The Contribution of Imports to Domestic Prices

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Disclaimer: *Views are those of the authors and not necessarily those of the Federal Reserve Bank of Boston, the Federal Reserve System, or any other institution.*

How do border price fluctuations impact consumer inflation?

- Tariffs in 2018–19 and 2025 passed through **fully** into U.S. **border** prices.

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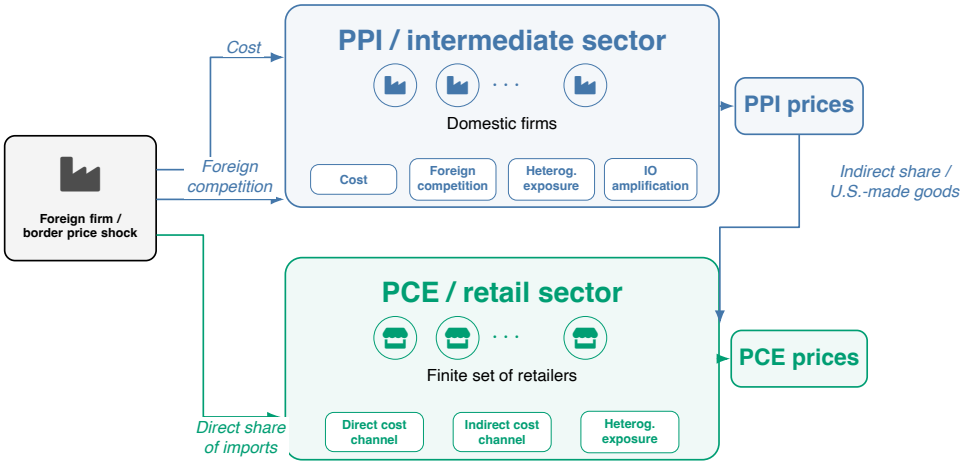
- This paper: provides a unified framework and take it to industry-level data

This paper: a price system response to a border shock



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- Interpret which wedge can best match cross sectional inflation variation

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  - baseline models understate tariff effect
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- 2025 tariff episode
  - the baseline model seems to fit well
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- Reconcile with the fact that the 2018 episode was more targeted

Model Sketch

Framework to carry a border shock from PPI to PCE

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  - direct final-good import exposure in retail
  - aggregation from firms to observed PPI industries and PCE categories

▸ Model setup

Baseline model: full pass-through in levels vs. log

- Full pass-through in logs (standard): Multiplicative markups

$$p_i = \mu_i \cdot \mathrm{mc}_i \quad \Longrightarrow \quad \mathrm{d}\log p_i = \mathrm{d}\log \mathrm{mc}_i$$

1% cost shock $\rightarrow$ 1% price increase

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- Full pass-through in levels: Additive markups [Sangani, 2026]

$$p_i = \mu_i + \mathrm{mc}_i \quad \Longrightarrow \quad \mathrm{d}p_i = \mathrm{dmc}_i \quad \overset{\text{CRTS}}{\Longrightarrow} \quad \mathrm{d}\log p_i = \frac{\text{Costs}_i}{\text{Sales}_i}\,\mathrm{d}\log \mathrm{mc}_i$$

1% cost shock $\rightarrow$ *cost-share* % price increase

▸ Pricing details

Baseline model: IO propagation in the intermediate market

- Pass-through in levels

$$\mathrm{d}\log p_i^d = \Upsilon_i \mathrm{d}\log \mathrm{mc}_i$$

  - Pass-through in *logs* is "nested" ($\Upsilon_i = 1$)

MAPPABLE DATA OBJECTS

Ω^d, Ω^*	Υ
input cost shares (dom./imp.)	variable cost / sales

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$$\mathrm{d}\log p_i^d = \Upsilon_i \mathrm{d}\log \mathrm{mc}_i$$

