equation. Own Pass-through

$$\Delta \text{Price}_{p,f,t} = \beta \underbrace{\textit{Delivery Shortfall}_{f,t(k)}}_{\substack{\text{own} \\ \text{shortfall}}} + \gamma \underbrace{\Delta MC_{f,t}}_{\substack{\text{own} \\ \text{cost}}} + \alpha_f + \alpha_{j(p),q(t)} + \epsilon_{p,f,t}$$

- $\textit{Delivery Shortfall}_{f,t(k)}$: % deviation of k–mo imports vs. 2019.
- $\Delta MC_{f,t}$: 12-mo change in firm import unit and freight cost.

- α_f: firm FE
- $\alpha_{j(p),q(t)}$: product-category$\times$quarter FE
- β: own-shortfall elasticity
- γ: cost-pass-through

Identification. Delivery Shortfalls

OLS. Downward bias:

- Endogeneity: Demand shocks ↑ both ΔPrice and *Shortfall*
  - Firms adjust shipments in anticipation of price moves (simultaneity)
- Aggregate demand shocks: product-market-time f.e.
- Firm-level demand shocks: IV.

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IV for Shortfall:

1. Shortfall exposure;
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Firm Shortfalls Exposure

Delivery shortfall exposure combines external HS2-code shocks with firm's 2019 import shares:

$$\text{Exposure}_{f,t(k)} = \sum_{h \in S^{HS2}} \omega_{h,f,2019} \times \mathit{Shortfall}_{h,t(k)_{-f}}$$

$h \in S^{HS2}$	HS2 codes
$\mathit{Shortfall}_{h,t(k)_{-f}}$	Leave-out delivery shortfall for code h
$\omega_{h,f,2019}$	Firm f's 2019 HS2 import share

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Port Dwell Time Exposure

$$\text{DwellExp}_{f,t} = \sum_{p} \omega_{p,f,2019} \times \Delta\text{DwellTime}_{p,t}$$

$\Delta\text{DwellTime}_{p,t}$ Change in log port-level dwell time (residualized)

$\omega_{p,f,2019}$ Firm f's 2019 port share

Identification. ΔMC

ΔMC: **imported-input index**

1. $\Delta FreightCost$
2. $\Delta UnitCost$

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Freight Cost Exposure

$$\Delta \text{FreightCostExp}_{f,t} = \sum_{p} \omega_{p,f,2019}\, \Delta \text{FreightCost}_{p,t}$$

$\omega_{p,f,2019}$ Firm f's 2019 port p import share

$\Delta \text{FreightCost}_{p,t}$ 12-mo log change in port-level freight cost

Identification. ΔMC

ΔMC: **imported-input index:**

1. $\Delta FreightCost$
2. $\Delta UnitCost$

Unit Cost Exposure

$$\Delta \text{UnitCostExp}_{f,t} = \sum_{h} \omega_{h,f,2019}\, \Delta \text{UnitCost}_{h,t}$$

$\omega_{h,f,2019}$ Firm f's 2019 HS2 import share

$\Delta \text{UnitCost}_{h,t}$ 12-mo log change in HS-level unit cost

1. Estimating Pass-Through. Own Disruptions

1. *Significant pass-through from delivery shortfalls and cost shocks to prices.*

	(1) OLS	(2) OLS-Shift Share	(3) IV	(4) IV
Shortfall (k=3)	-0.005	-0.102***	-0.231***	-0.320***
	(0.0047)	(0.0376)	(0.0862)	(0.0932)
$\Delta UnitC$	0.001	0.146**	0.134**	0.131**
	(0.0096)	(0.0602)	(0.0609)	(0.0626)
$\Delta FreightC$	0.023	-0.024	0.203*	0.360***
	(0.0370)	(0.0778)	(0.1188)	(0.1247)
Lag Shortfall				0.036
				(0.0803)
Lag2 Shortfall				-0.072
				(0.0795)
Firm FE	✓	✓	✓	✓
Cat-Quarter FE	✓	✓	✓	✓
Observations	979076	979076	979076	925638
Weak IV F-stat			658.481	131.833

Notes: 12-month price changes at the product level on delivery shortfalls (12-week ma) at the firm level. Robust se in parentheses clustered at category-quarter level. Durable I-stage

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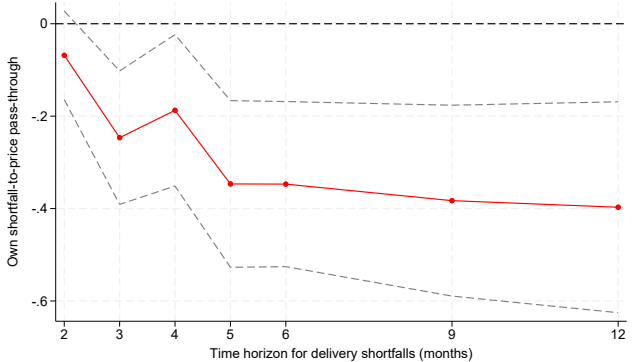
Lag2 Shortfall				-0.072
				(0.0795)
Firm FE	✓	✓	✓	✓
Cat-Quarter FE	✓	✓	✓	✓
Observations	979,076	979,076	979,076	925,638
Weak IV F-stat			658.481	131.833

Notes: 12-month price changes at the product level on delivery shortfalls (12-week ma) at the firm level. Robust se in parentheses clustered at category-quarter level. Durable I-stage

Horizons of delivery shortfalls

$$\Delta \ln \text{ Price}_{p,f,t} = \beta_k \widehat{\text{DeliveryShortfall}}_{f,t(k)} + ...,$$

for various k-weeks moving averages.



Notes: Coefficients from the separate regressions of 12-month price changes at the product level on firm-level delivery delays in moving averages at different horizons. Robust se clustered at the category-quarter level.

