Markups and Inflation in Oligopolistic Markets: Evidence from Wholesale Price Data

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Does market power influence inflation dynamics and transmission of MP?

Markets are concentrated; rising market power over time (De Loecker, Eeckhout, & Unger 20)

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Recent theory: important interactions between firms' market power and nominal rigidity

- Stronger non-neutrality due to pricing complementarity (Mongey 21; Wang & Werning 22)

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Recent theory: important interactions between firms' market power and nominal rigidity

- Stronger non-neutrality due to pricing complementarity (Mongey 21; Wang & Werning 22)

Lack of direct empirical evidence

- Existing studies focus on flexible price (Auer & Schoenle 16; Amiti, Itskhoki, Konings 19)

This paper: studies how market power interacts with nominal rigidity using micro data

This paper

Model with oligopolistic competition, Calvo sticky prices and heterogeneous firms

- derive closed-form solution for firm-level price adjustments to cost shocks
- differential reset price pass-through of 'common' (industry) vs idiosyncratic cost changes

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Estimate pass-throughs using confidential micro data from Canadian wholesale firms:

- accurate proxy of the marginal cost changes ⇒ decompose into 'common' vs idio components
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Micro to macro: empirical estimates of market power imply

- one-sector model: $1/3$ decline in slope of New Keynesian Phillips Curve (NKPC)
- multi-sector model: $2/3$ decline in slope of NKPC

Roadmap

- Model and closed form
- Empirical results
- Micro to macro: aggregate price and output dynamics

Multi-sector model with oligopolistic competition and sticky prices

- Oligopolistically-competitive distributors
- Distributors buy goods from monopolistically-competitive producers
- Sector heterogeneity in market power and price stickiness

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- Distributors buy goods from monopolistically-competitive producers
- Sector heterogeneity in market power and price stickiness
- Timing of distributor's price and cost changes is *synchronized* ▸ data
  - standard feature of distributors (Eichenbaum, Jaimovich & Rebelo 11; Goldberg & Hellerstein 13)

Multi-sector model with oligopolistic competition and sticky prices

- Oligopolistically-competitive distributors
- Distributors buy goods from monopolistically-competitive producers
- Sector heterogeneity in market power and price stickiness
- Timing of distributor's price and cost changes is *synchronized* ▸ data

Additional (standard) assumptions to get closed form solution:

- Log consumption utility and linear labour: $U = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\ln C_t + L_t\right)$
- Cobb-Douglas aggregation across sectors: $C_t = \Pi_j C_{jt}^{\alpha_j}$
- Cash-in-advance constraint: $M_t = W_t = P_t C_t$
- Small shocks (first order approximation remains accurate)

Optimal reset price

Distributors' optimal reset price takes the usual Calvo form:

$$P_{ijt,t} = \frac{\mathbb{E}_t \sum_{\tau=0}^{\infty} \left(\beta\lambda_j\right)^{\tau} \vartheta_{ijt+\tau,t} C_{ijt+\tau,t}}{\mathbb{E}_t \sum_{\tau=0}^{\infty} \left(\beta\lambda_j\right)^{\tau} \left(\vartheta_{ijt+\tau,t} - 1\right) C_{ijt+\tau,t} / Q_{ijt+\tau}}$$

- i, j, t denotes firm, industry, time; λ_j is probability of no price adjustment
- $Q_{ijt+\tau}$ is cost of product sold; $C_{ijt+\tau,t}$ is expected demand of $t+\tau$ at t

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Expected effective demand elasticity:

$$\mathbb{E}_t \vartheta_{ijt+\tau,t} = \mathbb{E}_t \left[\frac{1}{\theta}\left(1 - s_{ijt+\tau,t}\right) + s_{ijt+\tau,t}\right]^{-1}$$

Changes in expected market share depends on expected future sector price $\mathbb{E}_t \widehat{P}_{jt+\tau}$:

$$\mathbb{E}_t \widehat{s}_{ijt+\tau,t} = -(\theta - 1)\left[\widehat{P}_{ijt,t} - \mathbb{E}_t \widehat{P}_{jt+\tau}\right]$$

With small shocks: $\mathbb{E}_t \widehat{P}_{jt+\tau}$ can be solved analytically $\Rightarrow$ closed-form solution