  - Pass-through in *logs* is "nested" ($\Upsilon_i = 1$)
- Domestic producers buy domestic and imported inputs under CRS:

$$\mathrm{d}\log \mathrm{mc}_i = \sum_j \Omega_{ij}^d \,\mathrm{d}\log p_j^d + \sum_j \Omega_{ij}^* \,\mathrm{d}\log p_j^*$$

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Baseline model: IO propagation in the intermediate market

- Chain cost shocks across industries $\Rightarrow$ vectorized PPI response:

$$\mathrm{d}\log \mathbf{p}^{d} = \left(I - \Upsilon \boldsymbol{\Omega}^{d}\right)^{-1} \Upsilon \, \boldsymbol{\Omega}^{*} \, \mathrm{d}\log \mathbf{p}^{*}$$

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- Take into account first + all downstream rounds of IO propagation:

$$\left(I - \Upsilon \Omega^{d}\right)^{-1} \Upsilon \, \Omega^{*} = \Upsilon \Omega^{*} + \Upsilon \Omega^{d} \Upsilon \Omega^{*} + \Upsilon (\Omega^{d})^{2} \Upsilon \Omega^{*} + \cdots$$

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Baseline model: Retail markups layered on IO propagation

- Vectorized PPI response:

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$\boldsymbol{\Omega}^{d}, \boldsymbol{\Omega}^{*}$	$\boldsymbol{\Upsilon}, \boldsymbol{\Upsilon}^{r}$	$\boldsymbol{\Theta}^{d}, \boldsymbol{\Theta}^{*}$
input cost shares (dom./imp.)	variable cost / sales	**retail sourcing shares**

Baseline model: Retail markups layered on IO propagation

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$$\mathrm{d}\log \mathbf{p}^{d} = (\boldsymbol{I} - \boldsymbol{\Upsilon}\boldsymbol{\Omega}^{d})^{-1}\,\boldsymbol{\Upsilon}\,\boldsymbol{\Omega}^{*}\,\mathrm{d}\log \mathbf{p}^{*}$$

- Retailers buy domestic and imported final goods (no IO loop among retailers):

$$\mathrm{d}\log \mathbf{p}^{\mathrm{PCE}} = \boldsymbol{\Upsilon}^{r}\Big[\boldsymbol{\Theta}^{*} + \boldsymbol{\Theta}^{d}(\boldsymbol{I} - \boldsymbol{\Upsilon}\boldsymbol{\Omega}^{d})^{-1}\boldsymbol{\Upsilon}\boldsymbol{\Omega}^{*}\Big]\mathrm{d}\log \mathbf{p}^{*}$$

▸ Mapping details

MAPPABLE DATA OBJECTS

$\boldsymbol{\Omega}^{d}, \boldsymbol{\Omega}^{*}$	$\boldsymbol{\Upsilon}, \boldsymbol{\Upsilon}^{r}$	$\boldsymbol{\Theta}^{d}, \boldsymbol{\Theta}^{*}$
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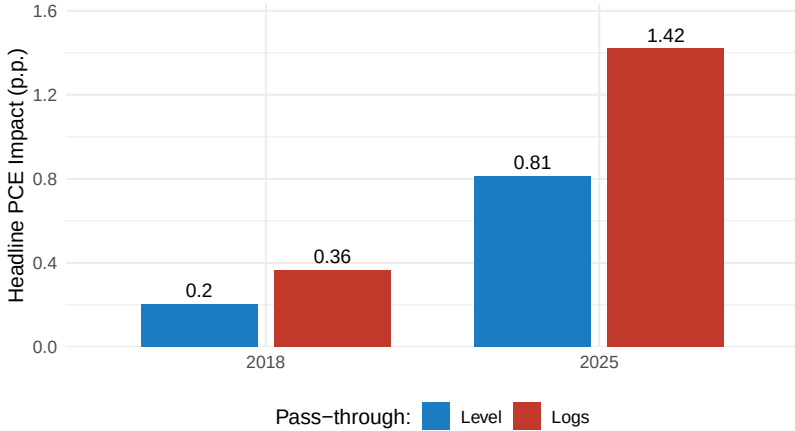
Data and Shock

