Are Sticky Prices Costly? Evidence from the Stock Market

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Motivation

- Does money matter?
- Nominal non-neutralities critically depend on degree of price stickiness
- Micro-level evidence on duration of price spells:

	incl sales	excl sales
Nakamura and Steinsson (2008)	5	8 - 12
Kehoe and Midrigan (2007)	3 weeks - 3 months	8
Bils and Klenow (2004)	4.3	5.4

- New Keynesian explanation: cost of changing nominal prices
- Implication: sticky prices are costly
- Does observed price stickiness at micro level imply costly sticky prices?
  - No, not necessarily. Head et al. (JEEA 2012) develop counterexample

Motivation cont.

Blinder: (1991) *In principle, fixed costs of changing prices can be observed and measured. In practice, such costs take disparate forms in different firms, and we have no data on their magnitude. So the theory can be tested at best indirectly, at worst not at all.*

- We propose to look at stock market valuations of firms
  - Holistic approach
  - Do firms with different price stickiness earn differential returns?
  - Do returns of firms with differential price stickiness behave differentially following in response to identified exogenous shock?

Framework

- Use micro-level price data from the Bureau of Labor Statistics to calculate price stickiness at firm level
- Merge with stock returns of constituents of S&P500
- Construct measure of monetary policy shock using changes in fed funds futures around Fed's policy announcement
- Focus on narrow event windows and high frequency to rule out alternative explanations

Framework

- Use basic New Keynesian model to guide choice of empirical specifications

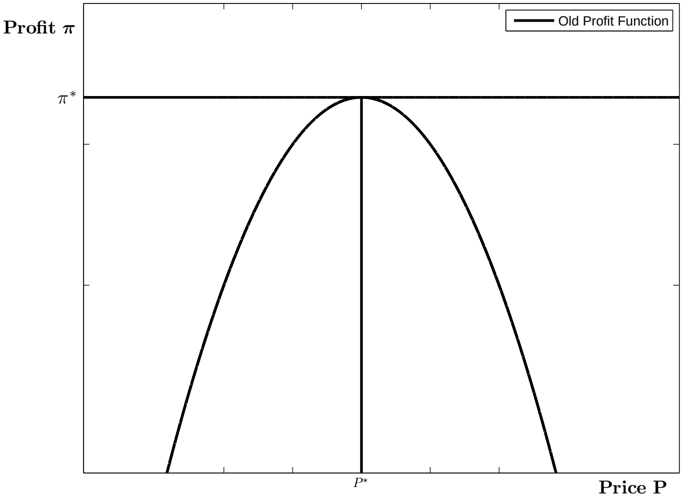
- 25 bps monetary policy shocks leads to increase in squared returns of $8\%^2$ for most sticky firms; reduced by factor of 3 for firms with most flexible prices

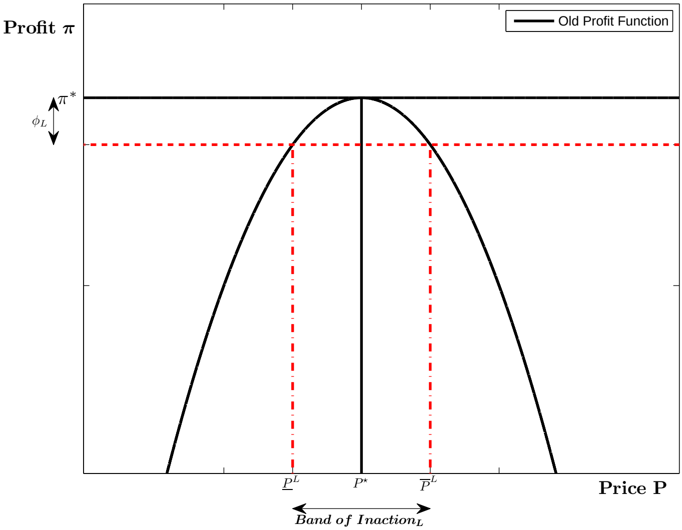
- Result consistent with costly sticky prices – a key tenet of New Keynesian macroeconomics

