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

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Motivation

Does market power influence inflation dynamics and transmission of monetary policy?

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

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

This paper

Build a 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-wide) vs idiosyncratic cost changes

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Exploiting unique data from Canadian wholesale firms (2013M1-2019M12):

- accurate proxy of the marginal cost changes $\Rightarrow$ decompose into 'common' vs idio components
- estimate pass-through of the two cost changes and find strong support of model predictions

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Micro to macro: market power and heterogeneity lead to

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

Roadmap

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

Model overview

Includes standard features from New Keynesian models and additional novel features:

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

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- Timing of distributor's price and cost changes is *synchronized* data
  - standard feature of distributors (Eichenbaum, Jaimovich & Rebelo 11; Goldberg & Hellerstein 13)

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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)

Key proposition

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

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

- $\widehat{Q}_{ijt}$ is the firm's cost shock; $\widehat{Q}_{jt} \equiv \sum_i s_{ij} \widehat{Q}_{ijt}$
- s_{ij} denotes firm's market share; λ_j denotes share of firms that do not adjust prices
- Strategic complementarity due to market power: φ_{ij}

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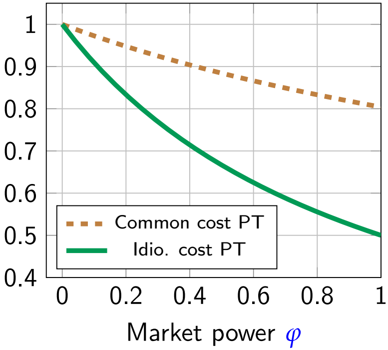
Predictions:

- Pass-through of idio. cost change is decreasing in φ_{ij}, independent of λ_j
- Pass-through of common cost change is decreasing in $\vec{\varphi}_j$ and λ_j

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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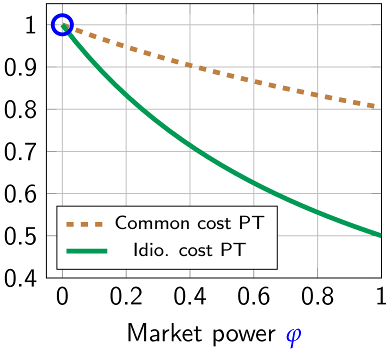

- No market power: complete PT to both shocks as in standard NK models

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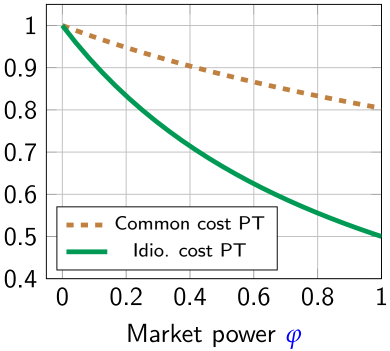

- For given price stickiness λ, PT to both shocks are decreasing in market power φ

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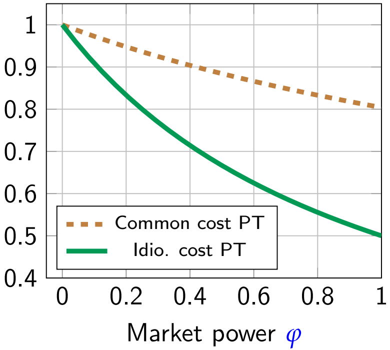
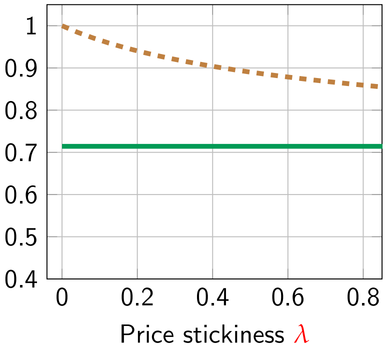


Market power fixed at $\varphi = 0.4$



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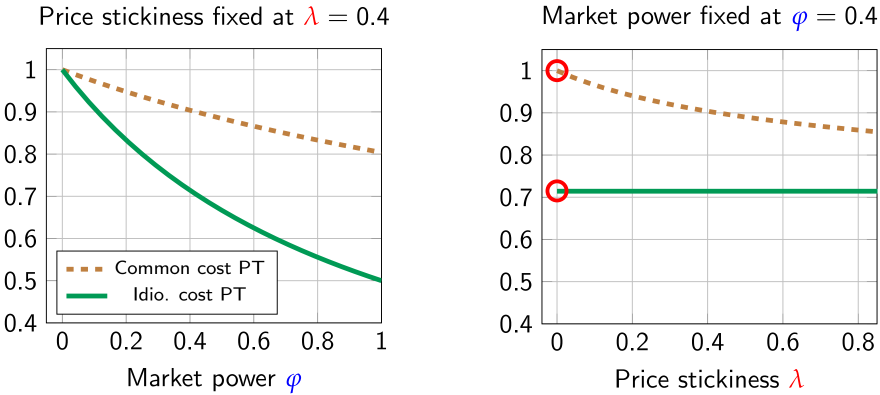