▸ Details

Key proposition

The distributor's optimal reset price, up to a first-order approximation, is:

$$\widehat{P}_{ijt,t} = \frac{1}{1+\varphi_{ij}} \times \underbrace{\left(\widehat{Q}_{ijt} - \widehat{Q}_{jt}\right)}_{\text{Idiosyncratic change}} + \left[\frac{1}{1+\varphi_{ij}} + \frac{\varphi_{ij}}{1+\varphi_{ij}}\left(\frac{1-\Lambda(\vec{\varphi}_j,\lambda_j)}{1-\beta\lambda_j\Lambda(\vec{\varphi}_j,\lambda_j)}\right)\right] \times \underbrace{\widehat{Q}_{jt}}_{\text{Common change}}$$

- $\widehat{Q}_{ijt}$ – firm's cost shock; $\widehat{Q}_{jt} \equiv \sum_i s_{ij} \widehat{Q}_{ijt}$
- s_{ij} – firm's market share
- λ_j – share of firms that do not adjust prices
- $\varphi_{ij} \equiv (\theta-1)s_{ij}/(1-s_{ij})$ – strategic complementarity due to market power
- $\Lambda(\vec{\varphi}_j,\lambda_j)$ is 'sticky price multiplier' that governs dynamics of sectoral prices

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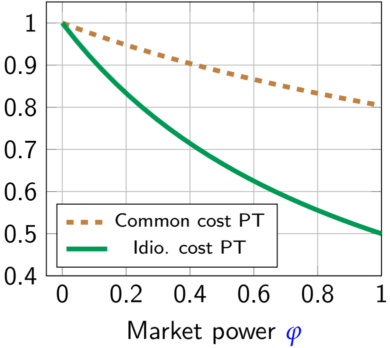
- s_{ij} – firm's market share
- λ_j – share of firms that do not adjust prices
- $\varphi_{ij} = (\theta - 1)\left(\frac{\theta-1}{\theta}\mu_{ij} - 1\right)$ – monotonically increases in markup μ_{ij}
- $\Lambda(\vec{\varphi}_j, \lambda_j)$ is 'sticky price multiplier' that governs dynamics of sectoral prices

Differential pass-through by market power and price stickiness

$$\widehat{P}_{ijt,t} = \frac{1}{1+\varphi_{ij}} \times \left(\widehat{Q}_{ijt} - \widehat{Q}_{jt}\right) + \left[\frac{1}{1+\varphi_{ij}} + \frac{\varphi_{ij}}{1+\varphi_{ij}} \left(\frac{1-\Lambda(\vec{\varphi}_j, \lambda_j)}{1-\beta\lambda\Lambda(\vec{\varphi}_j, \lambda_j)}\right)\right] \times \widehat{Q}_{jt}$$

Price stickiness fixed at $\lambda = 0.4$



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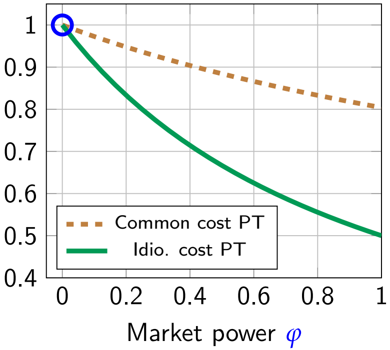

- No market power: complete PT to both shocks as in standard NK models

Differential pass-through by market power and price stickiness

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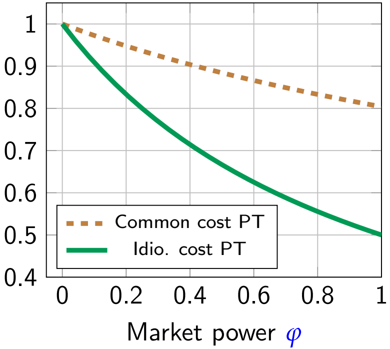

- For given price stickiness λ, PT to both shocks are decreasing in market power φ

Differential pass-through by market power and price stickiness

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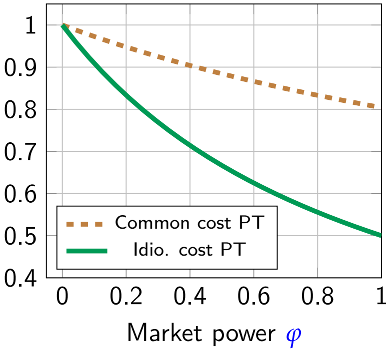
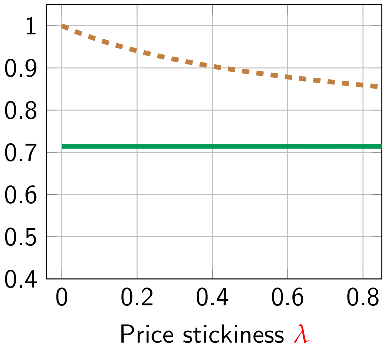