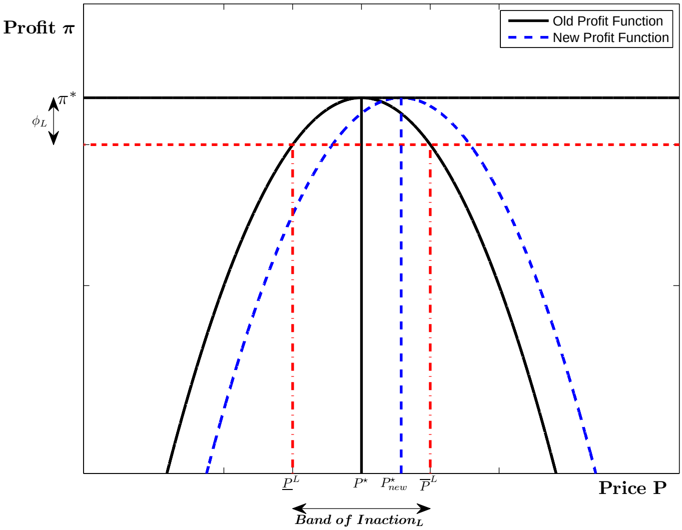
Related Literature

- Evidence from case studies of retail chains (e.g. Levy et. al. (1997, 1999), Zbaracki et al. (2004), Anderson et al. (2012))
  - Pro: Great insights into mechanisms of price adjustment
  - Con: How to generalize practice of a firm to macro level?
- Questionnaires (e.g. Blinder (1991))
  - Pro: Elicit information of reasons and costs of price adjustment
  - Con: Mostly qualitative information
- Indirect/ structural evidence from (calibrated) theoretical models (e.g. Klenow and Willis (2007), Nakamura and Steinsson (2008))
  - Pro: Model-consistent inference
  - Con: What is the right model? Sensitive to auxiliary assumptions?

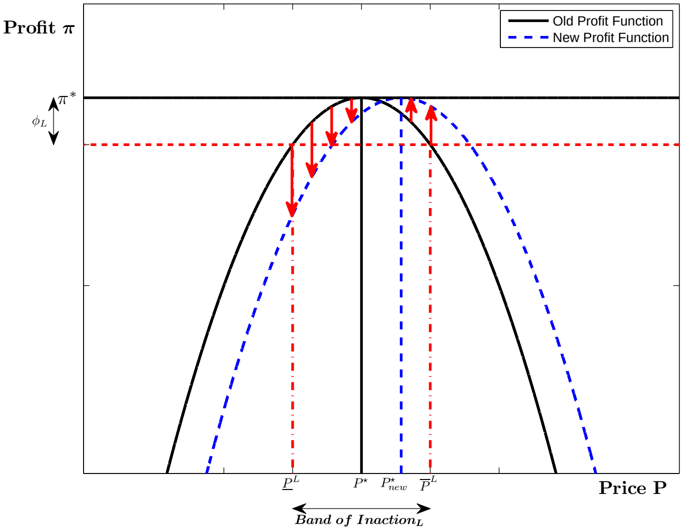
Model Intuition: Profit as Function of Price (static model)




Profit π
Old Profit Function
π^*
ϕ_L
$\underline{P}^L$
$P^\star$
$\overline{P}^L$
Price P
$Band\ of\ Inaction_L$



Profit π
Old Profit Function
New Profit Function
π*
ϕ_L
P^L
P*
P*_new
P^L
Price P
Band of Inaction_L



Profit π
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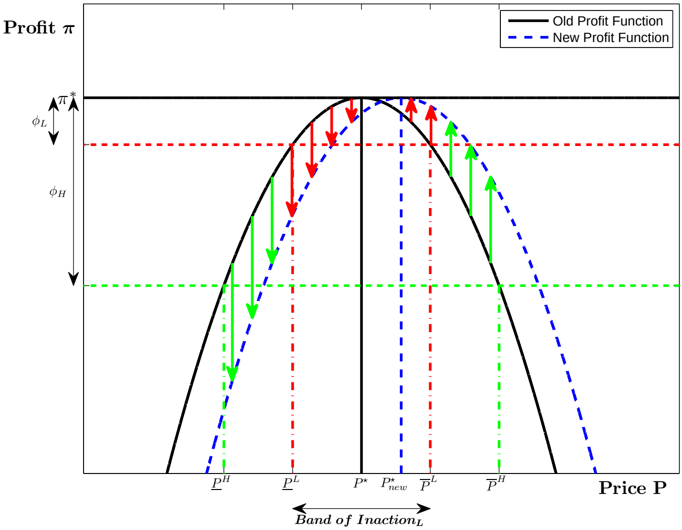
Profit π
Old Profit Function
New Profit Function
π*
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P̲^H
P̲^L
P*
P*_new
P̄^L
P̄^H
Price P
Band of Inaction_L

Theoretical Framework: Recap

- Returns can increase or decrease following shift in profit function
- After shocks, volatility of high-menu cost firms larger than volatilities of low-menu cost firms
- Empirical Specification:

$$R_{it}^2 = b_0 + b_1 \times v_t^2 + b_2 \times \lambda_i \times v_t^2 + b_3 \times \lambda_i + Controls + \varepsilon_{it},$$