2. Estimating Pass-Through. Strategic interactions

$$\Delta \text{Price}_{p,f,t} = \underbrace{\beta \, Shortfall_{f,t(k)}}_{\substack{\text{own} \\ \text{shortfall}}} + \underbrace{\gamma \, \Delta MC_{f,t}}_{\substack{\text{own} \\ \text{cost}}} + \underbrace{\delta \, Shortfall_{-f,t(k)}}_{\substack{\text{rivals'} \\ \text{shortfall}}} + \underbrace{\zeta \, \Delta MC_{-f,t}}_{\substack{\text{rivals'} \\ \text{cost}}} + \alpha_f + \alpha_{j(p),q(t)} + \epsilon_{p,f,t}$$

- Competitors' shortfall: $Shortfall_{-f,t(k)}$
  market-share-weighted competitors' shortfalls.

- Competitors' cost: $\Delta MC_{-f,t}$
  market-share-weighted competitors' unit and freight cost changes.

2. Estimating Pass-Through. Strategic interactions

2. *Competitors' shortfalls important for own prices (incl. for unaffected firms).*

	(1) OLS	(2) OLS-Shift Share	(3) IV	(4) IV
Shortfall	-0.005	-0.094**	-0.202**	-0.249*
	(0.0048)	(0.0417)	(0.0994)	(0.1305)
$\Delta UnitC$	0.006	0.153**	0.149**	0.275***
	(0.0097)	(0.0603)	(0.0616)	(0.0643)
$\Delta FreightC$	0.045	0.031	0.199	0.175
	(0.0373)	(0.0786)	(0.1388)	(0.1661)
Shortfall, competitor	0.005	-0.063	-0.300	-0.203
	(0.0132)	(0.0845)	(0.3769)	(0.3852)
$\Delta UnitC$, competitor	0.061*	0.301*	0.272	0.330**
	(0.0327)	(0.1613)	(0.1668)	(0.1332)
$\Delta FreightC$, competitor	0.387***	0.875***	0.892***	0.474*
	(0.1070)	(0.2067)	(0.3068)	(0.2434)
Firm FE	Yes	Yes	Yes	Yes
Cat-Quarter FE	Yes	Yes	Yes	Yes
Observations	972302	972302	972302	1682619
Weak IV F-stat			26.882	22.588

Notes: 12-month price changes at the product level on delivery shortfalls (12-week ma) at the firm level. Robust se in parentheses clustered at the category-quarter level. 1-stage

2. Estimating Pass-Through. Strategic interactions

2. *Competitors' shortfalls important for own prices (incl. for unaffected firms).*

	(1) OLS	(2) OLS-Shift Share	(3) IV	(4) IV
Shortfall	-0.005	-0.094**	-0.202**	-0.249*
	(0.005)	(0.042)	(0.099)	(0.131)
Δ UnitC	0.006	0.153**	0.149**	0.275***
	(0.010)	(0.060)	(0.062)	(0.064)
Δ FreightC	0.045	0.031	0.199	0.175
	(0.037)	(0.079)	(0.139)	(0.166)
Shortfall, competitor	0.005	-0.063	-0.300	-0.203
	(0.013)	(0.085)	(0.377)	(0.385)
Δ UnitC, competitor	0.061*	0.301*	0.272	0.330**
	(0.033)	(0.161)	(0.167)	(0.133)
Δ FreightC, competitor	0.387***	0.875***	0.892***	0.474*
	(0.107)	(0.207)	(0.307)	(0.243)
Firm FE	✓	✓	✓	✓
Cat–Quarter FE	✓	✓	✓	✓
Observations	972,302	972,302	972,302	1,682,619
Weak IV F-stat			26.882	22.588

Notes: 12-month price changes at the product level on delivery shortfalls (12-week ma) at the firm level. Robust se in parentheses clustered at the category-quarter level. 1-stage

Aggregate implications

Quantification Methodology

Equilibrium Pricing Rule

$$\Delta \mathbf{p} = (I - \gamma W)^{-1} \Big[\alpha \, \Delta \mathbf{mc} \; - \; \beta \, \Delta \boldsymbol{\tau} \; + \; \delta \, W \, \Delta \boldsymbol{\tau} \Big]$$

where $W_{ij} = S_j/(1 - S_i)$ captures competitor shares.

Quantification Methodology

Equilibrium Pricing Rule

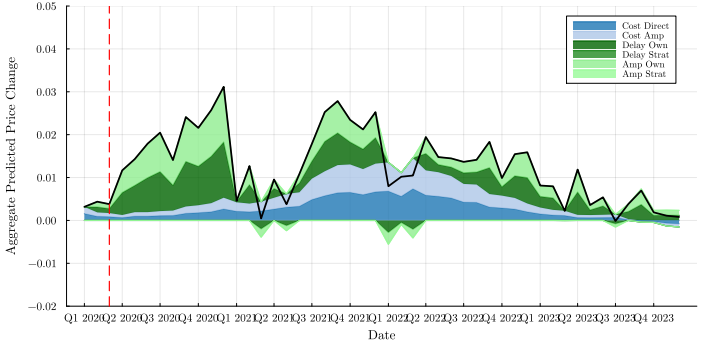
$$\Delta \mathbf{p} = (I - \gamma W)^{-1}\Big[\alpha\, \Delta \mathbf{mc} \;-\; \beta\, \Delta \boldsymbol{\tau} \;+\; \delta\, W\, \Delta \boldsymbol{\tau}\Big]$$

where $W_{ij} = S_j/(1 - S_i)$ captures competitor shares.