Data

- Several tables from the (BEA) Input-Output Accounts:
  - Use/Make Tables
  - Import Matrices
  - PCE Bridge
  - Commodity [= final good] level: $N = 402$
  - NIPA-code final expenditure category [= retail] level: $E = 212$
- Effective tariffs calculated at the product-country-month level
  - from public US Census data
  - HS-10-level tariffs are aggregated to BEA commodity categories
    - country-level import value shares from the year before the tariff episode

Estimated tariff impact of two tariff episodes: 2018-19 vs 2025



- 2018–19: concentrated on China (∼90% of impact)
- 2025: broad-based across many source countries

Pass-through estimation under monopolistic competition

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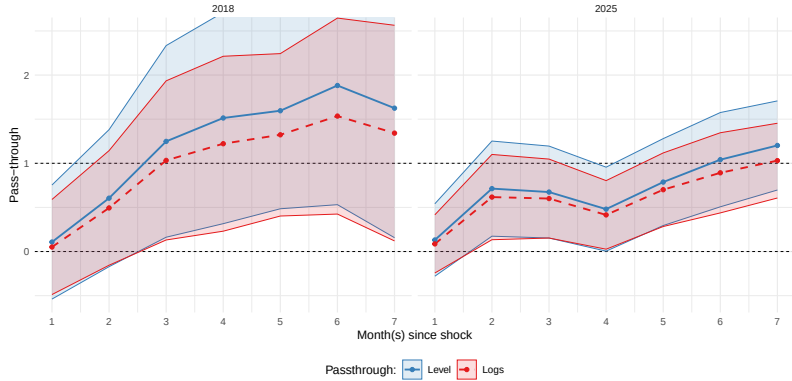
$$\Delta_h \log p_{i,t+h} = \alpha_i + \delta_t + \beta_h s_{i,t} + \sum_{k=-6, k\neq 0}^{6} c_{h,k} s_{i,t-k} + \lambda_h \Delta \log w_{i,t-1} + \varepsilon_{i,t+h} \quad (1)$$

- $s_{i,t}$: model-implied tariff exposure of item i.
- $\beta_{\text{Long Horizon}} = 1 \Leftrightarrow$ model matches observed price change.
- Next: PPI and PCE pass-through estimates for 2018 and 2025 episodes.

PPI: baseline model fits 2025, undershoots 2018

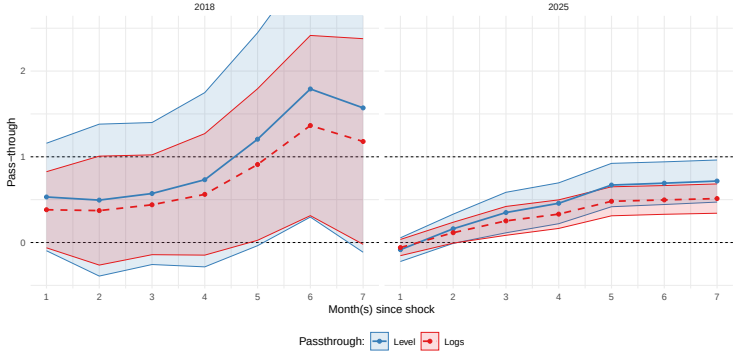
$$\Delta_h \log p^{\text{PPI}}_{i,t+h} = \alpha_i + \delta_t + \beta_h s^{\text{PPI}}_{i,t} + \sum_{k=-6,k\neq 0}^{6} c_{h,k} s^{\text{PPI}}_{i,t-k} + \lambda_h \Delta \log w_{i,t-1} + \varepsilon_{i,t+h} \quad (2)$$



- **2018**: $\beta_h > 1$. Residual wedge?
- **2025**: long-horizon $\beta_h \approx 1$.

