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) 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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Build a model with oligopolistic competition, Calvo sticky prices and heterogeneous firms

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- 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

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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  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: $U = \mathrm{E}_0 \, \text{å}_{t=0}^{\text{¥}} b^t (\ln C_t + L_t)$
- Cobb-Douglas aggregation across sectors: $C_t = \mathrm{P}_j C_{jt}^{a_j}$
- 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:

$$P_{ijt,t} = \frac{E_t \sum_{\tau=0}^{\infty} (\beta\lambda_j)^{\tau} \vartheta_{ijt+\tau,t} C_{ijt+\tau,t}}{E_t \sum_{\tau=0}^{\infty} (\beta\lambda_j)^{\tau} (\vartheta_{ijt+\tau,t} - 1) C_{ijt+\tau,t} / \Theta_{ijt+\tau}}$$

- i, j, t denotes firm, industry, time; λ_j is probability of no price adjustment
- $\Theta_{ijt+\tau}$ 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:

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

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Changes in expected market share depends on expected future sector price $E_t \hat{P}_{jt+\tau}$:

$$E_t \hat{s}_{ijt+\tau,t} = -(\theta - 1) \left[\hat{P}_{ijt,t} - E_t \hat{P}_{jt+\tau} \right]$$

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With small shocks: $E_t \hat{P}_{jt+\tau}$ can be solved analytically $\Rightarrow$ closed-form solution

Details

Key proposition

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

$$\hat{p}_{ijt,t} = \frac{1}{1+\varphi_{ij}} \underbrace{\left(\hat{c}_{ijt} - \hat{c}_{jt}\right)}_{\text{Idiosyncratic change}} + \frac{1}{1+\varphi_{ij}} + \frac{\varphi_{ij}}{1+\varphi_{ij}} \frac{1 - \Lambda(\gamma_j, \lambda_j)}{1 - \beta\lambda_j \Lambda(\gamma_j, \lambda_j)} \underbrace{\hat{c}_{jt}}_{\text{Common change}}$$

- $\hat{c}_{ijt}$ is the firm's cost shock, $\hat{c}_{jt} \equiv \sum_i s_{ij}\hat{c}_{ijt}$
- Strategic complementarity due to market power: φ_{ij}

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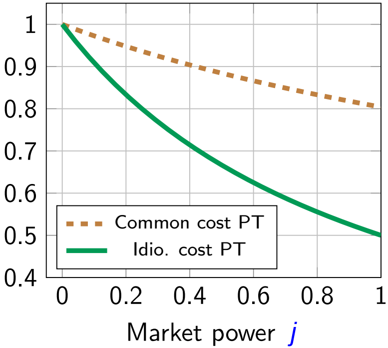
Predictions:

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

Di erential pass-through by market power and price stickiness

$$\hat{p}_{ijt,t} = \frac{1}{1+j_{ij}} \quad \hat{c}_{ijt} \quad \hat{c}_{jt} + \frac{1}{1+j_{ij}} + \frac{j_{ij}}{1+j_{ij}} \quad \frac{1 \quad L(\bar{j}_j, l_j)}{1 \quad b\, l\, L(\bar{j}_j, l_j)} \quad \hat{c}_{jt}$$

Price stickiness fixed at $l = 0.4$



Differential pass-through by market power and price stickiness

$$\hat{p}_{ijt,t} = \frac{1}{1+j_{ij}} \quad \hat{q}_{ijt} \quad \hat{q}_{jt} + \frac{1}{1+j_{ij}} + \frac{j_{ij}}{1+j_{ij}} \quad \frac{1 \quad L(\bar{j}_j, l_j)}{1 \quad b\, l\, L(\bar{j}_j, l_j)} \quad \hat{q}_{jt}$$

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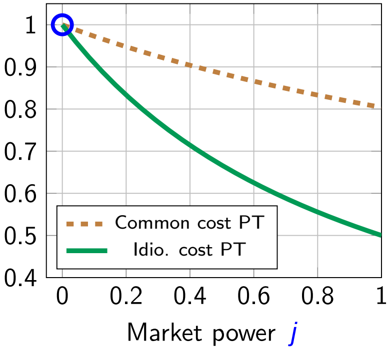