- Flexible price case: complete pass through to common cost change (Amiti, Itskhoki, Konings 19)

Differential pass-through by market power and price stickiness

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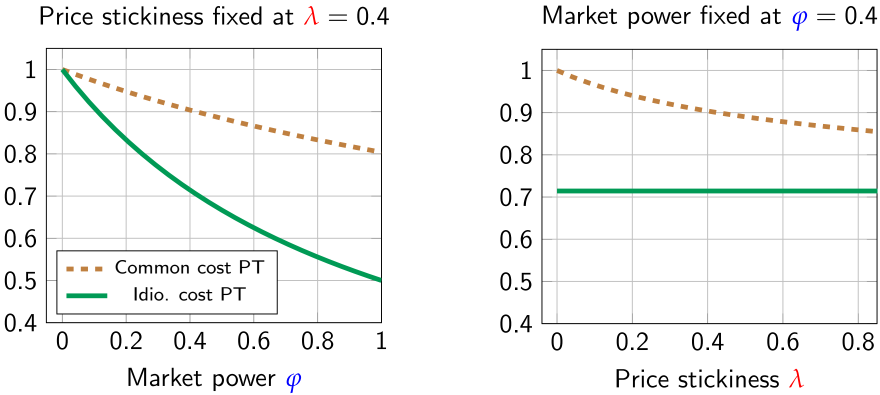

- Common cost PT decreases in λ: given my competitors' prices are sticky, my PT is lower

Differential pass-through by market power and price stickiness

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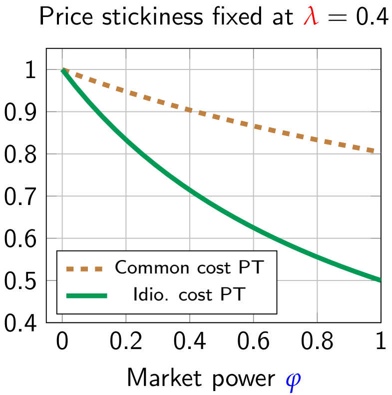

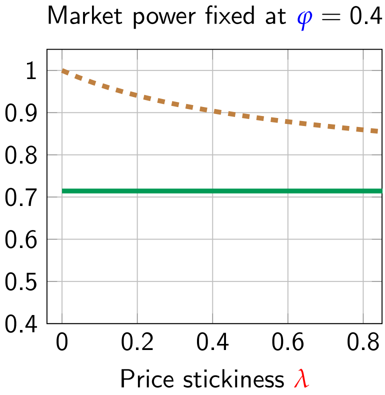

- PT of idiosyncratic part of cost shock is not affected by price stickiness λ

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 industry (4-digit NAICS and 7-digit NAPCS codes) of the firm-product
  - exploit industry-level variation in price stickiness and market power (average markup)

▸ markup by industry

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, industry, month, respectively

Empirical specification: Step 2

Estimate selling price adjustments to these two cost changes:

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

- 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) industries

Reset price pass-through estimates by industry characteristics

	Data	Model prediction
Common cost		≈ 1
Common cost × Industry stickiness		< 0
Common cost × High-markup industry		< 0
Idio. cost		< 1
Idio. cost × Industry stickiness		≈ 0
Idio. cost × High-markup industry		< 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

Reset price pass-through estimates by industry characteristics

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Common cost	1.08† (0.11)	≈ 1
Common cost × Industry stickiness	-0.96** (0.34)	< 0
Common cost × High-markup industry	-0.29** (0.11)	< 0
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Idio. cost	0.75‡ (0.06)	< 1
Idio. cost × Industry stickiness	0.03 (0.13)	≈ 0
Idio. cost × High-markup industry	-0.25*** (0.05)	< 0
Observations	136,085	
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Roadmap

- Model and closed form
- Empirical results
- 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 $\frac{\Lambda(1-\lambda)}{\lambda(1-\Lambda)} \approx 1.28$

Note: $\Lambda(\lambda, \varphi) \geq \lambda$ and $\Lambda \to \lambda$ as $\varphi \to 0$.