PCE: baseline model undershoots 2018-19, overshoots 2025

$$\Delta_h \log p^{\text{PCE}}_{i,t+h} = \alpha_i + \delta_t + \beta_h s^{\text{PCE}}_{i,t} + \sum_{k=-6, k\neq 0}^{6} c_{h,k} s^{\text{PCE}}_{i,t-k} + \lambda_h \Delta \log w_{i,t-1} + \varepsilon_{i,t+h}$$



- 2018 overshoots $\beta_h = 1$, 2025 undershoots.
- PCE is identified mostly from *direct* exposure $\implies$ pattern not driven by PPI.

Taking stock thus far

- Levels predicts less aggregate price response than logs
- Actual prices responded more than both would predict in 2018
  - under monopolistic competition!
- What else would increase or decrease the price response?

What explains the wedge?

Two wedges on top of the full pass-through baseline

$$\mathrm{d}\log p_i^d = \frac{1}{\bar{\rho}_i^d + (1-\bar{\rho}_i^d)s_{Fi}}\left[\bar{\rho}_i^d\,\Upsilon_i^d\,\mathrm{d}\log \bar{\mathrm{mc}}_i + (1-\bar{\rho}_i^d)s_{Fi}\,\mathrm{d}\log p_{Fi} + \Upsilon_i^d\,\mathrm{Cov}_{\tilde{\delta}_i}(\boldsymbol{\rho}_i, \mathrm{d}\log \mathbf{mc}_i)\right]$$

Cost channel (baseline)

Monopolistic-competition benchmark. Explains some of the cross-sectional variation, both episodes.

Foreign competition (ρ)

Firms more sensitive to market price; high *foreign sales share* s_{Fi} implies markups increase with own-industry tariff.

Covariance

Are the exposed firms the high-pass-through ones? Within-industry heterogeneity in *who is hit*.

▸ Derivation

Foreign competition wedge can fit 2018 story, but not 2025

- Smaller $\rho \Rightarrow$ *larger* predicted impact.
  - Lower ρ means stronger foreign-competition pass-through.

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- GMM parametric identification from industry observables
  - HHI, markups, import share.

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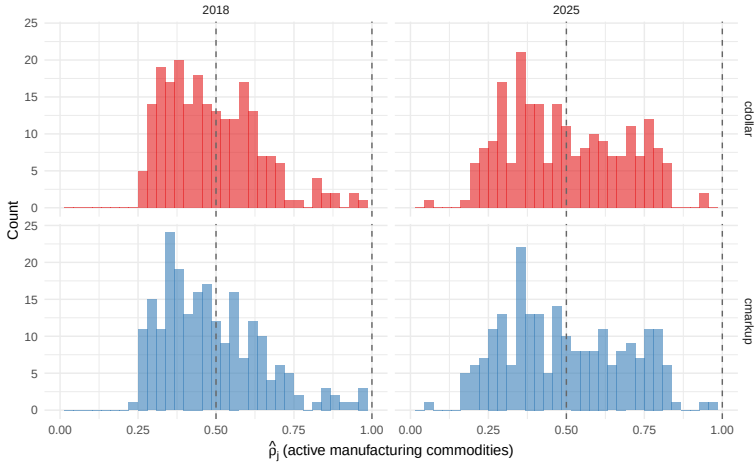

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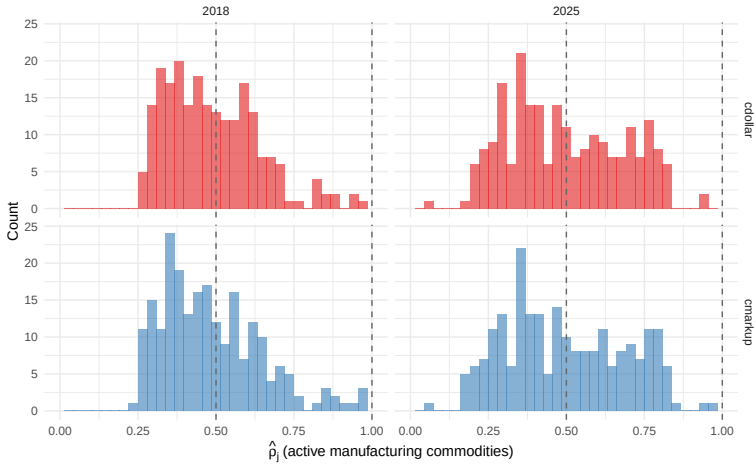