- **Step 1:** Gather monthly firm-level { Δmc_i, $\Delta \tau_i$, S_i, CPI weights}.
- **Step 2:** Compute $\Delta \hat{\mathbf{p}} = (I - \gamma W)^{-1}[\alpha\, \Delta mc - \beta\, \Delta \tau + \delta\, W\, \Delta \tau]$.
- **Step 3:** Decompose each $\Delta \hat{p}_i$:
  - Cost direct: $\alpha\, \Delta mc$
  - Cost amplification: $(I - W)\, \alpha\, \Delta mc$
  - Delay direct: $-\beta\, \Delta \tau + \delta\, W\, \Delta \tau$
  - Delay amplification: $(I - W)\Big[-\beta\, \Delta \tau + \delta\, W\, \Delta \tau\Big]$

The role of supply chain disruptions in COVID inflation surge

Supply chain disruptions contributed to the recent inflation surge: 95% in 2020; 15% in 2021; 4% in 2022.



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The role of supply chain disruptions in COVID inflation surge

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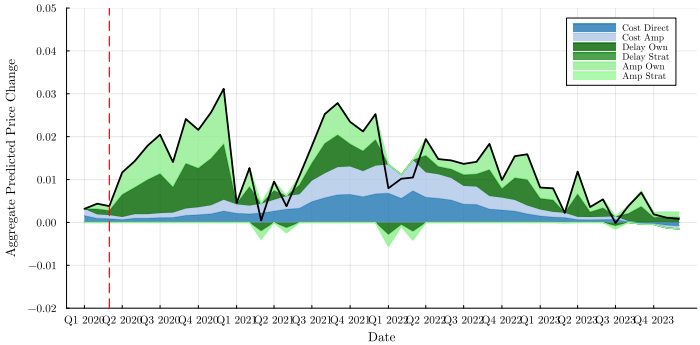

Delay channel:

- Most of the effect in 2020 (lockdowns, SC bottlenecks);
- Some after reopening (port congestion during high demand).

Cost channel:

- Mostly, contributed in the 2021-2022 period.

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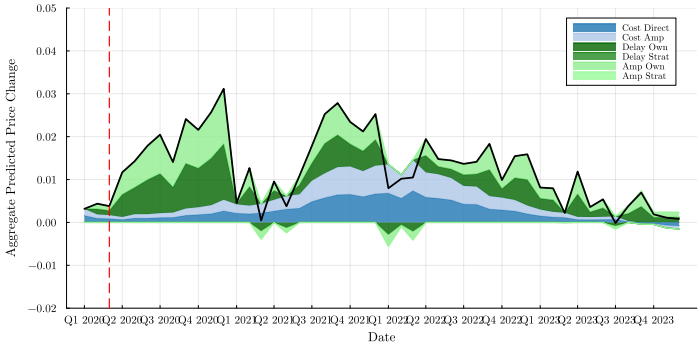
The role of supply chain disruptions in COVID inflation surge

Supply chain disruptions contributed to the recent inflation surge: 95% in 2020; 15% in 2021; 4% in 2022.



Delay channel:

- Most of the effect in 2020 (lockdowns, SC bottlenecks);
- Some after reopening (port congestion during high demand).

Cost channel:

- Mostly, contributed in the 2021-2022 period.

Strategic amplification doubled the direct incidence on firms.

Conclusions & Next Steps

- New micro-level evidence for the effect of firm-level supply chain disruptions (shortfalls & costs) on consumer prices in 2020-2023.
- Framed by a joint inventory–pricing model with stochastic delays.

Main Findings

- Macro data and standard indices conflate supply, cost, and demand shocks.
- Supply-chain delays and cost shocks raised prices and were amplified by competitor interactions.

Next Steps

- Refine identification: spatial shift–share port dwell-time IVs; extend HS-code merges.
- Validate with Compustat markups & inventory; implement counterfactual policy simulations.

Appendix

Identification: All Instruments

2SLS Specification

$$\Delta \text{Price}_{p,f,t} = \beta \widehat{Shortfall}_{f,t(k)} + \gamma \widehat{\Delta MC}_{f,t} + \delta \widehat{Shortfall}_{-f,t(k)} + \zeta \widehat{\Delta MC}_{-f,t} + \alpha_f + \alpha_{j(p),q(t)} + \epsilon_{p,f,t}$$

Identification: All Instruments

2SLS Specification

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Shortfall IVs

- Shortfall shift–share exposure:
  $\sum_h Shortfall_{h,t(k)_{-f}} \omega_{h,f,2019}$
- Dwell time exposure:
  $\sum_p \Delta DwellTime_{p,t} \omega_{p,f,2019}$
- $Shortfall_{-f,t(k)} \rightarrow$
  $$\sum_{j \neq f} \frac{S_j}{1 - S_f} \left(\sum_h Shortfall_{h,t(k)_{-j}} \omega_{h,j,2019} \right)$$

Identification: All Instruments

2SLS Specification

$$\Delta \text{Price}_{p,f,t} = \beta \widehat{Shortfall}_{f,t(k)} + \gamma \widehat{\Delta MC}_{f,t} + \delta \widehat{Shortfall}_{-f,t(k)} + \zeta \widehat{\Delta MC}_{-f,t} + \alpha_f + \alpha_{j(p),q(t)} + \epsilon_{p,f,t}$$

Shortfall IVs

- Shortfall shift–share exposure: $\sum_h Shortfall_{h,t(k)_{-f}} \omega_{h,f,2019}$
- Dwell time exposure: $\sum_p \Delta DwellTime_{p,t} \omega_{p,f,2019}$
- $Shortfall_{-f,t(k)} \rightarrow$ $\sum_{j \neq f} \frac{S_j}{1 - S_f} \left(\sum_h Shortfall_{h,t(k)_{-j}} \omega_{h,j,2019} \right)$

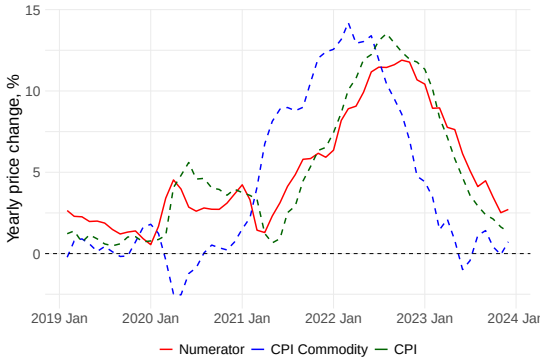
ΔMC

- Unit cost exposure: $\sum_h \Delta UnitCost_{h,t} \omega_{h,f,2019}$
- Freight cost exposure: $\sum_p \Delta FreightCost_{p,t} \omega_{p,f,2019}$
- $\Delta MC_{-f,t} \rightarrow$ $\sum_{j \neq f} \frac{S_j}{1 - S_f} \left(\sum_h \Delta UnitCost_{h,t} \omega_{h,j,2019} \right)$
- Scale all variables with input import share (Census).