- No market power: complete PT to both shocks as in standard NK models

Di erential pass-through by market power and price stickiness

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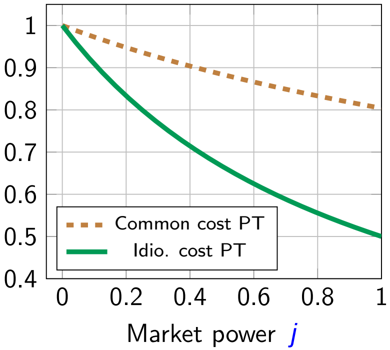

- For given price stickiness l, PT to both shocks are decreasing in market power j

Differential pass-through by market power and price stickiness

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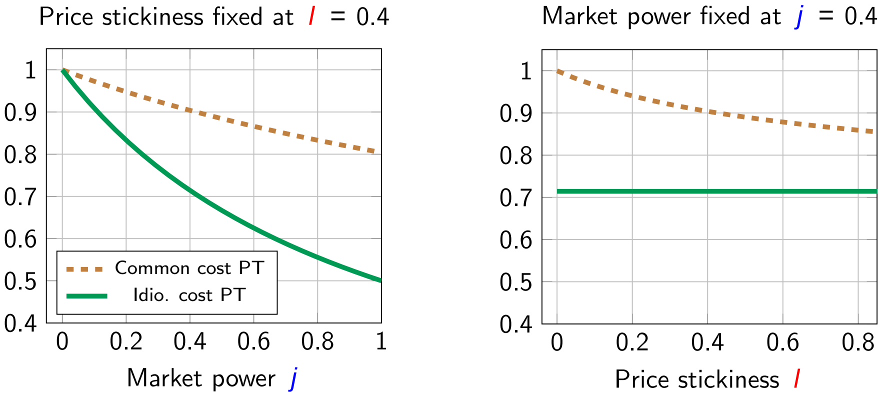
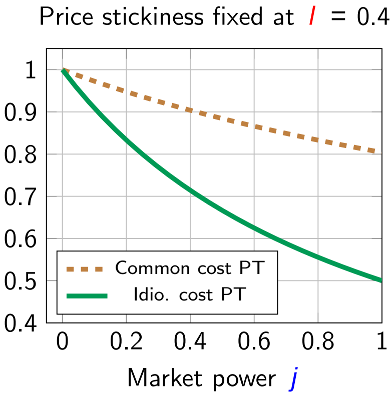
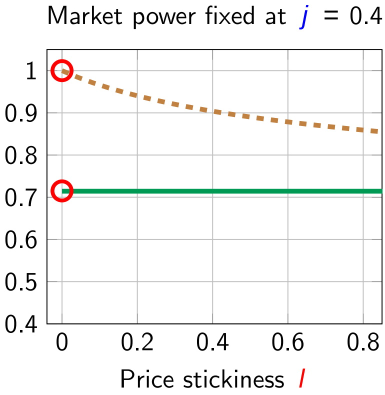


Differential pass-through by market power and price stickiness

$$\hat{p}_{ijt,t} = \frac{1}{1+\Gamma_{ij}}\left(\hat{c}_{ijt} - \hat{c}_{jt}\right) + \left[\frac{1}{1+\Gamma_{ij}} + \frac{\Gamma_{ij}}{1+\Gamma_{ij}}\,\frac{1-\Lambda(\bar{\Gamma}_j,\theta_j)}{1-\beta\theta\Lambda(\bar{\Gamma}_j,\theta_j)}\right]\hat{c}_{jt}$$





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

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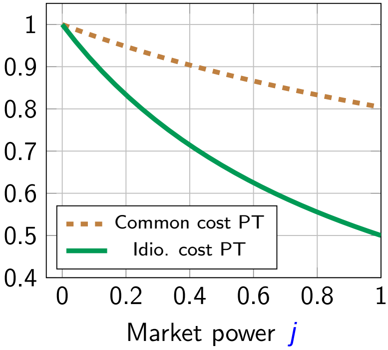
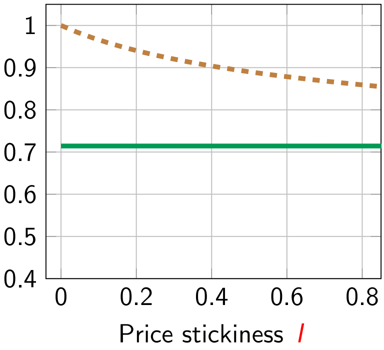