- ρ acts mostly as a residual shock absorber
  - smaller in 2018, nearer monopolistic competition in 2025.
  - $\Rightarrow$ skeptical of foreign competition as a stand-alone story.

The additional story: shocks varied on *who* got them

- $\mathrm{Cov}_{\tilde{\delta}_i}(\boldsymbol{\rho}_i, \mathrm{d}\log \mathbf{mc}_i)$ can plausibly vary across episodes
  - it captures the interaction between a *particular* shock and the firms exposed to it

▸ Full system

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  - $(1-\rho_i)$ loads on foreign-competition share $\boldsymbol{S}_F$.
  - PCE: retail has no foreign-competition term ($\rho^r = 1$)
    $\Rightarrow$ γ^r identified *directly* via GMM from direct-exposure variation.

▸ Full system

Takeaways

- A single framework nests
  - direct exposure
  - IO propagation
  - levels-vs-logs pass-through
  - oligopolistic competition
- Baseline full pass-through of cost channel explains
  - most of PPI and PCE cross-sectional variation in *both* episodes.
  - But 2018 inflation responded more than what the model predicts
  - vice versa for 2025
- Neither levels-vs-logs nor the foreign-competition stably explains both episodes.
- Residual story seems to be about *who* is exposed within an industry
  - Work in progress!

Thank you!

asilvub.github.io

Appendix

Where this sits: pass-through $\times$ networks $\times$ imperfect competition

1. **Tariff pass-through.** Amiti, Redding & Weinstein (2019); Fajgelbaum et al. (2020); Cavallo, Llamas & Vazquez (2025); Flaaen & Pierce (2024); Minton & Somale (2025).
   - We clarify *which* downstream object each design is identifying.
2. **Production networks & inflation.** Baqaee & Farhi (2019); La'O & Tahbaz-Salehi (2022); Baqaee & Rubbo (2023).
   - We map border shocks through IO while keeping imperfect competition and firm-level heterogeneity.
3. **Markups & imperfect competition.** Atkeson & Burstein (2008); Amiti, Itskhoki & Konings (2019); Sangani (2026).
   - We embed pass-through *in levels* and oligopolistic competition with foreign firms into an IO + retail model.

back

From firm pricing to industry PPI: aggregation under oligopoly

N domestic firms f compete with each other and with one foreign firm F. Under pass-through in levels, $dp_{fi} \equiv d\mu_{fi} + d\mathrm{mc}_{fi}$.

1. Firm price.

$$\mathrm{d}\log p_{fi} = \rho_{fi}\,\Upsilon_{fi}\,\mathrm{d}\log \mathrm{mc}_{fi} + (1-\rho_{fi})\,\tfrac{p_{-f,i}}{p_{fi}}\,\mathrm{d}\log p_{-f,i}$$

2. Industry aggregator. Market clearing delivers share-weighted prices:

$$\mathrm{d}\log p_i = \sum_f s^d_{fi}\,\mathrm{d}\log p^d_{fi} + s_{Fi}\,\mathrm{d}\log p^*_i$$

3. Domestic PPI. Substitute and collect:

$$\mathrm{d}\log p^d_i = \frac{1}{\bar\rho^d_i + (1-\bar\rho^d_i)s_{Fi}}\left[\bar\rho^d_i\,\Upsilon^d_i\,\mathrm{d}\log \bar{\mathrm{mc}}_i + \Upsilon^d_i\,\mathrm{Cov}_{\tilde\delta_i}(\rho_i, \mathrm{d}\log \mathrm{mc}_i) + \frac{(1-\bar\rho^d_i)s_{Fi}}{\Upsilon^d_i}\,\mathrm{d}\log p_{Fi}\right]$$

$\rho_{fi} = \dfrac{(1-\pi_{fi})^2}{1-\pi_{fi}+\pi_{fi}^2}$, firm cost pass-through

$\bar\rho^d_i = \sum_{f\in\mathcal{D}_i} \tilde\delta_{fi}\,\rho_{fi}$, cost-share-weighted avg.