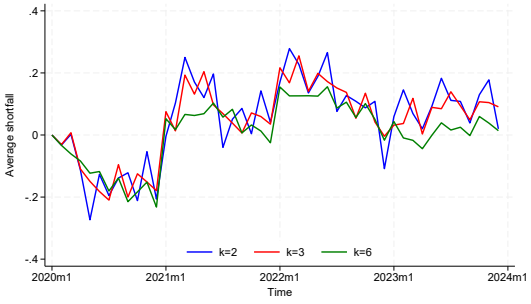
Fact 1: Shortfall in imports and increase in prices

Back

(A) Numerator price growth vs CPI



(B) Panjiva aggregate import shortfall



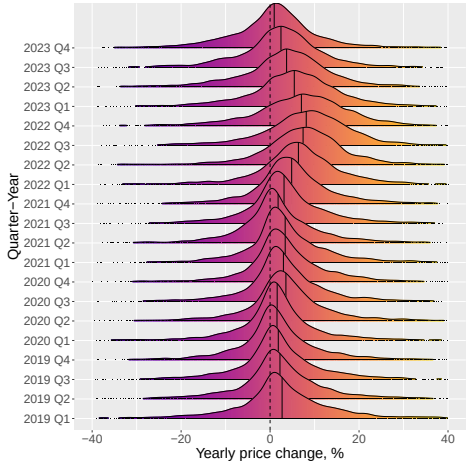
Notes: (A) Laspeyres index for static user: weighted with expenditure shares and demo weights, 1 percent trimmed micro sample (Numerator, own calculations) (B) Import shortfalls constructed as mean level deviations in the same month compared to 2019 baseline, weighted by quantity-weights constructed from US Trade online (Census, Panjiva, own calculations).

PanjivavsCensus (sample)

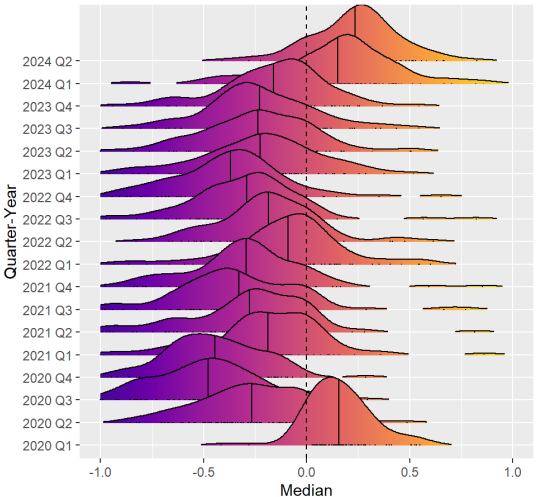
Fact 2: Heterogeneity across product groups over time

Back

(A) Distribution of price changes (by category)



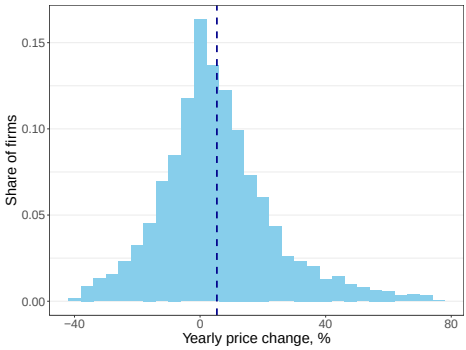
(B) Distribution of import shortfalls (by HS2 code)



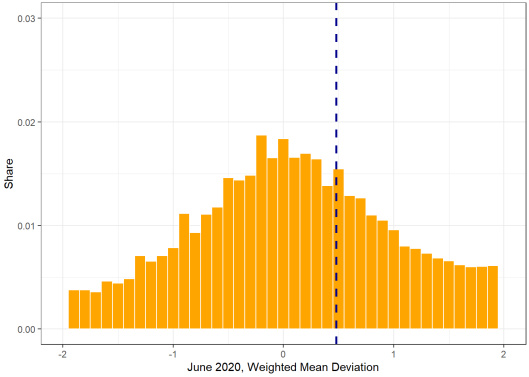
Fact 3: Heterogeneity across firms

Back

(A) Distribution of price changes
(by category)



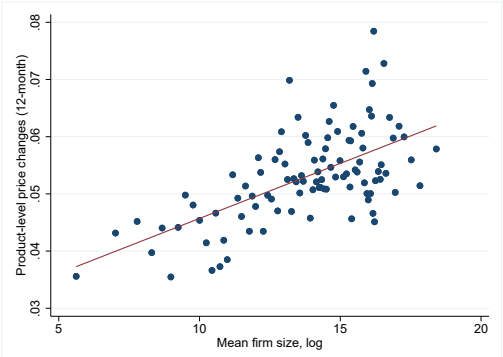
(B) Distribution of import shortfalls
(by HS2 code)