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$\Rightarrow$ Sizable amplification

Note: $\Lambda(\lambda, \varphi) \geq \lambda$ and $\Lambda \to \lambda$ as $\varphi \to 0$.

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%

NAPCS7 Results

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%

NAPCS7 Results

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

Conclusions

We study how interaction of market power and price stickiness impacts transmission of shocks in the macroeconomy

- Theoretically, we show that this interaction leads to:
  - 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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- Empirically, we find strong support for our theoretical predictions
- At aggregate level, market power and industry heterogeneity lead to:
  - 2/3 decline in slope of New Keynesian Phillips curve
  - 100% increase cumulative output response to monetary policy shock

Appendix

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
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Expected effective demand elasticity:

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

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

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

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

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

Aggregation: heterogeneous sectors

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

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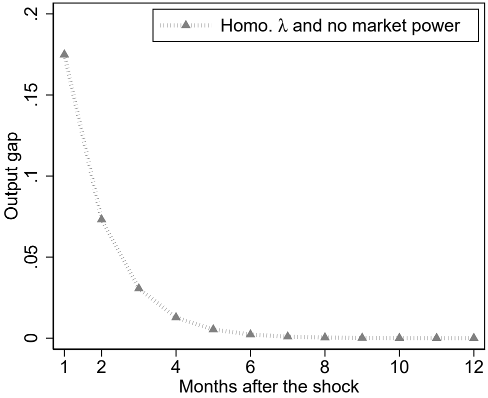
Next, calibrate the model to match industrial heterogeneity in λ_j and φ_j

Data

Amplification due to heterogeneity

(a) Output response to MP shock: $\widehat{C}_\tau$



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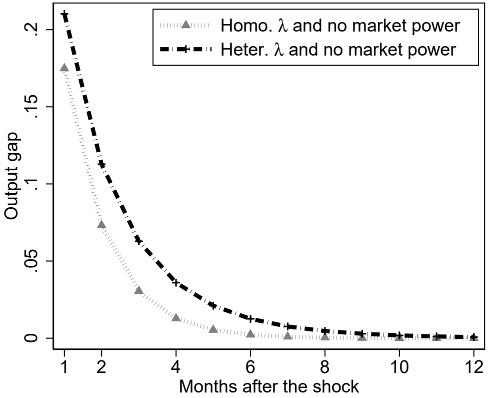
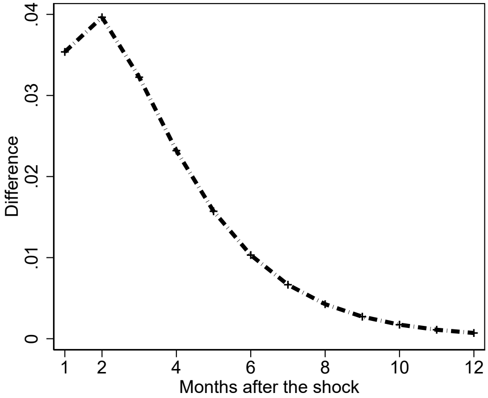
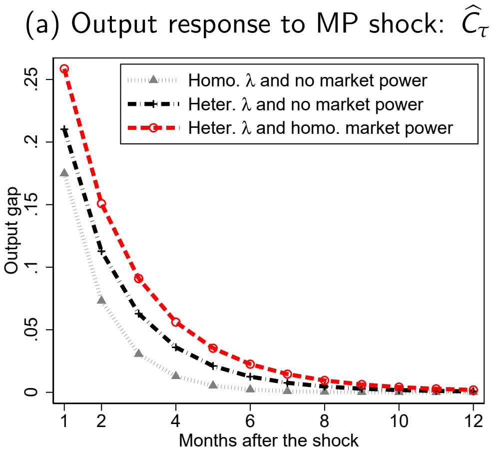
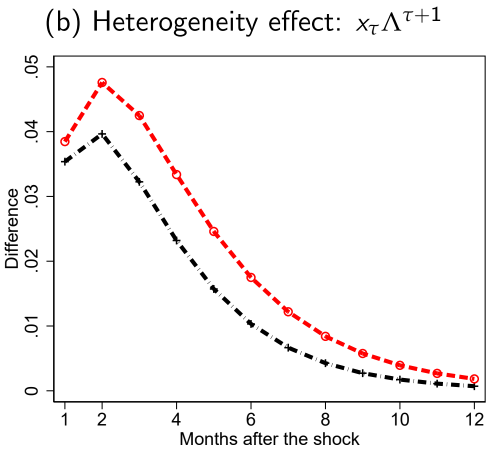