Market power fixed at $\varphi = 0.4$



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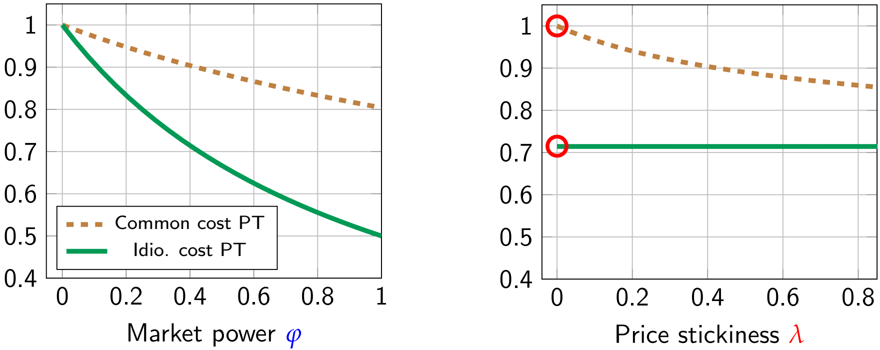
Price stickiness fixed at $\lambda = 0.4$ | Market power fixed at $\varphi = 0.4$



- Flexible price case: complete pass through to common cost change (Amiti, Itskhoki, Konings 19)

Differential pass-through by market power and price stickiness

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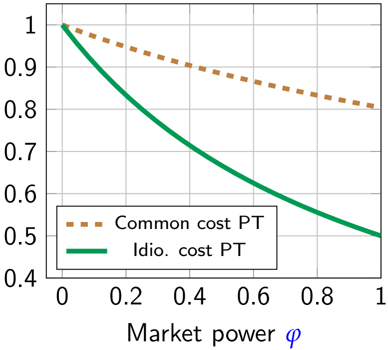

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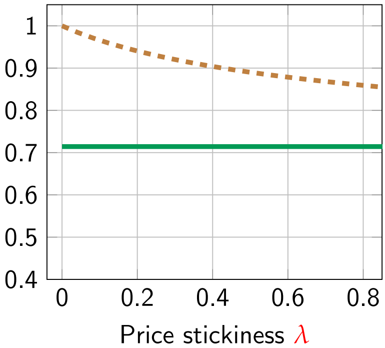

- Common cost PT decreases in λ: given my competitors' prices are sticky, my PT is lower

Differential pass-through by market power and price stickiness

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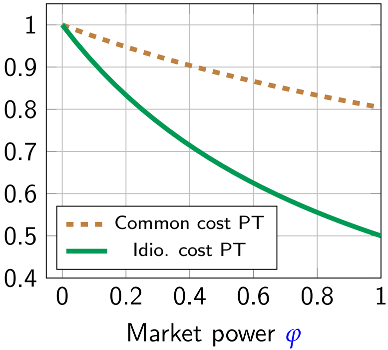

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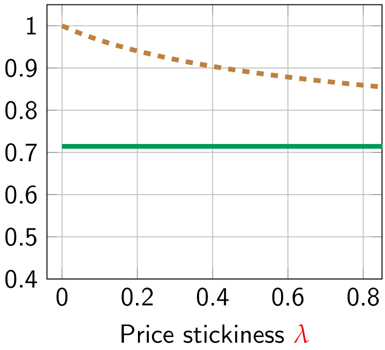

- PT of idiosyncratic part of cost shock is not affected by price stickiness λ

Roadmap

- Model and closed form
- Empirical results
- Micro to macro: aggregate price and output dynamics

Canadian Wholesale Services Price Index microdata

- Monthly data from Jan 2013 to Dec 2019
- Firm-product level info on price and cost ($\approx$ 280k obs after cleaning)
  - selling price, purchase price (reliable measure of marginal cost)
  - markup = (selling price)/(purchase price)
- A large sample of firms ($\approx$ 1,800 obs after cleaning)
  - can identify common (industry-wide) vs. idiosyncratic cost changes
- Observe the sector (4-digit NAICS and 7-digit NAPCS codes) of the firm-product
  - exploit sector-level variation in price stickiness and market power (average markup)