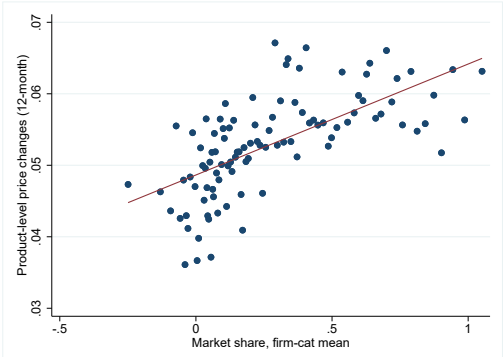
Fact 4: Price changes and firm size

Back

(A) Product Price Growth vs Firm Size



(B) Product Price Growth vs Firm Market Share



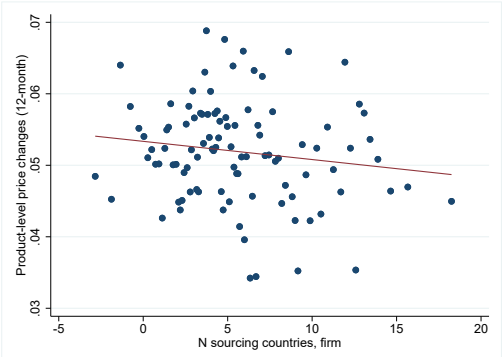
Notes: (A) Binscatters of product-level price changes against log firm size, defined as the average yearly sales of the firm in Numerator. (B) Binscatters of product-level price changes against firm market share, defined as the average firm's sales over total sales in the same product category in a year. Residualized for year and department f.e.

Time series

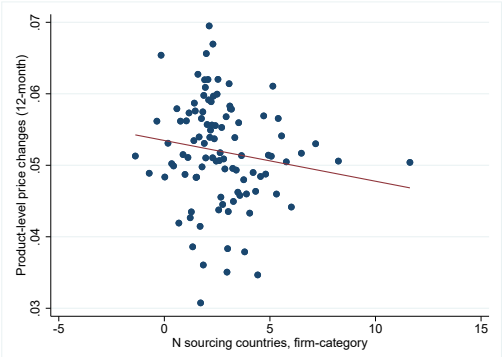
Fact 5: Price changes and supplier diversification

Back

(A) Product Price Growth vs Supplier Countries



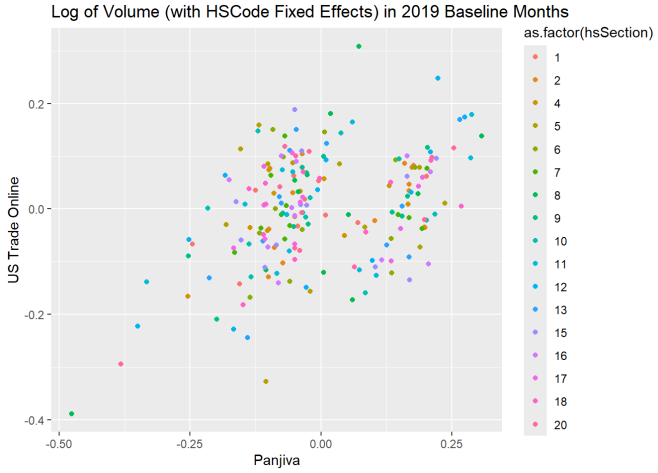
(B) Product Price Growth vs Industry-Supplier Countries



Notes: (A) Binscatters of product-level price changes against the number of countries the firm is sourcing from, controlling for firm size. (B) Binscatters of product-level price changes against the number of countries the firm is sourcing from for various HS codes, controlling for firm size. Residualized for year and department f.e.

Comparison with US Trade online

Back

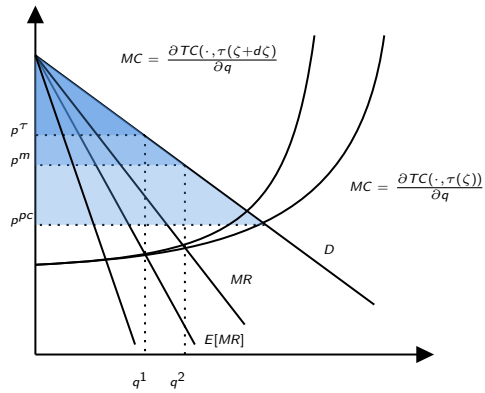


Notes: Panjiva aggregate trade volumes compared to US Trade online aggregate trade volumes, residualized with HS code fixed effects (Census, 2023, own calculation)

Monopolist Price

Back

- Increased τ might cause increased marginal cost.
- Now, price pressures also from higher marginal costs.



Data: Congestion at Intermodal Port Terminals

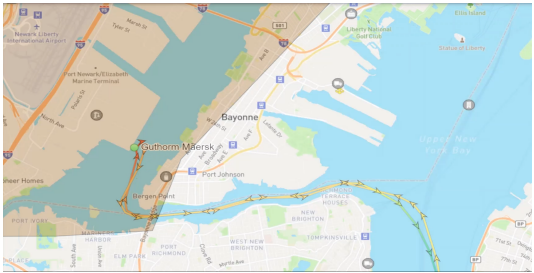
Back

- AIS Vessel Traffic Data (June 2015–Dec 2021, Marine Cadastre):
  - 1-minute vessel locations in US waters (200 land stations), with vessel info (IMO, tonnage), position, speed, and status (moving, moored, anchored).
  - Ship dwell time: Time spent moored at zero speed.
- Port Matching: Top 30 US ports (95% container trade).