$\tilde\delta_{fi} = \dfrac{s^d_{fi}(1-\alpha_{fi})}{\sum_g s^d_{gi}(1-\alpha_{gi})}$, firm variable-cost share

$\mathrm{d}\log \bar{\mathrm{mc}}_i = \sum_f \tilde\delta_{fi}\,\mathrm{d}\log \mathrm{mc}_{fi}$, avg. cost shock

$\Upsilon^d_i = \mathrm{VC}_i/R_i$, industry cost-over-sales ratio

s_{Fi} foreign-sales share in industry i

$\mathrm{Cov}_{\tilde\delta_i}(\rho_i, \mathrm{d}\log \mathrm{mc}_i) = \sum_f \tilde\delta_{fi}(\rho_{fi}-\bar\rho^d_i)(\mathrm{d}\log \mathrm{mc}_{fi} - \mathrm{d}\log \bar{\mathrm{mc}}_i)$, firm-level covariance

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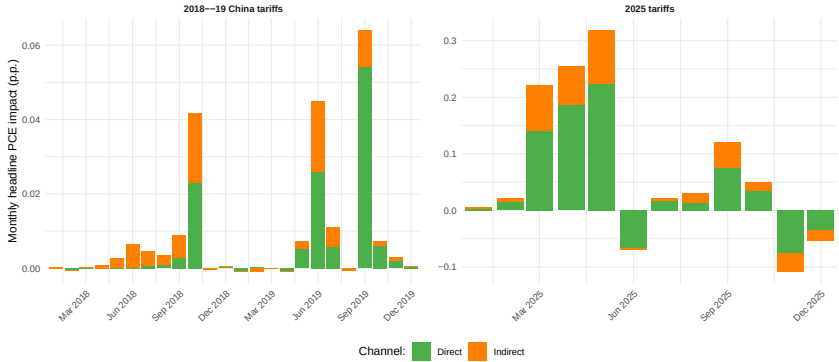
Pass-through estimation under monopolistic competition

$$\Delta_h \log p_{i,t+h} = \alpha_i + \delta_t + \beta_h s_{i,t} + \sum_{k=-6, k\neq 0}^{6} c_{h,k} s_{i,t-k} + \lambda_h \Delta \log w_{i,t-1} + \varepsilon_{i,t+h} \quad (3)$$



- $s_{i,t}$: model-implied tariff exposure of item i.
  - Feed $s_{i,t}$ into (3); compare β_h across episodes.
- $\beta_{\text{Long Horizon}} = 1 \Leftrightarrow$ model matches observed price change.

Full system with the covariance wedge

Under the regularity assumption $\mathrm{Cov}_{\tilde{\delta}_i}(\rho_i, \mathrm{d}\log \mathrm{mc}_i) = \gamma_i \, \Omega^*_{ij}$, the PPI system becomes

$$\mathrm{d}\log \mathbf{p}^d = \boldsymbol{\Xi}^{-1}\left[(\boldsymbol{\rho}^d + \boldsymbol{\gamma})\, \boldsymbol{\Upsilon}^d \boldsymbol{\Omega}^* + (\boldsymbol{I} - \boldsymbol{\rho}^d)\, \boldsymbol{S}_F\right] \mathrm{d}\log \mathbf{p}^*$$