▸ markup by sector

Empirical specification: Step 1

Decompose cost changes into two components using a fixed effect approach:

(*à la* Di Giovanni, Levchenko & Mejean 14)

$$\Delta \ln(Q_{ijt}) = \underbrace{\epsilon_{jt}}_{\text{Common cost change}} + \underbrace{\epsilon_{ijt}}_{\text{Idiosyncratic cost change}}$$

- i, j, t denotes firm-product, sector, month, respectively

Empirical specification: Step 2

Estimate selling price adjustments to these two cost changes:

$$\Delta \log(P_{ijt}) = \underbrace{(\Psi + \Psi^{ps}\lambda_j + \Psi^{mp}D_j)}_{\text{common cost PT}} \cdot \widehat{\epsilon}_{jt} + \underbrace{(\psi + \psi^{ps}\lambda_j + \psi^{mp}D_j)}_{\text{idiosyncratic cost PT}} \cdot \widehat{\epsilon}_{ijt} + FE_{ij} + \nu_{ijt}$$

- Estimate conditional on price adjustment: when $\Delta \log(P_{ijt}) \neq 0$
- Weighted by market share of firm-product s_{ij}
- λ_j: sectoral price stickiness
- D_j: dummy for high markup (market power) sectors

Reset price pass-through estimates (NAICS4 industries)

	Data	Model prediction
Common cost		≈ 1
Common cost $\times$ Sector stickiness		< 0
Common cost $\times$ High-markup sector		< 0
Idio. cost		< 1
Idio. cost $\times$ Sector stickiness		≈ 0
Idio. cost $\times$ High-markup sector		< 0
Observations	136,085	
Firm-product fixed effects	✓	
R^2	0.5	

† means not statistically different from 1; ‡ means statistically different from 1; $**$ means statistically different from 0.

By industry estimates | Firm Heter. | NAPCS7 Estimates

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Common cost	1.08†	≈ 1
	(0.11)	
Common cost × Sector stickiness	-0.96**	< 0
	(0.34)	
Common cost × High-markup sector	-0.29**	< 0
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Common cost × High-markup sector	-0.29**	< 0
	(0.11)	
Idio. cost	0.75‡	< 1
	(0.06)	
Idio. cost × Sector stickiness	0.03	≈ 0
	(0.13)	
Idio. cost × High-markup sector	-0.25***	< 0
	(0.05)	
Observations	136,085	
Firm-product fixed effects	✓	
R^2	0.5	

† means not statistically different from 1; ‡ means statistically different from 1; ** means statistically different from 0.

▸ By industry estimates ▸ Firm Heter. ▸ NAPCS7 Estimates

Roadmap

- Model and closed form
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- Micro to macro: aggregate price and output dynamics

Aggregation: homogeneous sectors

When $\varphi_j = \varphi$ and $\lambda_j = \lambda$, the aggregate New Keynesian Phillips curve is given by:

$$\widehat{\pi}_t = \frac{(1-\beta\lambda)(1-\lambda)}{\lambda\,(1+\varphi)}\widehat{mc}_t + \beta\mathbb{E}_t\widehat{\pi}_{t+1}$$

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Relative to standard monopolistic competitive Calvo,

- Slope of NKPC is reduced by a factor of $\frac{1}{1+\varphi} \approx 0.7$
- Cumulative output response to MP shock is amplified by a factor of $\frac{\Lambda(1-\lambda)}{\lambda(1-\Lambda)} \approx 1.28$

$\Rightarrow$ Sizable amplification

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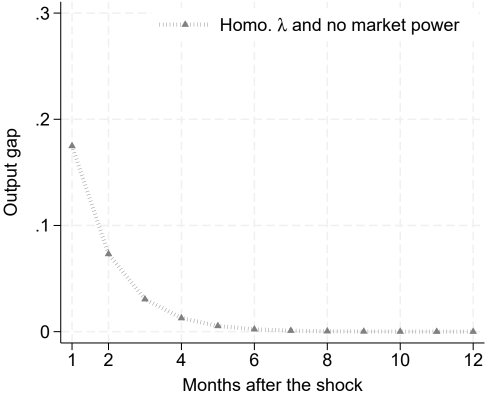
⇒ Sizable amplification

⇒ Next: **Further amplification** due to **heterogeneity** in price stickiness and market power

