

Financial Heterogeneity and the Investment Channel of Monetary Transmission

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Motivation

- **Aggregate investment** central to monetary transmission
- **Financial frictions** potentially impede firms investment decisions
 - Rich **heterogeneity** in financial positions across firms

Motivation

- **Aggregate investment** central to monetary transmission
- **Financial frictions** potentially impede firms investment decisions
 - Rich **heterogeneity** in financial positions across firms
- What is the role of financial heterogeneity in monetary transmission?
 1. Does effect of monetary policy depend on firms' **financial position**?
 2. What are the implications for **aggregate transmission**?

Our Contributions

1. Does effect of monetary policy depend on firms' financial position?
 - Combine **high-frequency** identified shocks with quarterly **Compustat**
 - Firms with **low debt** are **more responsive** to shocks
 - 50% least indebted account for nearly all of aggregated response
 - Additional facts
 1. Differences driven by **short term debt**
 2. Differences driven by effect of monetary policy on **current rates**
 3. Also see differences in **stock returns**

Our Contributions

1. Does effect of monetary policy depend on firms' financial position?
2. Implications for aggregate transmission mechanism?
 - Develop NK model w/ heterogeneous firms + financial frictions
 - Model consistent with micro evidence
 - Low-debt firms respond through intertemporal substitution
 - High-debt firms dampened by costly external finance
 - Aggregate transmission depends on distribution of net worth
 - Less effective when balance sheets weak
 - Less effective if already tried to stimulate

Related Literature

1. [The Investment Channel of Monetary Policy](#)

Leeper, Sims and Zha (1996); Fisher (1997); Christiano, Eichenbaum, and Evans (2005)

2. [Financial Frictions and Monetary Transmission](#)

Bernanke and Gertler (1995); Bernanke, Gertler, and Gilchrist (1999); Gertler, and Gilchrist (1994); Kashyap, Lamont, and Stein (1994); Kashyap and Stein (1995)

3. [Heterogeneity and Monetary Policy](#)

Doepke and Schneider (2006); Coibon et al (2012); Auclert (2015); Werning (2015); McKay, Nakamura, Steinsson (2016); Wong (2016); Kaplan, Moll, and Violante (2016); Gilchrist, Schoenle, Sim, and Zakrajsek (2016)

Does effect of monetary policy
depend on firms' financial
position?

Data

1. Monetary policy shocks ε_t^m : high-frequency identification
 - Compare FFR future before vs. after FOMC announcement
 - Assume nothing else affects FFR in window
 - Time aggregate to quarterly frequency [▶ Summary Statistics](#)

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 - Investment $\Delta \log k_{it+1}$: capital stock from perpetual inventory
 - Leverage x_{it} : debt divided by total assets (standardized)

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 - **Investment** $\Delta \log k_{it+1}$: capital stock from perpetual inventory
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Merge 1990q1 - 2007q2

[▶ Summary Statistics](#)

Empirical Strategy

$$\Delta \log k_{it+1} = \alpha_i + \alpha_{st} + \mathbf{\Gamma}' Z_{it} + \beta x_{it-1} \varepsilon_t^m + \varepsilon_{it}$$

- Coefficient β measures slope of investment semi-elasticity w.r.t. leverage
- Want to isolate differences due to leverage
 - α_{st} : compare within narrow sector-quarter
 - Z_{it} : conditional on sales growth, current assets, size, fiscal quarter
- Cluster standard errors at quarter level

High-Leverage Firms Less Responsive to Monetary Shocks

	(1)	(2)	(3)	(4)
leverage × ffr shock	-0.93*** (0.33)	-0.73** (0.29)		
ffr shock				
Observations	233232	233232		
R^2	0.107	0.119		
Firm controls	no	yes		
Time sector FE	yes	yes		
Time clustering	yes	yes		

$$\Delta \log k_{it+1} = \alpha_i + \alpha_{st} + \mathbf{\Gamma}' Z_{it} + \beta x_{it-1} \varepsilon_t^m + \varepsilon_{it}$$