$\boldsymbol{\Xi}$: block collecting domestic-propagation terms
$\boldsymbol{\rho}^d$: cost-weighted industry pass-through
$\boldsymbol{\gamma}$: diagonal covariance wedge
$\boldsymbol{S}_F$: diagonal of foreign-sales shares

back

Model details: assignment primitives

- Industry $i \in \mathcal{I}$ has domestic firms $\mathcal{D}_i$ and one foreign firm F_i.
- A continuum of tasks is assigned to discrete firms; firm f receives task share π_{fi}.
- Final-demand categories $e \in \mathcal{E}$ use the same assignment structure, but all firms are domestic retailers.

$$p_i^{\text{eff}} = \min_{\pi_i \in \Delta_i} \left\{ b_i + \sum_{f \in \mathcal{N}_i} \pi_{fi}(p_{fi} - z_{fi}) + \sigma_i \sum_{f \in \mathcal{N}_i} \pi_{fi} \log \pi_{fi} \right\}$$

$$\pi_{fi} = \frac{\exp((z_{fi} - p_{fi})/\sigma_i)}{\sum_{g \in \mathcal{N}_i} \exp\big((z_{gi} - p_{gi})/\sigma_i\big)}, \qquad q_{fi} = \pi_{fi} q_i, \qquad R_{fi} = p_{fi} \pi_{fi} q_i.$$

back pricing

Model details: pricing and pass-through

- Domestic producers and retailers choose prices under Bertrand competition.
- The logit assignment block delivers an additive markup:

$$\Pi_{fi} = \max_{p_{fi}} (p_{fi} - \mathrm{mc}_{fi})\pi_{fi} q_i \quad \Longrightarrow \quad p_{fi} = \mathrm{mc}_{fi} + \frac{\sigma_i}{1 - \pi_{fi}}.$$

Levels.

$$\mathrm{d}p_{fi} = (1 - \pi_{fi})\mathrm{dmc}_{fi} + \pi_{fi}\mathrm{d}p_{-f,i}$$

Percentage changes.

$$\mathrm{d}\log p_{fi} = (1 - \alpha_{fi})(1 - \pi_{fi})\mathrm{d}\log \mathrm{mc}_{fi} + \pi_{fi}\frac{p_{-f,i}}{p_{fi}}\mathrm{d}\log p_{-f,i}$$

$1 - \alpha_{fi} = \mathrm{mc}_{fi}/p_{fi}$ is the cost share in the price. Even with complete pass-through in levels, percentage pass-through is attenuated by the cost share.

back mapping

Model details: observed indices and data mapping

- Observed PPI is a domestic-sales weighted index; marginal costs aggregate through observed input shares:

$$\mathrm{d}\log p_i^d = \sum_{f\in\mathcal{D}_i} s_{fi}^d \,\mathrm{d}\log p_{fi}, \qquad \mathrm{d}\log \mathrm{mc}_i^d = \sum_j \Omega_{ij}^d \,\mathrm{d}\log p_j^d + \sum_j \Omega_{ij}^* \,\mathrm{d}\log p_j^*.$$

$$\mathrm{d}\log \mathbf{p}^d = \left(I - \boldsymbol{\Upsilon}^d\boldsymbol{\Omega}^d\right)^{-1}\boldsymbol{\Upsilon}^d\boldsymbol{\Omega}^* \,\mathrm{d}\log \mathbf{p}^*.$$

- Retailer marginal costs combine domestic sourcing and direct imported final goods:

$$\mathrm{d}\log \mathbf{p}^{\mathrm{PCE}} = \boldsymbol{\Upsilon}^r\left[\boldsymbol{\Theta}^d\left(I - \boldsymbol{\Upsilon}^d\boldsymbol{\Omega}^d\right)^{-1}\boldsymbol{\Upsilon}^d\boldsymbol{\Omega}^* + \boldsymbol{\Theta}^*\right]\mathrm{d}\log \mathbf{p}^*.$$

$\boldsymbol{\Omega}$ maps imported-input shocks into producer marginal costs; $\boldsymbol{\Theta}$ maps producer prices and imported finished goods into PCE categories.

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