Ship Dwell Time Calculation

Back

- Ship path indicated by line, redder color = slower speed. Darker regions are port areas



CMA CGM Christophe Colomb (13.8k TEUs) at Port of LA

Guthorm Maersk (11k TEUs) at Port of Newark

Microfoundation of Stock-In Function

Back

- **Setup:** Demand arrivals are Poisson(λ), lead time is Exp(μ) (Fluid approximation of M/M/1 Queue with utilization μ)
- **Exponential 'race' logic:**
  - If replenishment (time W) occurs before the next arrival (time A), no stock-out.
  - Otherwise a sale reduces inventory ($\tau \to \tau - 1$) and the process restarts (memoryless).
- **Geom. distribution:** Number of sales before replenishment

$$N \sim \mathrm{Geom}(p), \quad p = \frac{\mu}{\lambda + \mu}.$$

- **Availability:**

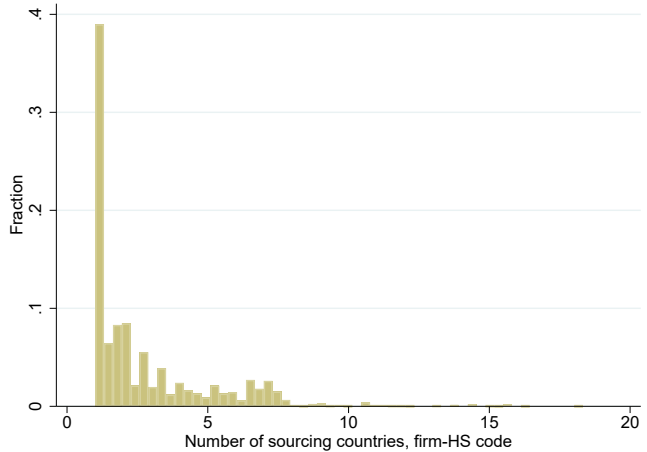
$$s(\tau, \lambda, \mu) = \Pr[N \leq \tau] = 1 - \Big(1 - p\Big)^{\tau+1} = 1 - \left(\frac{\lambda}{\lambda+\mu}\right)^{\tau+1}.$$

- **In terms of** $\rho = \lambda/\mu$:

$$s = 1 - \left(\frac{\rho}{1+\rho}\right)^{\tau+1}.$$

Number of Sourcing Countries

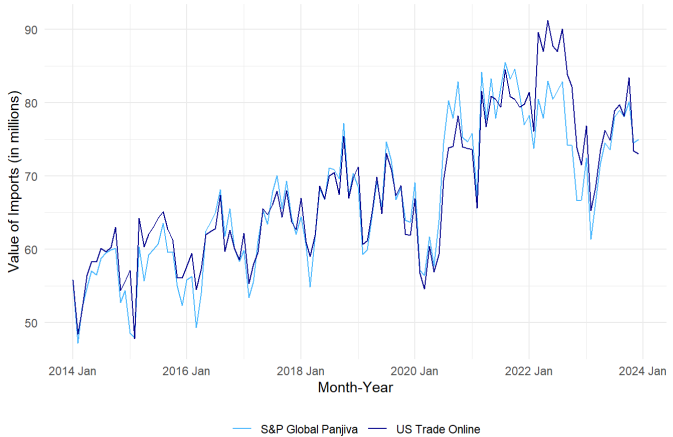
Back



Notes: Number of sourcing countries for the firm-HS2 in a year. Sample of Panjiva firms that match to Numerator.

US Imports in Panjiva vs. Census

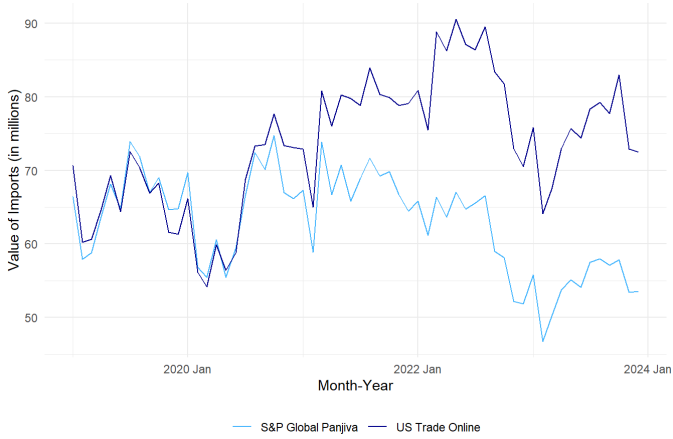
Back



Notes: Aggregate imports in BoL Panjiva against USA Trade Online - U.S. Census Bureau imports data. Panjiva import volumes are indexed to the 2019 unit value of an HS code in Census data.

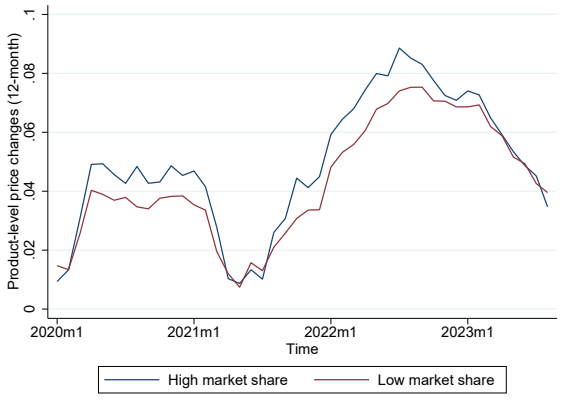
Panjiva Imports vs Census. Importing sample in 2019

Back



Fact 4 ctd.: Price changes and firm size

Back



Notes: High-market share firms: in the top quartile of sales distribution in the respective product category.