Market power fixed at $j = 0.4$



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

Differential pass-through by market power and price stickiness

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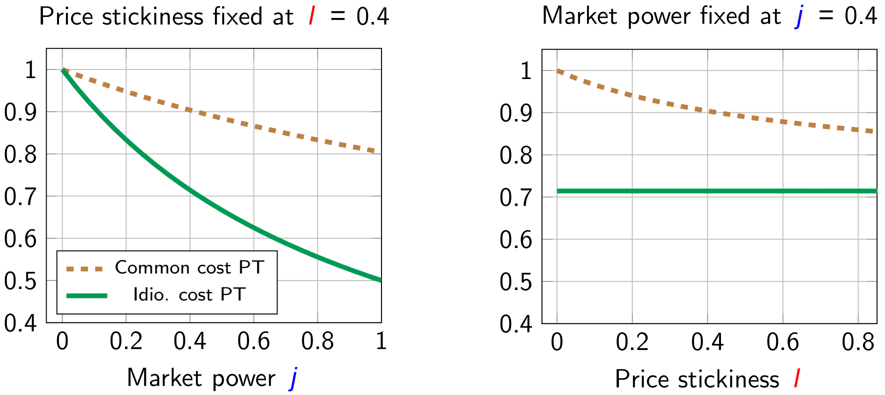

- PT of idiosyncratic part of cost shock is not affected by price stickiness l

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 (280k obs after cleaning)
  selling price, purchase price (reliable measure of marginal cost)
  markup = (selling price)/(purchase price)
- A large sample of firms (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:

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

- 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		X	
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

		Data	Model prediction
Common cost		1.08[†]	1
		(0.11)	
Common cost	Industry stickiness	-0.96	< 0
		(0.34)	
Common cost	High-markup industry	-0.29	< 0
		(0.11)	
Idio. cost			< 1
Idio. cost	Industry stickiness		0
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Common cost	High-markup industry	-0.29	< 0
		(0.11)	
Idio. cost		0.75‡	< 1
		(0.06)	
Idio. cost	Industry stickiness	0.03	0
		(0.13)	
Idio. cost	High-markup industry	-0.25	< 0
		(0.05)	
Observations		136,085	
Firm-product fixed effects		X	
R^2		0.5	

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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:

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

Aggregation: homogeneous sectors

When $j_j = j$ and $l_j = l$, the aggregate New Keynesian Phillips curve is given by:

$$b_t = \frac{(1 \quad b\,l)(1 \quad l)}{l\,(1 + j)} mc_t + b\,\mathrm{E}_t b_{t+1}$$

Relative to standard monopolistic competitive Calvo,

- Slope of NKPC is reduced by a factor of $\frac{1}{1+j}$ 0.7
- Cumulative output response to MP shock is amplified by a factor of $\frac{L(1 \quad l)}{l(1 \quad L)}$ 1.28

Note: $L(l, j)$ l and $L \,!\, l$ as $j \,!\, 0$.

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) Sizable amplification (as in WW 22) but much smaller than in menu cost model (Mongey 21)

Note: $L(l, j) \quad l$ and $L \; ! \; l$ as $j \; ! \; 0$.

Aggregation: heterogeneous sectors

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

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Under a permanent monetary policy shock at $t = 0$ (i.e., $\hat{m}_t = 1 \; \forall t \geq 0$):

$$\hat{p}_t = (1 - \lambda)\hat{p}_{t,t} + \lambda \hat{p}_{t-1} - Cov_j[\lambda_j, (\lambda_j)^t]$$

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- $\Lambda_j(\lambda_j, \varphi_j) \geq \lambda_j$ is sticky price multiplier with $\Lambda_j \to \lambda_j$ as $\varphi_j \to 0$

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$$\hat{c}_t = 1 - \hat{p}_t = \Lambda^{t+1} + \underbrace{\chi_t \Lambda^{t+1}}_{\text{heterogeneity effect} \geq 0}$$

- $\Lambda_j(\lambda_j, \zeta_j) \leq \lambda_j$ is sticky price multiplier with $\Lambda_j \to \lambda_j$ as $\zeta_j \to 0$
- $\Lambda \equiv \sum_j a_j \Lambda_j$ and $\chi_t \equiv \sum_j a_j \Lambda_j^{t+1} / \Lambda^{t+1} - 1 \geq 0$