- where R_{it} is return of firm i at time t, v_t is a monetary policy surprise and λ_i is frequency of price adjustment at firm level

Prediction: *Monetary policy shocks increase the variability of returns ($b_1 > 0$). This effect is decreasing with increasing price flexibility ($b_2 < 0$).*

Data and Sample Period

- 137 event dates between February 1994 and December 2009 for 8 scheduled FOMC meetings per year
- We consider 30 min, 60 min and daily event windows around the press releases of the FOMC statements
- Time stamps of press releases from FOMC Freedom of Information Service Act Center
- Stock returns for constituents of S&P500 from NYSE taq
- Firm level controls such as size, book-to-market, price-cost margin, sales volatilities, staff expenditures are mostly from CRSP and Compustat

Measuring Price Stickiness

- We use *confidential* micro data underlying the Producer Price Index (PPI) constructed by the Bureau of Labor Statistics

- Three step procedure to collect prices:

  1. Construct sampling frame (rotated every seven years)
  2. Stratified sampling of price-forming units (cluster of establishments)
  3. Stratified random sampling of goods/ services with probabilities proportional to value of shipments

- Basic characteristics:

  - 25,000 establishments
  - 100,000 individual items
  - Monthly frequency of sampling
  - Establishment names, address, industry code, etc. (manual match to S&P500 firms)

PPI Monthly Frequency of Price Adjustment

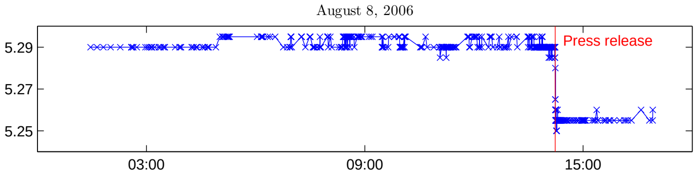
Sector	Mean	Std
Agriculture	25.4%	17.2%
Manufacturing	11.9%	11.1%
Utilities	21.5%	13.4%
Trade	22.2%	13.7%
Finance	13.8%	11.4%
Services	8.1%	7.7%
Overall	14.7%	12.9%

- Average duration of price spells, $-1/ln(1-\lambda)$, of 6.03 months
- Substantial variation both across and within industries

Monetary Policy Shocks

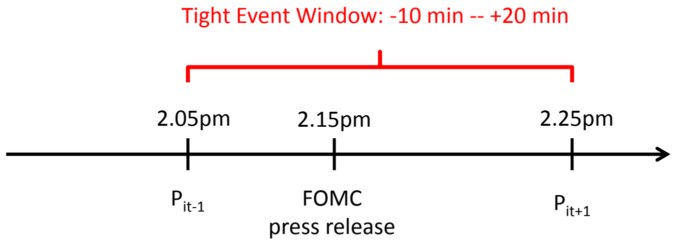
- Main challenge: need unanticipated, exogenous shocks $\longrightarrow$ we use high-frequency identification of monetary policy shocks
- Tick-by-tick Federal Funds Futures (FFF) Globex data from Chicago Mercantile Exchange
- FFF ff^0 settles on average effective fed funds rate: use scaled change

$$v_t = \frac{D}{D-t}\left(ff^0_{t+\Delta t^+} - ff^0_{t-\Delta t^-}\right) \qquad \text{where } D \text{ is \# of days in month}$$



- High trading activity around FOMC press releases with immediate market reaction

Event Returns

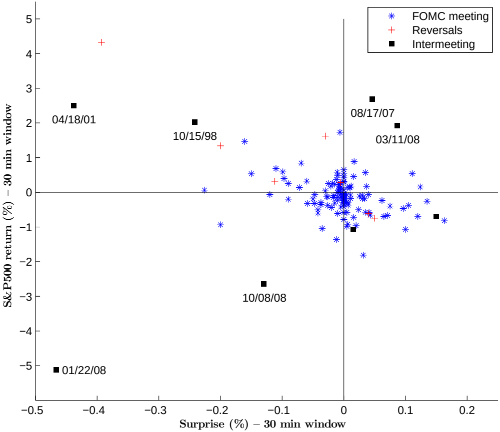


- Use tick-by-tick data from NYSE taq
- Take last trade before start of the event window (P_{it-1}) and first trade after end of the event window (P_{it+1}) to calculate event return
- Volume weighted returns as robustness: take all trades in 10 minutes before and after event window to calculate volume weighted prices
- Check all returns larger than 5% in absolute value