(b) Heterogeneity effect: $x_\tau \Lambda^{\tau+1}$



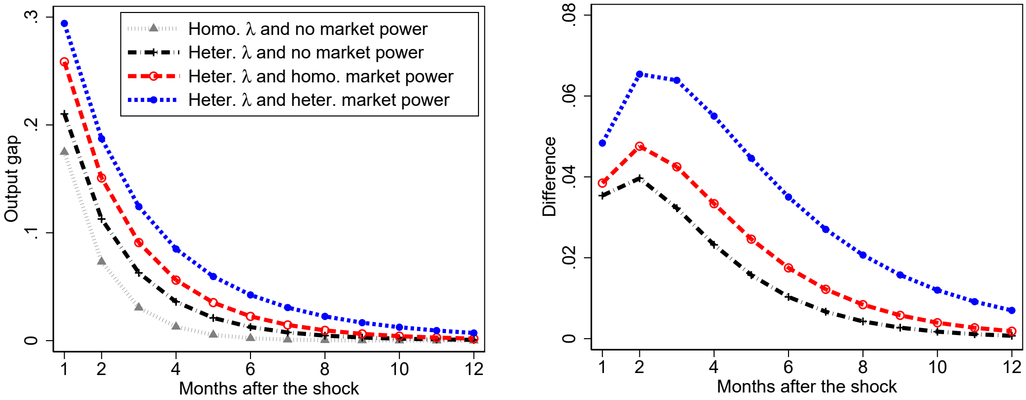
Amplification due to heterogeneity





Amplification due to heterogeneity

(a) Output response to MP shock: $\widehat{C}_\tau$ (b) Heterogeneity effect: $x_\tau \Lambda^{\tau+1}$



⇒ Much larger effects due to heterogeneity in price stickiness and market power

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

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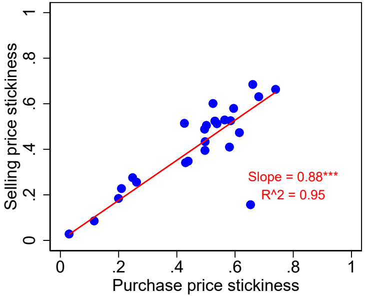
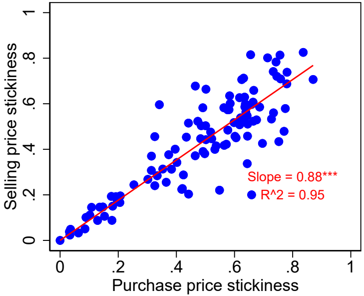
(a) firm-product level

		Selling price change Yes	Selling price change 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



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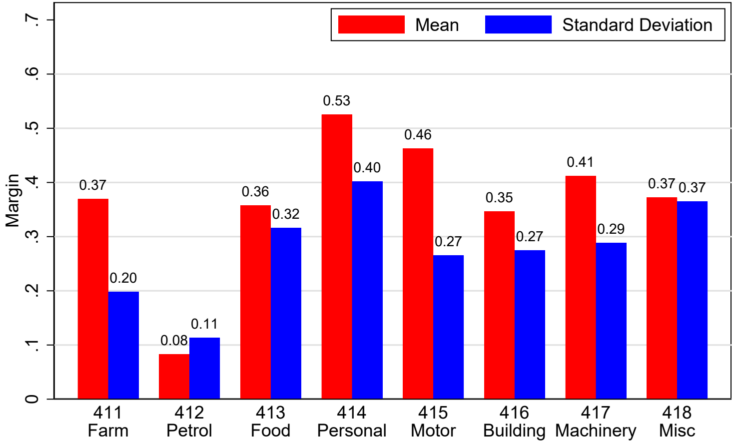
Average markup by 3-digit NAICS wholesale industry