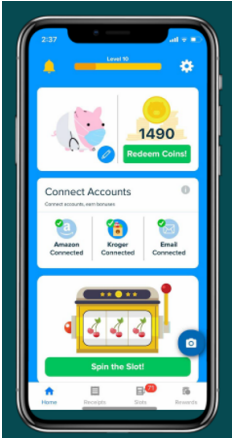
Summary Statistics: Stores (Numerator)

Back

Channel	Frequency	Percent	Cum.
Food	10,142	20.85%	20.85%
FSR - Regional/Ethnic	8,428	17.32%	38.17%
Gas & Convenience	7,421	15.25%	53.43%
Liquor	2,905	5.97%	59.40%
Bodega	2,317	4.76%	64.16%
Apparel	1,692	3.48%	67.64%
Drug	1,471	3.02%	70.66%
LSR - Bakery/Cafe	1,270	2.61%	73.27%
Beauty	999	2.05%	75.33%
Pet	990	2.04%	77.36%
Home Improvement	819	1.68%	79.05%
Craft	701	1.44%	80.49%
Online	531	1.09%	81.58%
Other	515	1.06%	82.64%
LSR - Ethnic/Regional	512	1.05%	83.69%
Dispensaries	433	0.89%	84.58%
Sporting Goods Stores	424	0.87%	85.45%
Postal Services	401	0.82%	86.27%
Other Retail Store	390	0.80%	87.08%
LSR - Coffee/Bakery	385	0.79%	87.87%
Book	357	0.73%	88.60%
Other Specialty Store	331	0.68%	89.28%
Dollar	311	0.64%	89.92%
Specialty Food Retailer	300	0.62%	90.54%
Mass	237	0.49%	91.03%
Health	226	0.46%	91.49%
Electronics	219	0.45%	91.94%
Shoe	203	0.42%	92.36%

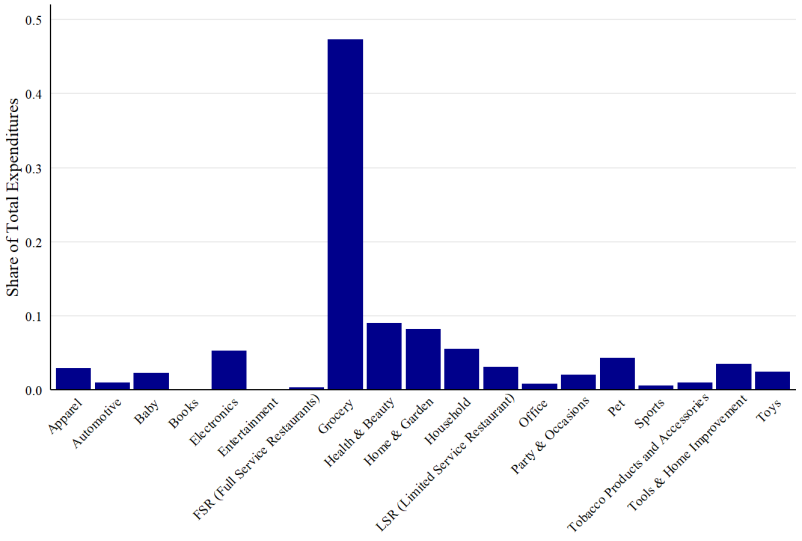
Numerator Consumer Insights and Data Company

Back



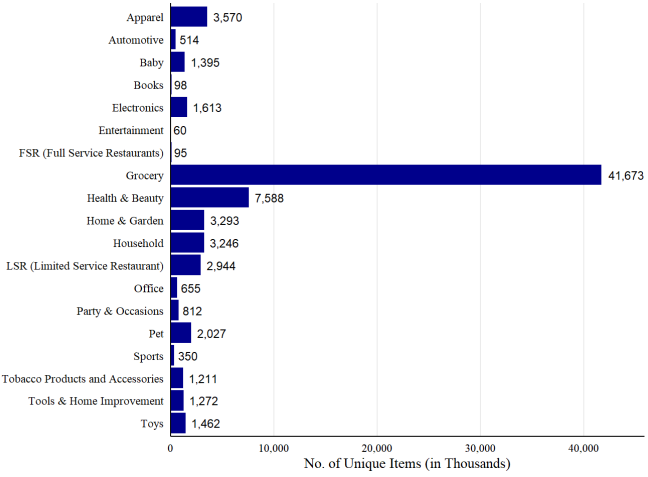
Summary Statistic: Expenditures by Sector (Numerator)

Back

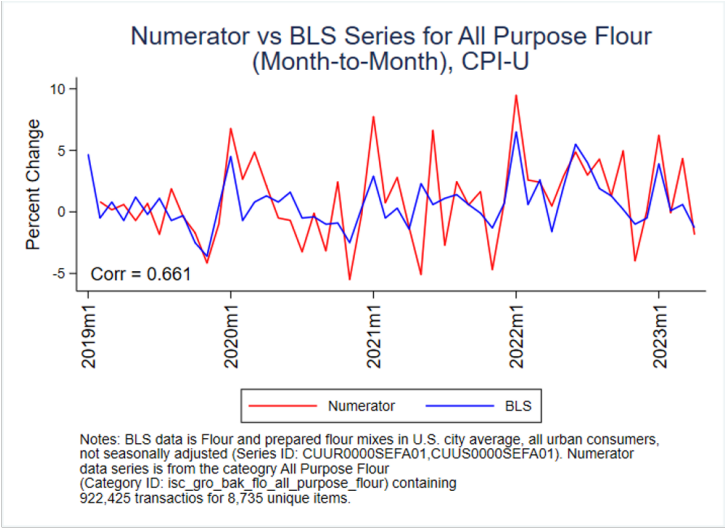


Summary Statistic: Unique Items by Sector (Numerator)

Back



Validation: Flour (Numerator) Back



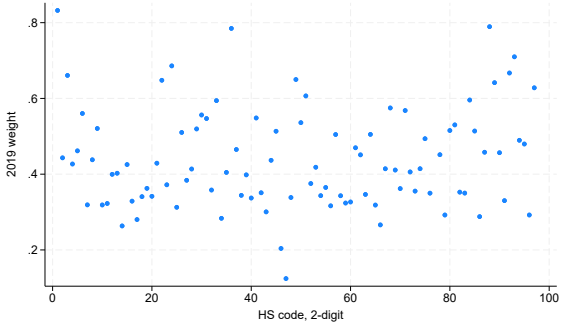
Notes: Price comparison for flour (Numerator, BLS, own calculations)

Identification. Variation in Shares

Back

Shares– $\omega_{h,f,2019}$– 2-digit HS-code import shares in 2019.