taq Trade Prices

	Stock Symbol	Transaction Date	Trade Time	Actual Trade Price per Share	Exchange on which the Trade occurred	Number of Shares Traded
43394	GE	20130131	14:04:46	22.31	K	100
43395	GE	20130131	14:04:46	22.31	K	100
43396	GE	20130131	14:04:46	22.31	K	100
43397	GE	20130131	14:04:46	22.31	K	200
43398	GE	20130131	14:04:46	22.31	K	100
43399	GE	20130131	14:04:46	22.31	K	100
43400	GE	20130131	14:04:46	22.31	K	100
43401	GE	20130131	14:04:46	22.3	D	600
43402	GE	20130131	14:04:46	22.31	K	100
43403	GE	20130131	14:04:46	22.31	K	100
43404	GE	20130131	14:04:46	22.31	K	100
43405	GE	20130131	14:04:46	22.31	K	400
43406	GE	20130131	14:04:46	22.31	K	100
43407	GE	20130131	14:04:46	22.31	K	100
43408	GE	20130131	14:04:46	22.305	D	100
43409	GE	20130131	14:04:46	22.31	K	100
43410	GE	20130131	14:04:46	22.31	K	100
43411	GE	20130131	14:04:46	22.31	K	100
43412	GE	20130131	14:04:46	22.31	K	200
43413	GE	20130131	14:04:46	22.31	C	100
43414	GE	20130131	14:04:46	22.31	C	500
43415	GE	20130131	14:04:46	22.31	K	200
43416	GE	20130131	14:04:47	22.3	D	1000
43417	GE	20130131	14:04:53	22.305	D	100
43418	GE	20130131	14:04:53	22.305	D	100
43419	GE	20130131	14:04:53	22.305	D	450
43420	GE	20130131	14:04:55	22.3	W	600
43421	GE	20130131	14:04:58	22.3	D	200
43422	GE	20130131	14:05:05	22.3	Z	800
43423	GE	20130131	14:05:05	22.3	Z	300
43424	GE	20130131	14:05:05	22.3	Z	500
43425	GE	20130131	14:05:05	22.305	D	100
43426	GE	20130131	14:05:07	22.3	N	200
43427	GE	20130131	14:05:09	22.3055	D	100
43428	GE	20130131	14:05:10	22.3	B	100
43429	GE	20130131	14:05:10	22.3	B	100
43430	GE	20130131	14:05:10	22.3	B	100
43431	GE	20130131	14:05:10	22.3	J	200
43432	GE	20130131	14:05:10	22.3	W	100

Return of S&P500 as of Function of Policy Surprises



- Negative relationship between stock returns and monetary policy surprises on average
- *Anything goes* on unscheduled policy decisions

Baseline Results

$$R^2_{it} = b_0 + b_1 \times v_t^2 + b_2 \times \lambda_i \times v_t^2 + b_3 \times \lambda_i + \varepsilon_{it}$$

	Baseline (Tight Window)		(Wide Window)	
	All obs.	No outliers	All obs.	No outliers
	(1)	(2)	(3)	(4)
v_t^2	128.50***	76.95***	119.60***	95.38***
	(23.05)	(15.25)	(30.71)	(20.87)
$\lambda_i \times v_t^2$	−169.8 * *	−67.26***	−130.40*	−78.07***
	(78.50)	(5.33)	(67.08)	(27.67)
λ_i	0.41	0.09	0.55	0.08
	(0.34)	(0.18)	(0.68)	(0.22)
# Obs	57,541	57,441	57,541	55,022
R^2	0.12	0.12	0.03	0.09

- 25 bps monetary policy surprise leads to increase in squared returns of $8\%^2$ for the most sticky firms ($0.25^2 \times 128.50 = 8.03$)
- Effect reduced by factor of 3 for firms with most flexible prices: $(b_1 - 0.5 \times b_2)/b_1 \approx 1/3$

Robustness: Fama&French Adjusted Returns

$$R_{it}^2 = b_0 + b_1 \times v_t^2 + b_2 \times \lambda_i \times v_t^2 + b_3 \times \lambda_i + \varepsilon_{it}$$

	Baseline (Tight Window)		Fama&French adjusted Returns	
	All obs. (1)	No outliers (2)	All obs. (3)	No outliers (4)
v_t^2	128.50***	76.95***	38.29***	25.80***
	(23.05)	(15.25)	(6.05)	(3.68)
$\lambda_i \times v_t^2$	−169.8 **	−67.26***	−42.57 **	−22.52***
	(78.50)	(5.33)	(18.79)	(3.61)
λ_i	0.41	0.09	0.05	−0.12
	(0.34)	(0.18)	(0.23)	(0.19)
# Obs	57,541	57,441	57,541	57,497
R^2	0.12	0.12	0.02	0.02