Amplification due to heterogeneity

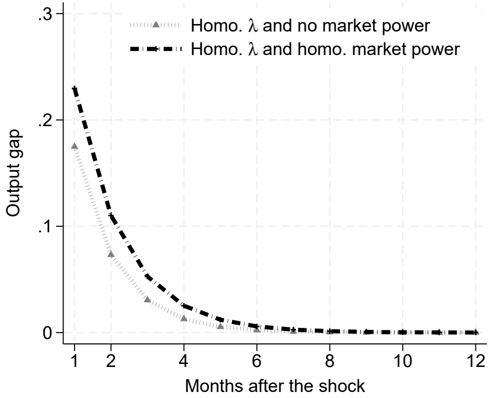
(a) Output response to MP shock



- Nominal shocks have real impacts due to nominal rigidity

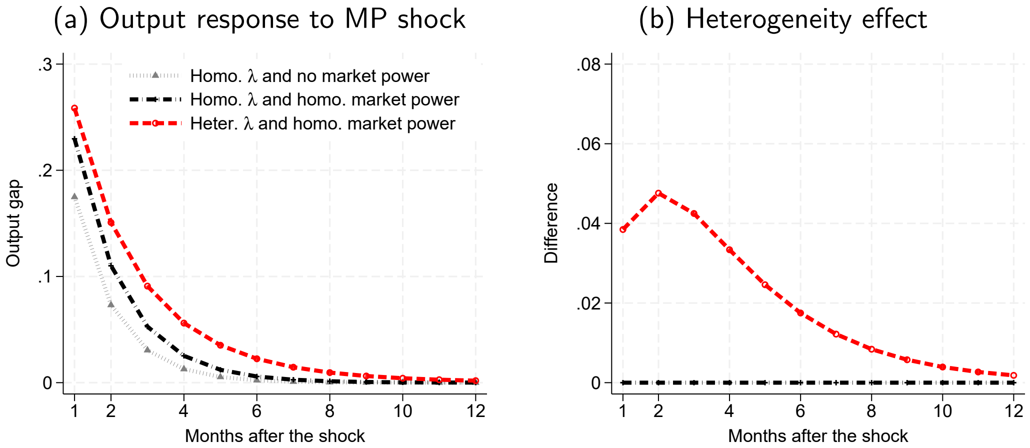
Amplification due to heterogeneity

(a) Output response to MP shock



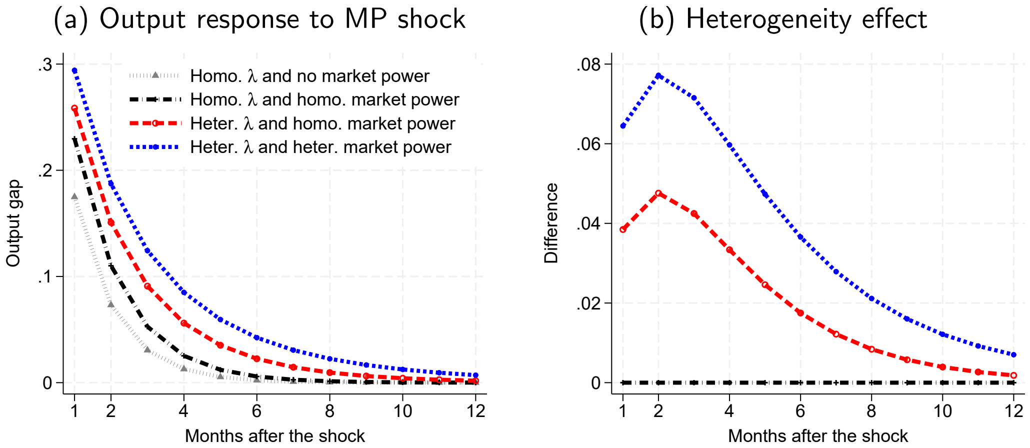
- Larger output changes due to smaller price adjustments

Amplification due to heterogeneity



- Heterogeneity in price stickiness amplifies real impact of MP shock (Carvalho 06)

Amplification due to heterogeneity



- Further amplification due to pos corr between price rigidity and str complementarity

Amplification of monetary non-neutrality

Relative to monopolistic competitive Calvo

	(1) one-sector OC
Slope of NKPC	0.70
Cum. Output to MP shock	1.28

1. Market power reduces the NKPC by 30%, resulting output amplification of 28%

Amplification of monetary non-neutrality

Relative to monopolistic competitive Calvo

	(1) one-sector OC	(2) multi-sector OC, heter price stick + homo market power
Slope of NKPC	0.70	0.52
Cum. Output to MP shock	1.28	1.57