► Extensive Margin

► Inventory Investment

► Pass-Through to Rates

► Net Leverage

► Post 1994

High-Leverage Firms Less Responsive to Monetary Shocks

	(1)	(2)	(3)	(4)
leverage $\times$ ffr shock	-0.93*** (0.33)	-0.73** (0.29)	-0.74** (0.30)	-0.74*** (0.20)
ffr shock			1.38 (0.99)	1.38*** (0.20)
Observations	233232	233232	233232	233232
R^2	0.107	0.119	0.104	0.104
Firm controls	no	yes	yes	yes
Time sector FE	yes	yes	no	no
Time clustering	yes	yes	yes	no

$$\Delta \log k_{it+1} = \alpha_i + \Gamma_0' Y_t + \Gamma' Z_{it} + \gamma \varepsilon_t^m + \beta x_{it-1} \varepsilon_t^m + \varepsilon_{it}$$

► Extensive Margin

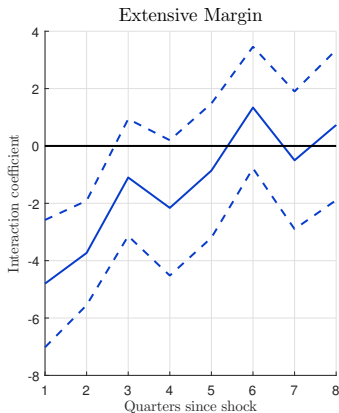
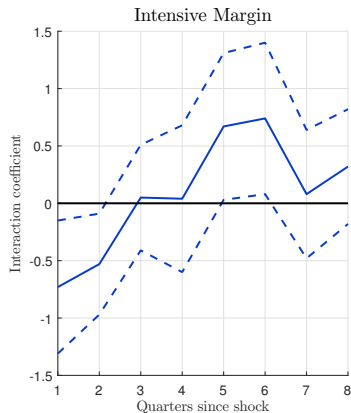
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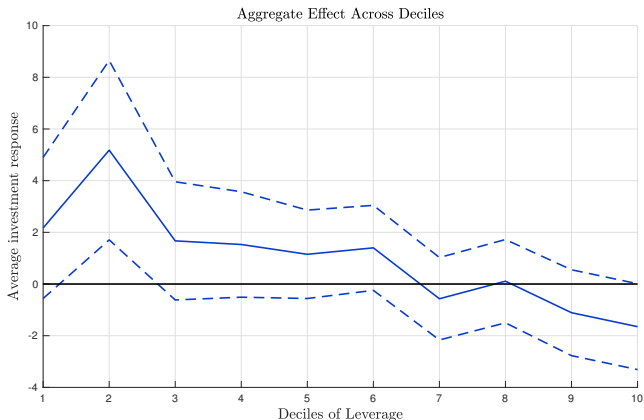
► Post 1994

Differences are Short-Lived



$$\Delta \log k_{it+j} = \alpha_i^j + \alpha_{st}^j + \mathbf{\Gamma}^{j'} Z_{it} + \beta_j x_{it-1} \varepsilon_t^m + \varepsilon_{it}$$

Aggregate Impact of Heterogeneity



- Aggregated by **leverage decile** $\Delta \log K_{jt} = \Gamma_0' Y_t + \beta_j \varepsilon_t^m + \varepsilon_{jt}$
- Bottom 60% account for all of aggregate response

Robustness of Main Result

1. Monetary shocks

- Alternative [time aggregation](#) [▶ Details](#)
- Interaction with other [cyclical variables](#) [▶ Details](#)
- [Instrument real rate](#) with high-frequency shocks [▶ Details](#)

Robustness of Main Result

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2. Leverage

- Interaction with other firm-level [covariates](#) [▶ Details](#)
- [Instrument leverage](#) with past leverage [▶ Details](#)

Additional Facts

- Model: high-leverage firms face stronger **financial frictions**
- Additional facts about this interaction
 1. Differences driven by **short-term debt**
 2. Differences driven by **current rates**
 3. Also see differences in **stock returns**