Fama&French adjusted Return $= (R_{it} - \sum_k \beta_{ik} FF_{kt})^2$

Robustness: Pre-2007 Sample

$$R_{it}^2 = b_0 + b_1 \times v_t^2 + b_2 \times \lambda_i \times v_t^2 + b_3 \times \lambda_i + \varepsilon_{it}$$

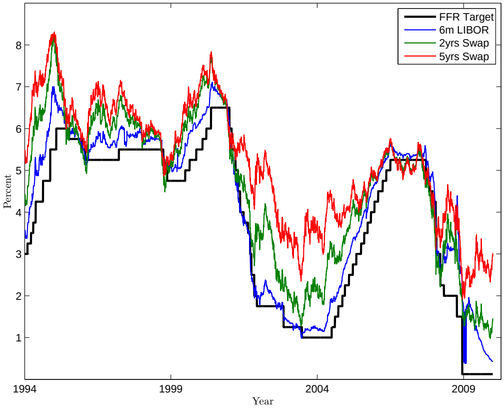
	Baseline (Tight Window)		Pre-2007 Sample	
	All obs. (1)	No outliers (2)	All obs. (3)	No outliers (4)
v_t^2	128.50***	76.95***	123.10***	53.81***
	(23.05)	(15.25)	(38.51)	(4.46)
$\lambda_i \times v_t^2$	−169.8 * *	−67.26***	−245.80***	−77.75***
	(78.50)	(5.33)	(88.51)	(11.83)
λ_i	0.41	0.09	0.54*	0.02
	(0.34)	(0.18)	(0.31)	(0.10)
# Obs	57,541	57,441	45,891	45,775
R^2	0.12	0.12	0.11	0.13

Robustness: Turning Points and Intermeetings

$$R_{it}^2 = b_0 + b_1 \times v_t^2 + b_2 \times \lambda_i \times v_t^2 + b_3 \times \lambda_i + \varepsilon_{it}$$

	Baseline (Tight Window)		All Observations	
			Turning Points	Intermeeting
	All obs.	No outliers		
	(1)	(2)	(3)	(4)
v_t^2	128.50***	76.95***	235.10***	78.25***
	(23.05)	(15.25)	(10.41)	(22.19)
$\lambda_i \times v_t^2$	−169.8 **	−67.26***	−512.20***	−99.31 **
	(78.50)	(5.33)	(26.87)	(32.93)
λ_i	0.41	0.09	5.48*	1.66
	(0.34)	(0.18)	(2.68)	(3.22)
# Obs	57,541	57,441	3,407	3,300
R^2	0.12	0.12	0.15	0.04

Time Series of Interest Rates



- Policy inertia and interest rate smoothing
- Turning points in monetary policy contain valuable information on future policy stance

Robustness: More Controls

$$R_{it}^2 = b_0 + b_1 \times v_t^2 + b_2 \times \lambda_i \times v_t^2 + b_4 \times v_t^2 \times X_{it} + FE_i + \varepsilon_{it}$$

Controls	b_1	b_2	# Obs.
Baselines (no controls)	76.59∗∗∗	−69.05∗∗∗	57,440
	(15.13)	(5.04)	
Concentration Ratio	83.02∗∗∗	−67.94∗∗∗	50,123
	(16.31)	(7.05)	
Std of Sales Growth	57.33∗∗∗	−71.98∗∗∗	51,941
	(11.43)	(8.72)	
Labor Share	83.23∗∗∗	−100.60∗∗∗	15,594
	(7.90)	(28.12)	
ALL controls	−224.90∗∗∗	−112.20∗∗∗	33,067
	(69.66)	(20.76)	

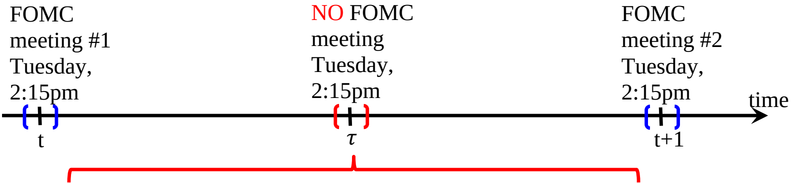
All controls also incl.: Price to cost margin, number of products, sync of prices changes, book to market, size, durability of output, fixed cost to sales, net receivables to sales, ivestment to sales, D&A to sales, credit rating, Kaplan - Zingales index, Engel curve slopes