2. Allowing industry heterogeneity in price stickiness further reduces slope of NKPC by 20%

Amplification of monetary non-neutrality

Relative to monopolistic competitive Calvo

	(1) one-sector OC	(2) multi-sector OC, heter price stick + homo market power	(3) multi-sector OC, heter price stick + heter market power
Slope of NKPC	0.70	0.52	0.36
Cum. Output to MP shock	1.28	1.57	1.96

3. With heterogeneity in market power and price stickiness, our model implies 64% reduction in slope of NKPC and 100% increase in cumulative output response

▸ NAPCS7 Results

Contributions

How interaction of market power and price stickiness impacts transmission of shocks

- Theoretically, we propose a model with closed-form solutions:
  - Pass-through of common costs that decreases in price stickiness
  - Pass-through of common and idiosyncratic costs that decreases in market power

- Empirically, we find strong support for our theoretical predictions

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  - Pass-through of common and idiosyncratic costs that decreases in market power
- Empirically, we find strong support for our theoretical predictions
- At aggregate level, this interaction results in:
  - 2/3 decline in slope of New Keynesian Phillips curve
  - 100% increase cumulative output response to monetary policy shock

Appendix

Aggregation: heterogeneous sectors

With heterogeneity in λ_j, aggregate price stickiness is no longer $\lambda \equiv \sum_j \alpha_j \lambda_j$ (Carvalho 06)

Under a permanent monetary policy shock at $t = 0$ (i.e., $\widehat{M}_\tau = 1 \ \forall \tau \geq 0$):

$$\widehat{P}_\tau = (1-\lambda)\widehat{P}_{\tau,\tau} + \lambda \widehat{P}_{\tau-1} - Cov_j \left[\lambda_j, \frac{1-\Lambda_j}{1-\lambda_j} (\Lambda_j)^\tau \right]$$

$$\widehat{C}_\tau = 1 - \widehat{P}_\tau = \Lambda^{\tau+1} \quad + \underbrace{x_\tau \Lambda^{\tau+1}}_{\text{heterogeneity effect } \geq 0}$$

- $\Lambda_j(\lambda_j, \varphi_j) \geq \lambda_j$ is sticky price multiplier with $\Lambda_j \to \lambda_j$ as $\varphi_j \to 0$
- $\Lambda \equiv \sum_j \alpha_j \Lambda_j$ and $x_\tau \equiv \sum_j \alpha_j \Lambda_j^{\tau+1} / \Lambda^{\tau+1} - 1 \geq 0$

Next, calibrate the model to match industrial heterogeneity in λ_j and φ_j

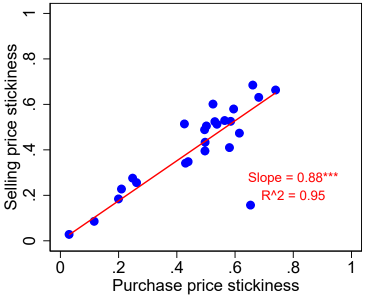
Data

Synchronization in selling and purchase price adjustments

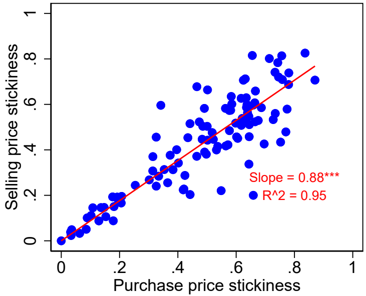
(a) firm-product level

		Selling price change	
		Yes	No
Purchase price change	Yes	**0.86**	0.14
	No	0.25	0.75