Differences Driven by Short-Term Debt

Dependent variable: $\Delta \log k_{it+1}$				
	(1)	(2)	(3)	(4)
ST debt $\times$ ffr shock	-0.54** (0.25)		-0.58** (0.25)	
LT debt $\times$ ffr shock		-0.38 (0.27)	-0.43 (0.28)	
leverage $\times$ ffr shock				-0.70** (0.29)
other liab $\times$ ffr shock				-1.39 (1.04)
Observations	233232	233232	233232	233211
R^2	0.118	0.117	0.119	0.119
Firm controls	yes	yes	yes	yes

► Decomposition with Extensive Margin investment

Effect Driven by Current – Not Expected Future – Rates

Dependent variable: $\Delta \log k_{it+1}$		
	(1)	(2)
leverage $\times$ ffr shock	-0.73** (0.29)	
leverage $\times$ target shock		-1.01*** (0.37)
leverage $\times$ path shock		1.35 (1.20)
Observations	233232	227652
R^2	0.119	0.121

$$\Delta \log k_{it+1} = \alpha_i + \alpha_{s,t} + \mathbf{\Gamma}' Z_{it} + \beta_1 x_{it-1} \epsilon_t^{m,target} + \beta_2 x_{it-1} \epsilon_t^{m,path} + \epsilon_{it}$$

$\epsilon_t^{m,target}$ and $\epsilon_t^{m,path}$ following Gurkanyak, Sack, and Swanson (2005)

► Post-1994

► Expansionary vs. Contractionary Shocks

Also Find Differences In Daily Stock Returns

Dependent variable: ΔR_{it+1}				
	(1)	(2)	(3)	(4)
leverage $\times$ ffr shock	-3.93*** (1.42)	-3.93*** (1.42)		
leverage $\times$ target shock			-6.32*** (2.11)	-6.33*** (2.11)
leverage $\times$ path shock			2.01 (2.29)	2.00 (2.29)
Observations	45821	45821	42087	42087
R^2	0.210	0.210	0.193	0.193
Firm Controls	no	yes	no	yes

$$\Delta R_{it+1} = \alpha_i + \alpha_{fq} + \gamma \epsilon_t^m + \beta x_{it-1} \epsilon_t^m + \epsilon_{it}$$

Implications for Aggregate Transmission

Model Overview

Heterogeneous production firms

- Produce and invest subject to financial frictions
- Financial intermediary lends resources from household to firms

New Keynesian block

- Retailers differentiate production firms' output + Calvo sticky prices
- Final good producer combines retailers goods into final output
- Monetary authority follows Taylor rule

Representative household

- Owns firms + labor-leisure choice + complete markets

Production Firms

Enter period with state variables z_{jt} , k_{jt} , and b_{jt}

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2. Production: $y_{jt} = z_{jt} k_{jt}^{\theta} n_{jt}^{\nu}$, $\theta + \nu < 1$

- $\log z_{jt+1} = \rho_z \log z_{jt} + \varepsilon_{jt+1}^z$, $\varepsilon_{jt+1}^z \sim N(0, \sigma_z^2)$
- Sell at relative price p_t

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3. Exogenous exit: w/ i.i.d. prob π_d , forced to exit

Production Firms

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- Sell at relative price p_t

3. **Exogeneous exit**: w/ i.i.d. prob π_d , forced to exit

4. **Investment**: choose k_{jt+1} and financing b_{jt+1} and d_{jt}

- **Debt finance** at price $q_{jt} = q_t(z_{jt}, k_{jt+1}, b_{jt+1})$
- **Equity finance** subject to $d_{jt} \geq 0$

Production Firms

$$v_t^0(z, k, b) = \max\{0, \pi_d v_t^{\text{exit}}(z, k, b) + (1 - \pi_d) v_t^{\text{cont}}(z, k, b)\}$$

Production Firms

$$v_t^0(z, k, b) = \max\{0, \pi_d v_t^{\text{exit}}(z, k, b) + (1 - \pi_d) v_t^{\text{cont}}(z, k, b)\}$$

$$v_t^{\text{exit}}(z, k, b) = \max_n p_t z k^\theta n^\nu - w_t n + (1 - \delta)k - b - \xi$$

$$v_t^{\text{cont}}(z, k, b) = \underbrace{\max_{n, k', b'} p_t z k^\theta n^\nu - w_t n + (1 - \delta)k - b - \xi - k' + q_t(z, k', b')l}_d + \beta \mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} v_{t+1}^0(z', k', b') \right] \quad \text{such that } d \geq 0$$