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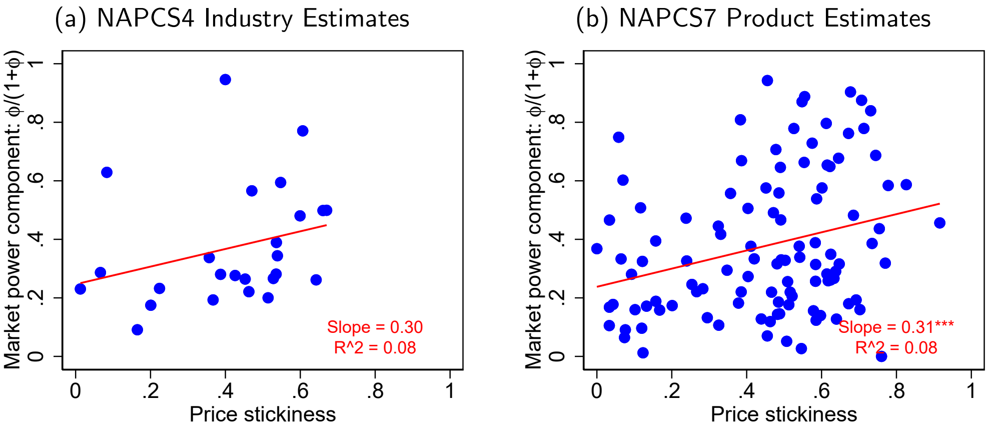
Correlation between market power and stickiness



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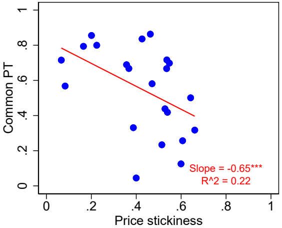
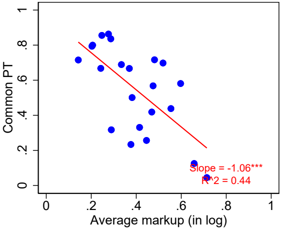
Estimates by 4-digit NAICS wholesale industries

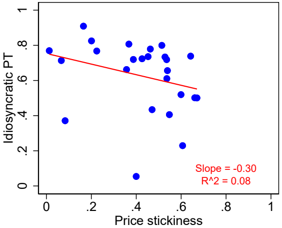
(a) Common PT vs price stick



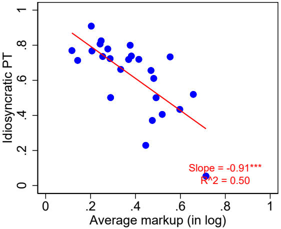
(b) Common PT vs markup



(c) Idio PT vs price stick



(d) Idio PT vs markup



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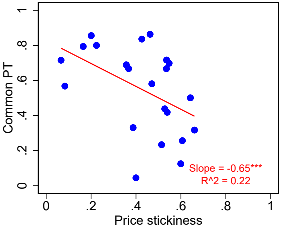
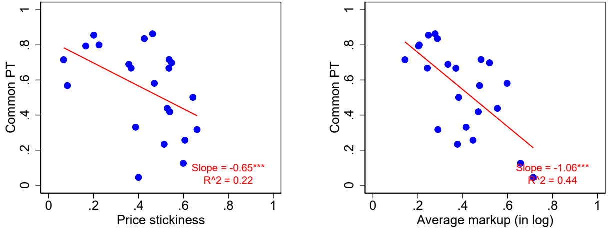
Estimates by 4-digit NAICS wholesale industries