(b1) 4-digit NAICS industry level

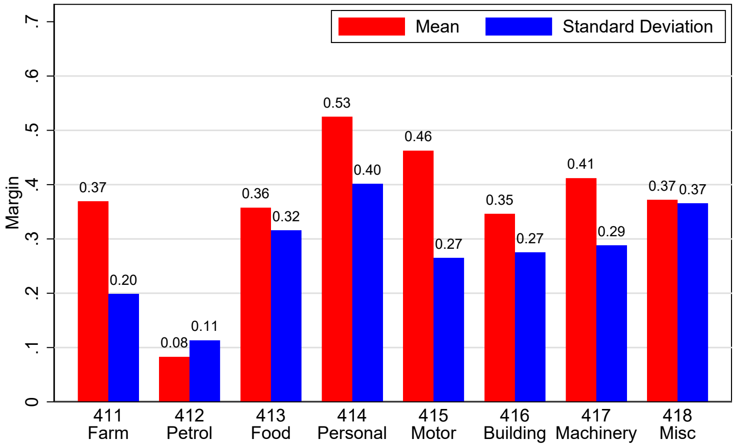


(b2) 7-digit NAPCS product level



Back

Average markup by 3-digit NAICS wholesale industry



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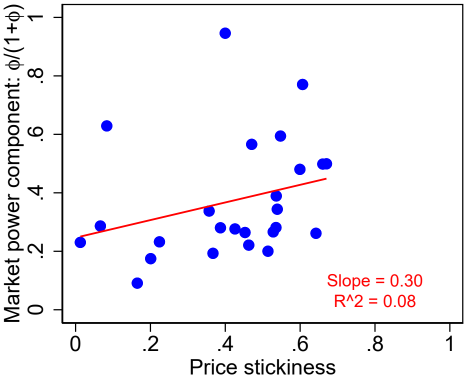
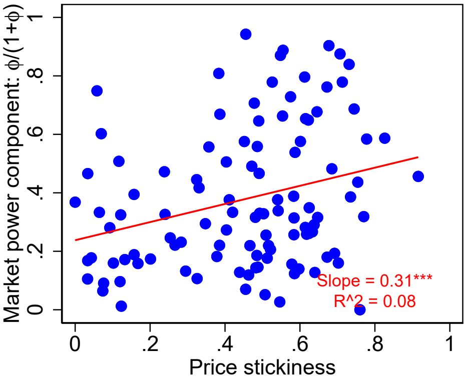
Correlation between market power and stickiness

(a) NAPCS4 Industry Estimates



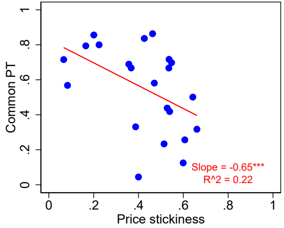
(b) NAPCS7 Product Estimates



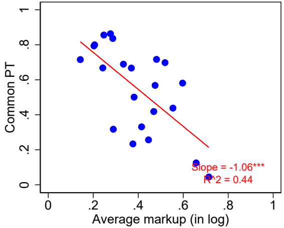
Back

Estimates by 4-digit NAICS wholesale industries

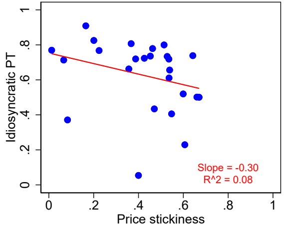
(a) Common PT vs price stick



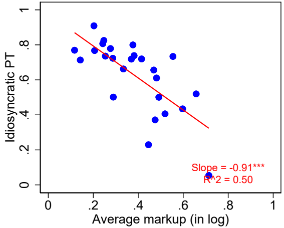
(b) Common PT vs markup



(c) Idio PT vs price stick

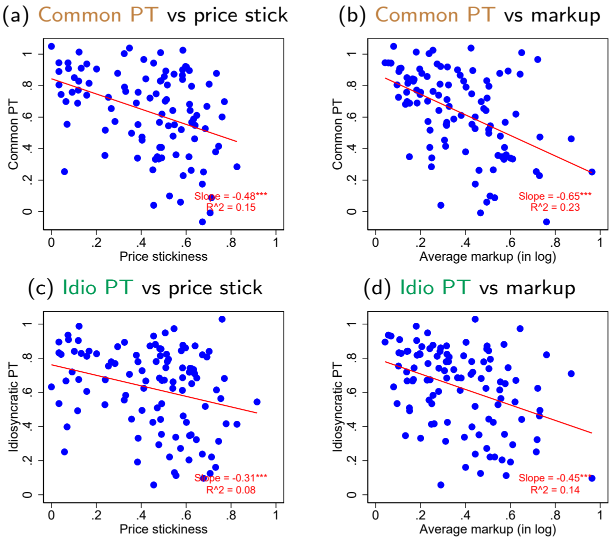


(d) Idio PT vs markup



▸ Back

(i) Estimates by NAPCS7 products



Back

(ii) Pooled pass-through estimates by NAPCS7 product characteristics

	Data	Model prediction
Common cost	0.89	≈ 1
	(0.04)	
Common cost × Product stickiness	-0.23	< 0
	(0.17)	
Common cost × High-markup product	-0.22	< 0
	(0.15)	
Idio. cost	$0.75^{\ddagger}$	< 1
	(0.04)	
Idio. cost × Product stickiness	0.04	≈ 0
	(0.10)	
Idio. cost × High-markup product	-0.23^{***}	< 0
	(0.09)	
Observations	133,620	
Firm-product fixed effects	✓	
R^2	0.57	

‡ means statistically different from 1; $**$ means statistically different from 0.