Financial Intermediary and New Entrants

- Risk-neutral financial intermediary lends from households to firms
 - If firm defaults, can recover up to αk_{jt+1} , $\alpha =$ recovery rate

$$q_t(z, k', b') = \beta \mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} (1 - \text{Prob}(v_{t+1}^0(z', k', b') = 0) \times (1 - \min\{1, \alpha \frac{k'}{b'}\})) \right]$$

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- Each period, constant mass π_e of **new entrants**
 1. Draw productivity z_{jt} from ergodic distribution
 2. Endowed with k_0 and b_0

$$\implies v_t^0(z_{jt}, k_0, b_0)$$

Retailers and Final Good Producer

- Monopolistically competitive **retailers**
 - Technology: $q_{it} = y_{it} \implies \text{marginal cost} = p_t$
 - Can reset price w/ i.i.d. probability $1 - \varphi$
- Perfectly competitive **final good producer**
 - Technology: $Y_t = \left(\int q_{it}^{\frac{\gamma-1}{\gamma}} di \right)^{\frac{\gamma}{\gamma-1}} \implies P_t = \left(\int p_{it}^{1-\gamma} di \right)^{\frac{1}{1-\gamma}}$

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- Implies **New Keynesian Phillips Curve**

$$\pi_t \approx \kappa Y_t p_t + \beta \varphi \mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} \pi_{t+1} \right]$$

Monetary Authority and Household

- Monetary authority follows Taylor rule

$$\log R_t^{\text{nom}} = \log \frac{1}{\beta} + \varphi_{\pi} \log(1 + \pi_t) + \varepsilon_t^m$$

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$$\log R_t^{\text{nom}} = \log \frac{1}{\beta} + \varphi_{\pi} \log(1 + \pi_t) + \varepsilon_t^m$$

- Representative household with preferences

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t (\log C_t - \psi N_t)$$

- Labor-leisure choice $\implies w_t C_t^{-1} = \psi$
- Complete markets $\implies \lambda_t = C_t^{-1}$

Equilibrium and Solution Method

- An **equilibrium** of this model satisfies
 1. **Production firms** choose investment $k'_t(z, k, b)$, financing $b'_t(z, k, b)$, and default decision
 2. **Financial intermediaries** price default risk $q_t(z, k', b')$
 3. **Retailers and final good producers** generate NK Phillips Curve
 4. **Monetary authority** follows Taylor rule
$$\log R_t^{\text{nom}} = \log \frac{1}{\bar{\beta}} + \varphi_{\pi} \log(1 + \pi_t) + \varepsilon_t^m$$
 5. **Household** chooses labor supply N_t and generates SDF w/ λ_t

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 5. **Household** chooses labor supply N_t and generates SDF w/ λ_t
- Compute **steady state** with no aggregate risk
- Compute **perfect foresight transition path** following $\varepsilon_0^m = -0.0025$

Fixed Parameters

Parameter	Description	Value
Household		
β	Discount rate	0.99
Firms		
θ	Labor coefficient	0.64
ν	Capital coefficient	0.21
δ	Depreciation	0.03
b_0	Initial debt	0
New Keynesian Block		
γ	Demand elasticity	10
φ_π	Taylor rule coefficient	1.25
φ	Prob keep price	0.25

Parameters to be Computed

Parameter	Description	Value
Productivity process		
ρ_z	Persistence	
σ_z	SD of innovations	
Financial frictions		
ξ	Operating cost	
α	Loan recovery rate	
Firm lifecycle		
k_0	Initial capital	
π_d	Exogenous exit rate	

Choose labor disutility Ψ to ensure steady state employment = 0.6

Choose entry rate π_e to ensure steady state mass of firms = 1

Targets

- [Investment](#): balanced panel from LRD (Cooper and Haltiwanger 2006)