Robustness: Results by Industry

$$R_{it}^2 = b_0 + b_1 \times v_t^2 + b_2 \times \lambda_i \times v_t^2 + FE_i + \varepsilon_{it}$$

Sector	b_1	b_2	# Obs.
Baselines (all sectors)	76.59***	−69.05***	57,440
	(15.13)	(5.04)	
Agriculture	81.73*	−106.60*	3,629
	(45.87)	(58.58)	
Manufacturing	71.85***	−35.98***	27,887
	(12.33)	(11.55)	
Utilities	73.68***	−125.00***	7,394
	(20.59)	(16.28)	
Trade	74.38***	−54.99*	3,839
	(15.99)	(29.91)	
Finance	86.48***	−20.11	9,836
	(19.15)	(24.98)	
Services	80.15***	33.97	4,815
	(13.78)	(69.23)	

Robustness: Relative Volatilities and Placebo Test



- Calculate event returns in pseudo event window
- Calculate relative volatilities: $\frac{(1+R_{it+1})^2}{(1+R_{i\tau})^2}$

Robustness: Relative Volatilities

$$\frac{(1+R_{it+1})^2}{(1+R_{i\tau})^2} = b_0 + b_1 \times v_t^2 + b_2 \times \lambda_i \times v_t^2 + b_3 \times \lambda_i + Controls + \varepsilon_{it}$$

Controls	b_1	b_2	# Obs.
Baseline	0.57∗∗∗	−1.07∗∗∗	53,682
	(0.08)	(0.19)	
Firm FE	0.57∗∗∗	−1.05∗∗∗	53,682
	(0.07)	(0.17)	
Event FE		−1.06∗∗∗	53,682
		(0.19)	
Firm and Event FE		−1.05∗∗∗	53,682
		(0.17)	

Robustness: Placebo

$$R^2_{i\tau} = b_0 + b_1 \times v^2_{t+1} + b_2 \times \lambda_i \times v^2_{t+1} + b_3 \times \lambda_i + Controls + \varepsilon_{it}$$

Controls	b_1	b_2	# Obs.
Baseline	2.26	5.68	53,262
	(3.79)	(7.60)	
Firm FE	2.33	5.25	53,262
	(3.14)	(6.78)	
Event FE		5.96	53,262
		(7.83)	
Firm and Event FE		5.51	53,262
		(6.83)	

Dynamic General Equilibrium Model

- Carvalho (BE Macro Advances, 2006) model:
  - Mutliple sectors (5 in calibration)
  - Continuum of firms in each sector (100 in calibration)
  - Sectors k differ in Calvo rate of price adjustment λ_k
  - Monopolistic Competions (CES aggregator)
  - Linear production function in labor
  - Taylor rule
  - Monetary shocks are only source of variation
- Derive firm valuations as function of firm's price
- Calibrate and simulate model at quarterly frequency (use 3^{rd} order approximation)

Calibration

Parameter		Value	Source
Frisch	η	2	Ashenfelter et al. (2010)
IES	σ	0.5	standard
Demand Elasticity	θ	7	standard
Discount Factor	β	0.99	standard
Inflation Response	ϕ_{pi}	1.5	Taylor (1993)
Output Gap Response	ϕ_y	0.5/4	Taylor (1993)
Shock Persistence	ρ_{mp}	0.9	Coibon and Gorodnichenko (2012)
Volatility of Shocks	std_{v_t}	0.0043	Coibon et al. (2012)

Sector k	Share	Frequency of Price Adjustment
1	0.2	0.094
2	0.2	0.164
3	0.2	0.277
4	0.2	0.638
5	0.2	0.985

Regressions on Simulated Data

$$R_{it}^2 = b_0 + b_1 \times v_t^2 + b_2 \times \lambda_i \times v_t^2 + b_3 \times \lambda_i + \varepsilon_{it}$$

	Baseline	Alternative	b_1	b_2	b_3
Baseline			163.2	-178.8	-0.006
IES σ	1/2	1/3	117.0	-118.2	-0.004
Frisch η	2	1	348.8	-401.5	-0.011
Demand Elasticity θ	7	6	81.7	-77.5	-0.003
Taylor Rule Parameters					
ϕ_π	1.5	2	85.7	-98.3	-0.003
ϕ_y	0.5/4	0.75/4	181.7	-203.7	-0.007
ρ_{mp}	0.9	0.91	321.2	-378.6	-0.011
$std(v_t)$	0.0043	0.004	143.1	-154.8	-0.004