Aggregation: heterogeneous sectors

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

Under a permanent monetary policy shock at $t = 0$ (i.e., $\hat{m}_t = 1\ \forall t \geq 0$):

$$\hat{\pi}_t = (1 - \lambda)\hat{\pi}_{t,t} + \lambda \hat{\pi}_{t-1} - Cov_j\left(\lambda_j, \frac{1 - \Lambda_j}{1 - \lambda_j}(\Lambda_j)^t\right)$$

$$\hat{c}_t = 1 - \hat{p}_t = \Lambda^{t+1} + \underbrace{x_t \Lambda^{t+1}}_{\text{heterogeneity effect} \geq 0}$$

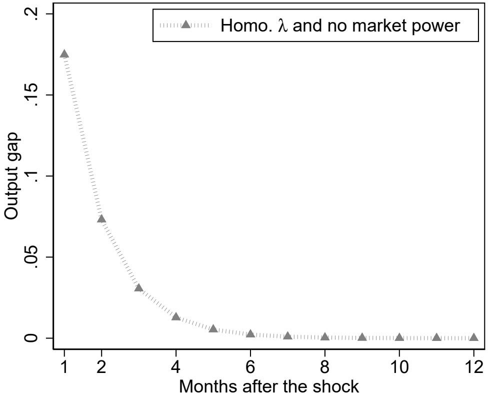
- $\Lambda_j(\lambda_j, \phi_j) \geq \lambda_j$ is sticky price multiplier with $\Lambda_j \to \lambda_j$ as $\phi_j \to 0$
- $\Lambda \equiv \sum_j a_j \Lambda_j$ and $x_t \equiv \sum_j a_j \Lambda_j^{t+1} / \Lambda^{t+1} - 1 \geq 0$