▸ Back

(ii) NAICS4 estimates with firm markup interactions

	Data	Model prediction
Common cost	1.05†	≈ 1
	(0.05)	
Common cost $\times$ Industry stickiness	-0.70**	< 0
	(0.25)	
Common cost $\times$ High-markup industry	-0.29**	< 0
	(0.10)	
Common cost $\times$ High-markup firm	**-0.05**	ambiguous
	(0.19)	
Idio. cost	0.88‡	< 1
	(0.04)	
Idio. cost $\times$ Industry stickiness	-0.04	≈ 0
	(0.10)	
Idio. cost $\times$ High-markup industry	-0.24***	< 0
	(0.04)	
Idio. cost $\times$ High-markup firm	**-0.33*****	< 0
	(0.04)	
Observations	136,085	
Firm-product fixed effects	✓	
R^2	0.52	

† means not statistically different from 1; ‡ means statistically different from 1; ∗∗ means statistically different from 0.

Back

Amplification of monetary non-neutrality: NAPCS7 product results

Relative to monopolistic competitive Calvo

	(1) one-sector OC	(2) multi-sector OC, heter price stick + homo market power	(3) multi-sector OC, heter price stick + heter market power
Slope of NKPC	0.70	0.40	0.26
Cum. Output from MP shock	1.28	1.84	2.38

Back

Expected sectoral price dynamics

The usual Calvo dynamics hold in **expectations**:

$$\begin{aligned}
\mathbb{E}_t \widehat{P}_{jt+\tau} &= \mathbb{E}_t \sum_i s_{ijt+\tau} \widehat{P}_{ijt+\tau} \\
&= (1-\lambda_j)\mathbb{E}_t \sum_i s_{ijt+\tau} \widehat{P}_{ijt+\tau,t+\tau} + \lambda_j \mathbb{E}_t \sum_i s_{ijt+\tau} \widehat{P}_{ijt+\tau-1} \\
&\approx (1-\lambda_j)\mathbb{E}_t \widehat{P}_{jt+\tau,t+\tau} + \lambda_j \mathbb{E}_t \widehat{P}_{jt+\tau-1}.
\end{aligned}$$

- Works for small shocks: $\sum_i s_{ijt+\tau} \widehat{P}_{ijt+\tau-1} \approx \sum_i s_{ijt+\tau-1} \widehat{P}_{ijt+\tau-1}$

Expected sectoral New Keynesian Phillips Curve can be expressed as:

$$\mathbb{E}_t \widehat{\pi}_{jt} = \sum_i s_{ij} \frac{(1-\beta\lambda_j)(1-\lambda_j)}{\lambda_j\,(1+\varphi_{ij})} \mathbb{E}_t(\widehat{Q}_{ijt,t} - \widehat{P}_{jt}) + \beta \mathbb{E}_t \widehat{\pi}_{jt+1}$$

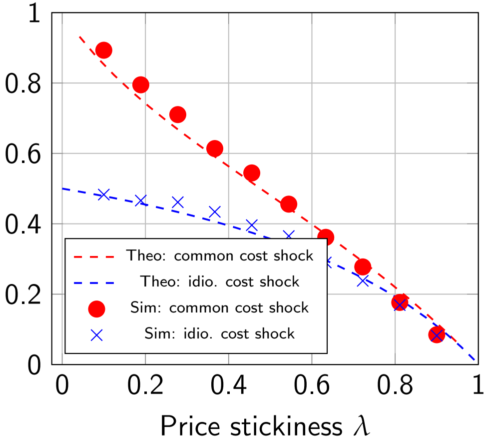
- Can be solved analytically and used in firm's problem to get closed-form solution

Back

Comparing theoretical vs simulated responses

(when $\theta = 3$, $\bar{s} = 0.5$ and $\beta = 0.98^{1/12}$)

(a): Persistence of cost shock $\rho = 0.6$



(b): Persistence of cost shock $\rho = 0.8$