Robustness

- Different measures of price stickiness
- Daily event windows
- Firm and event fixed effects
- Volume weighted returns
- Absolute returns
- Market and CAPM adjusted returns
- Conditioning on change in FFR and excl *small* monetary policy shocks
- Control for return sensitivity to monetary policy surprises
- Baseline regression for changes in profits

Conclusion

- Fundamental questions:
  - Does money matter?
  - Are sticky prices costly?
- Alternative explanations with vastly different normative and positive implications
- New Keynesian Macroeconomics: ”menu“ cost of price adjustment
- Main challenge: ”menu“ costs have different varieties and shapes
- We present robust and model-free evidence that conditional volatility of stock returns is larger for sticky price firms compared to firms with flexible prices — qualitatively and quantitatively consistent with Keynesian interpretation

Profits

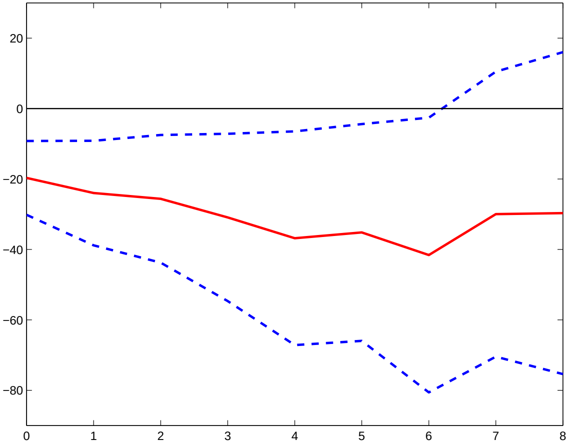
- Returns move differentially in response to monetary policy shocks
- Does it reflect something about current and future profits?
- Main challenge: quarterly frequency of profit data
- Modified monetary policy shocks: $\tilde{v}_t = \left(v_{t,M1} + v_{t,M2} + v_{t,M3}\right)$ is quarterly sum of monetary policy shocks
- Profits: $$\Delta\pi_{it,H} = \frac{\frac{1}{4}\sum_{s=t+H}^{t+H+3} OI_{is} - \frac{1}{4}\sum_{s=t-4}^{t-1} OI_{is}}{TA_i t - 1} \times 100$$

  where OI is quarterly operating income before depreciation, TA is total assets
- Modified empirical specification:

$$(\Delta\pi_{it,H})^2 = b_{0,H} + b_{1,H} \times \tilde{v}_t{}^2 + b_{2,H} \times \lambda_i \times \tilde{v}_t{}^2 + b_{3,H} \times \lambda_i + \varepsilon_{it}$$

Profits cont.

$$(\Delta\pi_{it,H})^2 = b_{0,H} + b_{1,H} \times \tilde{v}_t^2 + b_{2,H} \times \lambda_i \times \tilde{v}_t^2 + b_{3,H} \times \lambda_i + \varepsilon_{it}$$



Baseline Results cont.

$$R_{it}^2 = b_0 + b_1 \times v_t^2 + b_2 \times \lambda_i \times v_t^2 + b_3 \times \lambda_i + \varepsilon_{it}$$

	Baseline (Tight Window)		Firm Fixed Effects	
	All obs. (1)	No outliers (2)	All obs. (3)	No outliers (4)
v_t^2	128.50***	76.95***	127.50***	76.59***
	(23.05)	(15.25)	(22.80)	(15.13)
$\lambda_i \times v_t^2$	−169.8 **	−67.26***	−168.00 **	−69.05***
	(78.50)	(5.33)	(75.55)	(5.04)
λ_i	0.41	0.09		
	(0.34)	(0.18)		
# Obs	57,541	57,441	57,541	57,440
R^2	0.12	0.12		

Baseline Results cont.

$$R^2_{it} = b_0 + b_1 \times v^2_t + b_2 \times \lambda_i \times v^2_t + b_3 \times \lambda_i + \varepsilon_{it}$$

	Baseline (Tight Window)		Firm and Time Fixed Effects	
	All obs. (1)	No outliers (2)	All obs. (3)	No outliers (4)
v^2_t	128.50***	76.95***		
	(23.05)	(15.25)		
$\lambda_i \times v^2_t$	−169.8 **	−67.26***	−166.60 **	−41.33 **
	(78.50)	(5.33)	(76.18)	(5.89)
λ_i	0.41	0.09		
	(0.34)	(0.18)		
# Obs	57,541	57,441	57,541	57,420
R^2	0.12	0.12		

Baseline Results cont.

$$R_{it}^2 = b_0 + b_1 \times v_t^2 + b_2 \times \lambda_i \times v_t^2 + b_3 \times \lambda_i + \varepsilon_{it}$$