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

▸ Data

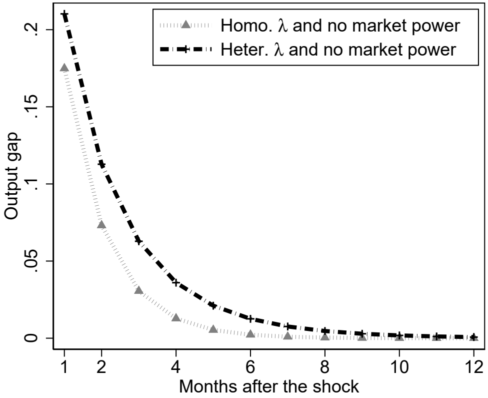
Ampli cation due to heterogeneity

(a) Output response to MP shock: $\hat{c}_t$

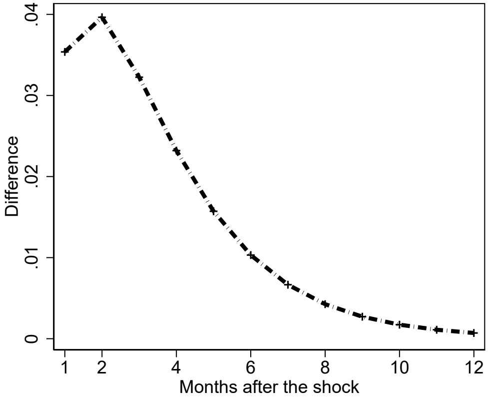


Ampli cation due to heterogeneity

(a) Output response to MP shock: $\hat{O}_t$

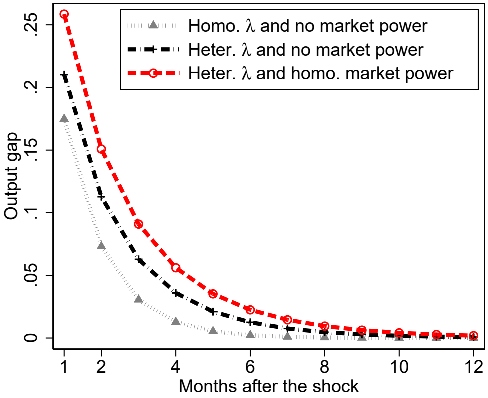


(b) Heterogeneity effect: x_t L $^{t+1}$

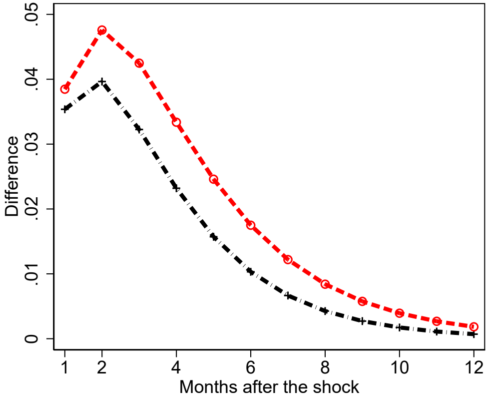


Ampli cation due to heterogeneity

(a) Output response to MP shock: $\hat{C}_t$

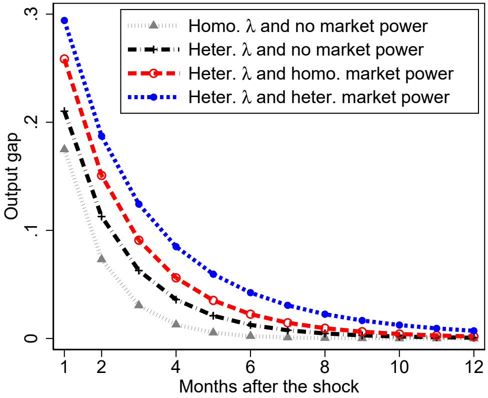


(b) Heterogeneity effect: $x_t \, \mathsf{L}^{\,t+1}$

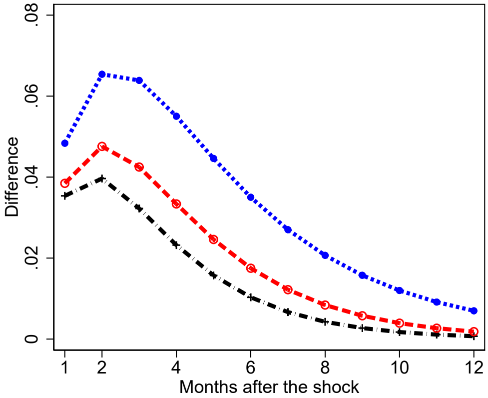


Ampli cation due to heterogeneity

(a) Output response to MP shock: $\overset{b}{C}_t$



(b) Heterogeneity effect: $x_t \, \mathrm{L}^{t+1}$



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

Ampli cation 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

Ampli cation 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

Ampli cation 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

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
- 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

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

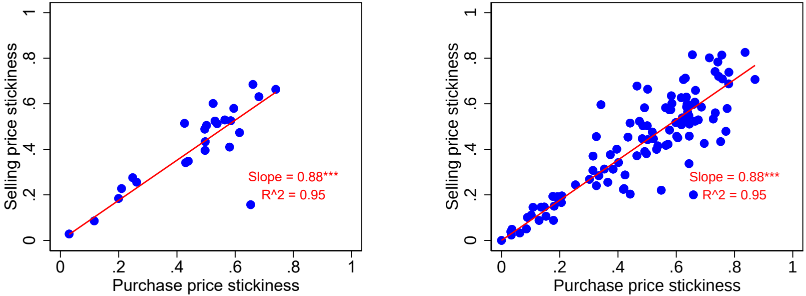
Synchronization in selling and purchase price adjustments

(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

Back

Correlation between market power and stickiness

(a) NAPCS4 Industry Estimates

(b) NAPCS7 Product Estimates

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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

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

(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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(i) Estimates by NAPCS7 products

(a) Common PT vs price stick

(b) Common PT vs markup

(c) Idio PT vs price stick

(d) Idio PT vs markup

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

		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‡	< 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 xed e ects		X	
R^2		0.57	

‡ means statistically di erent from 1; means statistically di erent from 0.

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(ii) NAICS4 estimates with rm 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 rm	-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 rm	-0.33	< 0
	(0.04)	
Observations	136,085	
Firm-product xed e ects	X	
R^2	0.52	

† means not statistically di erent from 1; ‡ means statistically di erent from 1; means statistically di erent from 0.

Ampli cation 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:

$$
\begin{aligned}
E_t \hat{\pi}_{jt+\tau} &= E_t \sum_i \sigma_{ijt+\tau} \hat{\pi}_{ijt+\tau} \\
&= (1-\lambda_j) E_t \sum_i \sigma_{ijt+\tau} \hat{\pi}_{ijt+\tau,t+\tau} + \lambda_j E_t \sum_i \sigma_{ijt+\tau} \hat{\pi}_{ijt+\tau-1} \\
&\approx (1-\lambda_j) E_t \hat{\pi}_{jt+\tau,t+\tau} + \lambda_j E_t \hat{\pi}_{jt+\tau-1}.
\end{aligned}
$$