- On average, an importing Numerator firm imports 4.6 HS codes in 2019. The mean HHI of 2019 weights $= 0.73$.
- Firms rely on many different HS codes– even within the same product category: product category f.e. account for just 7% of $\omega_{h,f,2019}$ variation.



Identification. Pre-Trends

Back

2019 price change at a firm-category level as a function of shift-shares.

	$\Delta p2019$	$\Delta p2019$	$\Delta p2019$	$\Delta p2019$
Shortfall 2020	-0.012	-0.334	-0.007	-0.338
	(0.1675)	(0.5478)	(0.1684)	(0.5725)
$\Delta ImpC$ 2020	-0.118	-0.333	-0.152	-0.235
	(0.3155)	(1.0197)	(0.3286)	(1.0934)
Cat FE	No	Yes	No	Yes
Weights	None	Firm sales	None	Firm sales

Own passthrough estimates. Durability

Back

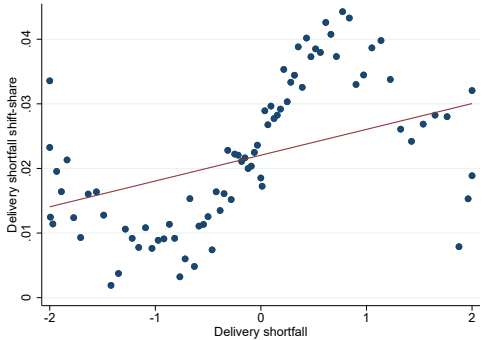
Table: Passthrough and Product Durability

	(1) Benchmark IV	(2) Durability	(3) Durability
Shortfall	-0.320***	-0.402*	-0.586**
	(0.0932)	(0.2098)	(0.2430)
Shortfall × Durability index		1.774	
		(4.0180)	
Shortfall × Durability dummy			0.558
			(0.4755)
$\Delta UnitC$	0.131**	0.134**	0.155**
	(0.0626)	(0.0633)	(0.0668)
$\Delta FreightC$	0.360***	0.309*	0.226
	(0.1247)	(0.1814)	(0.1860)
Lag Shortfall	0.036	0.036	0.081
	(0.0803)	(0.0805)	(0.0961)
Lag2 Shortfall	-0.072	-0.067	-0.009
	(0.0795)	(0.0829)	(0.1072)
Firm FE	✓	✓	✓
Cat-Quarter FE	✓	✓	✓
Observations	925638	925638	925638
Weak IV F-stat	131.833	1.182	12.545

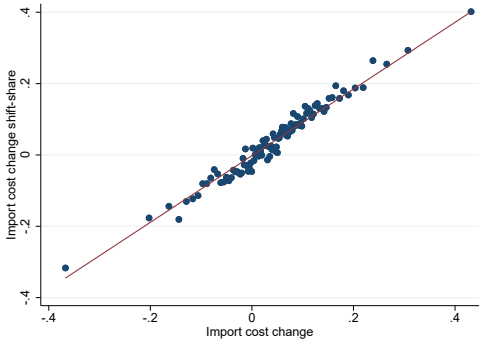
Identification. Instrument projections

Back

(A) Shortfall shift share on shortfall



(B) Cost change shift-share on cost change



Own pass-through: I stage

Back

I-stage estimates for own pass-through IV.

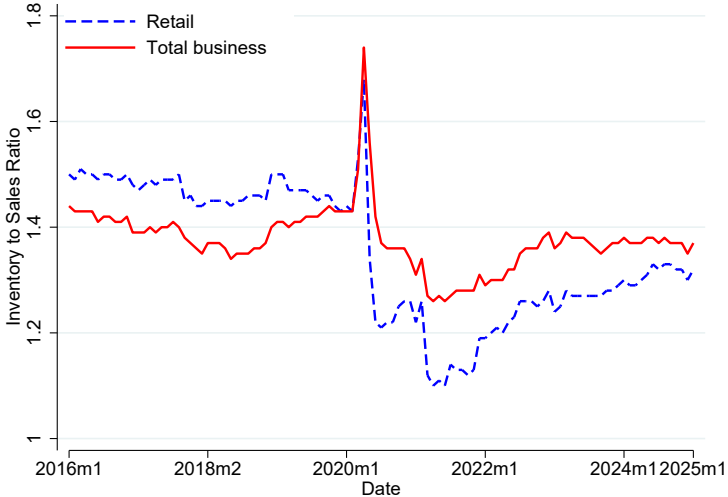
	(1) I stage (col3)	(2) I stage (col4)	(3) I stage (col5)
Shortfall, shift-share	0.439***	0.439***	0.439***
	(0.0171)	(0.0171)	(0.0171)
$\Delta UnitC$, shift-share	-0.050**	-0.050**	-0.050**
	(0.0255)	(0.0255)	(0.0255)
$\Delta FreightC$, shift-share	0.979***	0.979***	0.979***
	(0.0378)	(0.0378)	(0.0378)
I-stage F-stat	658.48	131.83	153.121

Strategic interactions. I stage

Back

	I stage-Shortfall	I stage-Shortfall Comp
Shortfall, shift-share	0.447***	0.014
	(0.0216)	(0.0087)
Compet. shortfall, shift-share	-0.020	0.224***
	(0.0383)	(0.0297)
$\Delta UnitC$, shift-share	-0.054**	0.023**
	(0.0256)	(0.0091)
$\Delta FreightC$, shift-share	0.945***	-0.078***
	(0.0369)	(0.0123)
Compet. $\Delta UnitC$, shift-share	-0.007	-0.092
	(0.0655)	(0.0597)
Compet. $\Delta FreightC$, shift-share	-0.576***	0.448***
	(0.0851)	(0.0734)
I-stage F-stat	439.30	48.65

Inventory-to-Sales over Time



Source: FRED, Census data.