	Baseline (Tight Window)		Volume Weighted	
	All obs. (1)	No outliers (2)	All obs. (3)	No outliers (4)
v_t^2	128.50∗∗∗	76.95∗∗∗	144.50∗∗∗	86.42 ∗ ∗
	(23.05)	(15.25)	(34.71)	(14.39)
$\lambda_i \times v_t^2$	−169.8 ∗ ∗	−67.26∗∗∗	−205.90∗	−64.59∗∗∗
	(78.50)	(5.33)	(110.20)	(24.52)
λ_i	0.41	0.09	0.82	0.45
	(0.34)	(0.18)	(0.68)	(0.58)
# Obs	57,541	57,441	55,065	54,996
R^2	0.12	0.12	0.06	0.04

Baseline Results cont.

$$R_{it}^2 = b_0 + b_1 \times v_t^2 + b_2 \times \lambda_i \times v_t^2 + b_3 \lambda_i + \varepsilon_{it}$$

	Baseline (Tight Window)		Daily Window	
	All obs. (1)	No outliers (2)	All obs. (3)	No outliers (4)
v_t^2	128.50***	76.95***	245.60 **	158.40 **
	(23.05)	(15.25)	(118.70)	(74.82)
$\lambda_i \times v_t^2$	−169.8 **	−67.26***	−340.10	−178.30
	(78.50)	(5.33)	(245.90)	(132.90)
λ_i	0.41	0.09	0.10	−2.27
	(0.34)	(0.18)	(2.83)	(2.56)
# Obs	57,541	57,441	57,541	57,506
R^2	0.12	0.12	0.01	0.00

Robustness: Absolute Returns

$$R_{it}^2 = b_0 + b_1 \times v_t^2 + b_2 \times \lambda_i \times v_t^2 + b_3 \times \lambda_i + \varepsilon_{it}$$

	Baseline (Tight Window)		Absolute returns ($\|R_{it}\|$) and absolute shocks ($\|v_t\|$)	
	All obs. (1)	No outliers (2)	All obs. (3)	No outliers (4)
v_t^2	128.50***	76.95***	6.33***	5.37***
	(23.05)	(15.25)	(1.17)	(1.06)
$\lambda_i \times v_t^2$	−169.8 **	−67.26***	−4.11*	−2.84***
	(78.50)	(5.33)	(2.20)	(0.83)
λ_i	0.41	0.09	0.11	0.06
	(0.34)	(0.18)	(0.07)	(0.04)
# Obs	57,541	57,441	57,541	57,426
R^2	0.12	0.12	0.21	0.19

Robustness: Market Adjusted Returns

$$R_{it}^2 = b_0 + b_1 \times v_t^2 + b_2 \times \lambda_i \times v_t^2 + b_3 \times \lambda_i + \varepsilon_{it}$$

	Baseline (Tight Window)		Market adjusted Returns	
	All obs. (1)	No outliers (2)	All obs. (3)	No outliers (4)
v_t^2	128.50***	76.95***	47.76***	25.40***
	(23.05)	(15.25)	(17.05)	(7.27)
$\lambda_i \times v_t^2$	−169.8 **	−67.26***	−71.52 **	−13.20***
	(78.50)	(5.33)	(30.70)	(1.95)
λ_i	0.41	0.09	0.05	−0.12
	(0.34)	(0.18)	(0.23)	(0.19)
# Obs	57,541	57,441	57,541	57,492
R^2	0.12	0.12	0.03	0.03

$$\text{Market adjusted Return} = (R_{it} - R_t^{SP})^2$$

Robustness: CAPM Adjusted Returns

$$R_{it}^2 = b_0 + b_1 \times v_t^2 + b_2 \times \lambda_i \times v_t^2 + b_3 \times \lambda_i + \varepsilon_{it}$$

	Baseline (Tight Window)		CAPM adjusted Returns	
	All obs.	No outliers	All obs.	No outliers
	(1)	(2)	(3)	(4)
v_t^2	128.50***	76.95***	43.80***	27.71***
	(23.05)	(15.25)	(8.87)	(5.32)
$\lambda_i \times v_t^2$	−169.8 **	−67.26***	−52.96***	−18.35***
	(78.50)	(5.33)	(15.99)	(5.32)
λ_i	0.41	0.09	−0.12	−0.23
	(0.34)	(0.18)	(0.22)	(0.21)
# Obs	57,541	57,441	57,541	57,491
R^2	0.12	0.12	0.03	0.03

$$\text{CAPM adjusted Return} = (R_{it} - \beta_i R_t^{SP})^2$$