- Works for small shocks: $\sum_i \sigma_{ijt+\tau} \hat{\pi}_{ijt+\tau-1} \approx \sum_i \sigma_{ijt+\tau-1} \hat{\pi}_{ijt+\tau-1}$

Expected sectoral price dynamics

The usual Calvo dynamics hold in expectations:

$$
\begin{aligned}
E_t \hat{\pi}_{jt+\tau} &= E_t \sum_i s_{ijt+\tau} \hat{\pi}_{ijt+\tau} \\
&= (1-\lambda_j) E_t \sum_i s_{ijt+\tau} \hat{p}_{ijt+\tau,t+\tau} + \lambda_j E_t \sum_i {\color{blue}s_{ijt+\tau}} \hat{\pi}_{ijt+\tau-1} \\
&\approx (1-\lambda_j) E_t \hat{p}_{jt+\tau,t+\tau} + \lambda_j E_t \hat{\pi}_{jt+\tau-1}.
\end{aligned}
$$

- Works for small shocks: $\sum_i {\color{blue}s_{ijt+\tau}} \hat{\pi}_{ijt+\tau-1} \approx \sum_i {\color{red}s_{ijt+\tau-1}} \hat{\pi}_{ijt+\tau-1}$

Expected sectoral New Keynesian Phillips Curve can be expressed as:

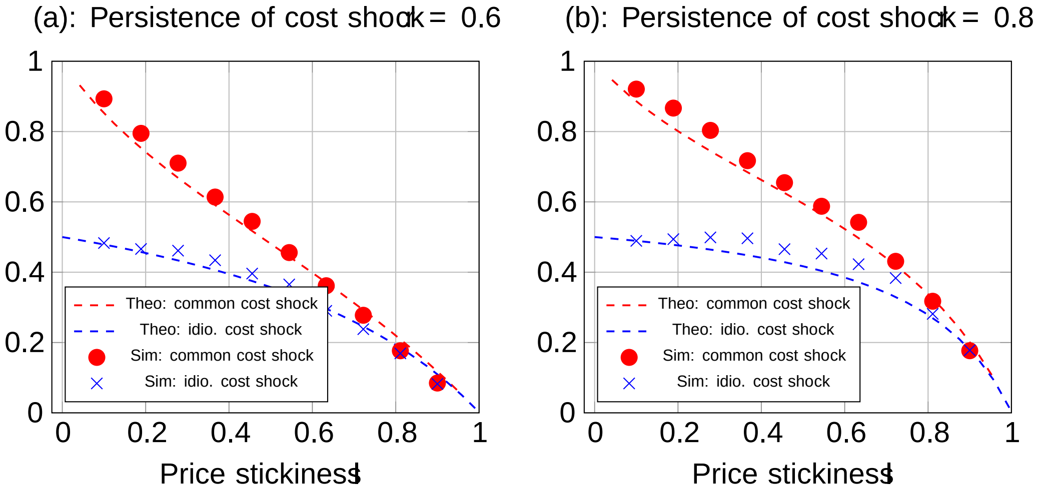
$$
E_t \hat{\pi}_{jt} = \sum_i {\color{blue}s_{ij}} \frac{(1-\beta\lambda_j)(1-\lambda_j)}{\lambda_j(1+{\color{blue}\varphi_{ij}})} E_t(\hat{Q}_{ijt,t} - \hat{p}_{jt}) + \beta E_t \hat{\pi}_{jt+1}
$$

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

Back

Comparing theoretical vs simulated responses

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



Di erential common vs idiosyncratic cost pass-through by market pow and price stickiness

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

- Common cost change does not a ect relative competitiveness ! PT = 100%
- Idio change a ects relative competitiveness ! PT = function of market power j_{ij}

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

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

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  Intuition: price stickiness implies changes in relative competitiveness

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

- Common PT: decreasing function of j_j and sectoral price stickiness l_j

  Intuition: price stickiness implies changes in relative competitiveness
- Idio PT: decreasing function of j_{ij}, independent of l_j

  Intuition: PT not a ected by l_j due to its idiosyncratic nature

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  Intuition: PT not affected by l_j due to its idiosyncratic nature

Empirically, our reset price pass-through estimates suggest:

- Common cost: 100% when l_j 0; declines to 40% for very sticky industries
- Idio cost: 70% on average; decrease in j_{ij} and independent of l_j