(a) Common PT vs price stick

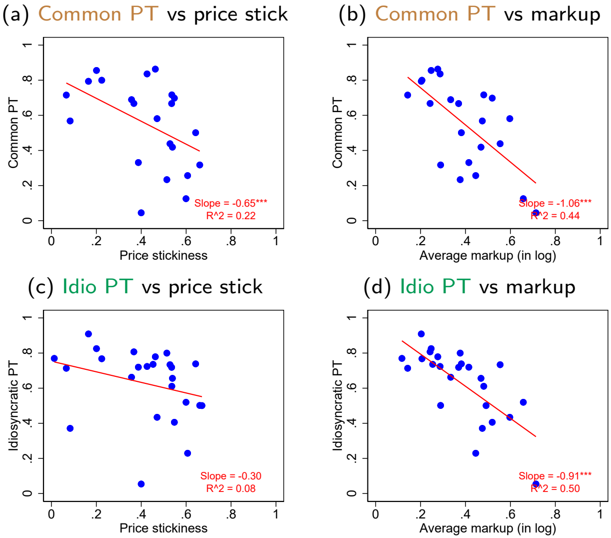


Estimates by 4-digit NAICS wholesale industries

(a) Common PT vs price stick (b) Common PT vs markup



Estimates by 4-digit NAICS wholesale industries



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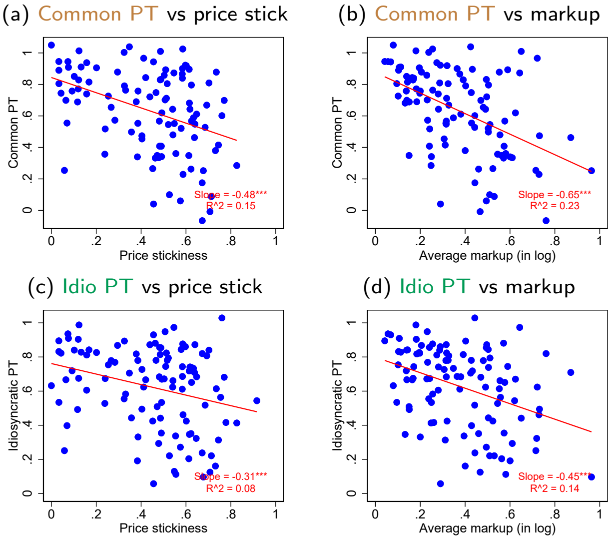
(i) Estimates by NAPCS7 products



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(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.

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(ii) NAICS4 estimates with firm markup interactions

	Data	Model prediction
Common cost	1.05†	≈ 1
	(0.05)	
Common cost × Industry stickiness	-0.70**	< 0
	(0.25)	
Common cost × High-markup industry	-0.29**	< 0
	(0.10)	
Common cost × High-markup firm	**-0.05**	ambiguous
	(0.19)	
Idio. cost	0.88‡	< 1
	(0.04)	
Idio. cost × Industry stickiness	-0.04	≈ 0
	(0.10)	
Idio. cost × High-markup industry	-0.24***	< 0
	(0.04)	
Idio. cost × 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.

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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

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

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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

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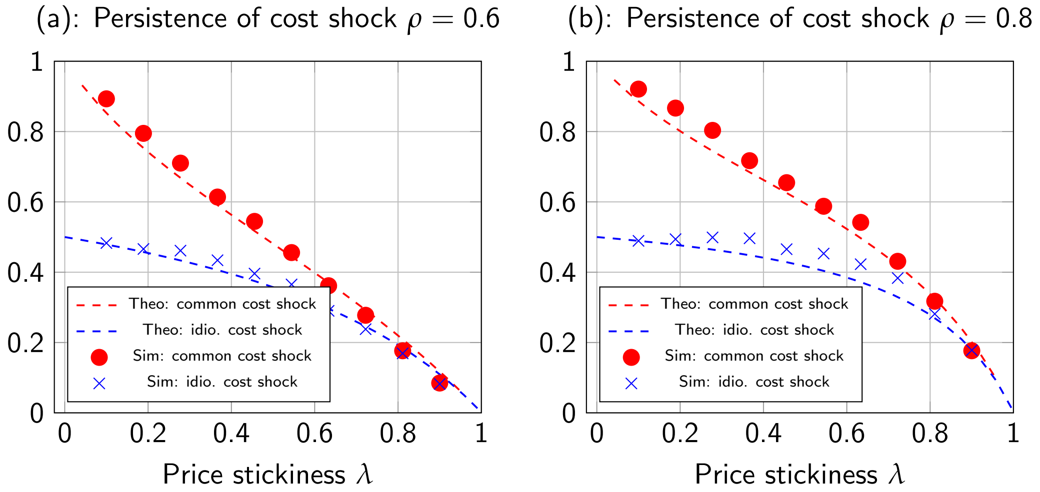
Comparing theoretical vs simulated responses

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



Differential common vs idiosyncratic cost pass-through by market power and price stickiness

Flexible price oligopolistic competition model (Atkeson & Burstein 08; Amiti, Itskhoki, Konings 19):

- Common cost change does not affect relative competitiveness $\rightarrow$ PT $=$ 100%
- Idio change affects relative competitiveness $\rightarrow$ PT $=$ function of market power φ_{ij}

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Calvo oligopolistic competition model (reset price pass-through):

- Common PT: decreasing function of φ_j and sectoral price stickiness λ_j

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- Idio PT: decreasing function of φ_{ij}, independent of λ_j
  Intuition: PT not affected by λ_j due to its idiosyncratic nature

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Empirically, our reset price pass-through estimates suggest:

- Common cost: $\approx$ 100% when $\lambda_j \approx 0$; declines to $\approx$ 40% for very sticky industries
- Idio cost: 70% on average; decrease in φ_{ij} and independent of λ_j