Moment	Description	Data	Model
$\mathbb{E} \left[\frac{i}{k} \right]$	Mean investment rate (annual)	12.2%	
$\sigma \left(\frac{i}{k} \right)$	SD investment rate (annual)	33.7%	

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- **Financial**: aggregate data (Bernanke, Gertler, and Gilchrist 1999)

Moment	Description	Data	Model
$\mathbb{E} [\text{default rate}]$	Mean default rate (annual)	3%	
$\frac{B}{K}$	Agg debt to capital ratio	0.5	

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- **Entry and exit:** business dynamics statistics (Khan, Seng, and Thomas 2016)

Moment	Description	Data	Model
$\mathbb{E} [\text{exit rate}]$	Mean exit rate (annual)	10%	
$k_0 / \mathbb{E} [k - b]$	Avg size of new entrants	28.5%	

Targets

- **Investment**: balanced panel from LRD (Cooper and Haltiwanger 2006)

Moment	Description	Data	Model
$\mathbb{E} \left[\frac{i}{k} \right]$	Mean investment rate (annual)	12.2%	9.8%
$\sigma \left(\frac{i}{k} \right)$	SD investment rate (annual)	33.7%	32.0%

- **Financial**: aggregate data (Bernanke, Gertler, and Gilchrist 1999)

Moment	Description	Data	Model
$\mathbb{E} [\text{default rate}]$	Mean default rate (annual)	3%	3.01%
$\frac{B}{K}$	Agg debt to capital ratio	0.5	0.52

- **Entry and exit**: business dynamics statistics (Khan, Seng, and Thomas 2016)

Moment	Description	Data	Model
$\mathbb{E} [\text{exit rate}]$	Mean exit rate (annual)	10%	10.1%
$k_0 / \mathbb{E} [k - b]$	Avg size of new entrants	28.5%	20.7%

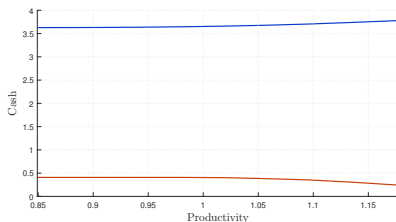
Parameters to be Computed

Parameter	Description	Value
Productivity process		
ρ_z	Persistence	0.9
σ_z	SD of innovations	0.0285
Financial frictions		
ξ	Operating cost	0.0748
α	Loan recovery rate	0.16
Firm lifecycle		
k_0	Initial capital	0.412
π_d	Exogenous exit rate	0.0215

Choose labor disutility Ψ to ensure steady state employment = 0.6

Choose entry rate π_e to ensure steady state mass of firms = 1

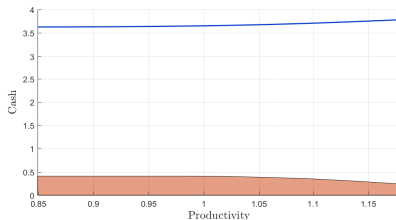
Individual Firm Decisions



- Collapse individual state variables (k, b) into **cash-on-hand**

$$x = \max_n p_t z k^\theta n^\nu - w_t n + (1 - \delta)k - b - \xi$$

Individual Firm Decisions

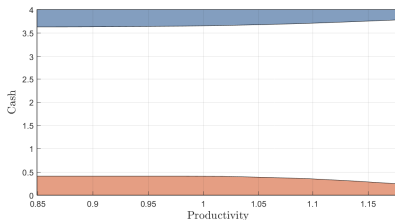


- **Default** if no feasible choice (k', b') such that

$$d = x + q_t(z, k', b')b' \geq 0$$

- Default if $x < \underline{x}(z)$

Individual Firm Decisions

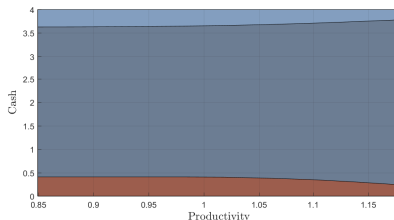


- **Unconstrained** if can invest $k_t^*(z)$ without default risk

$$k' = k_t^*(z) \quad b' \text{ and } d \text{ indeterminate}$$

- Unconstrained if $x > \bar{x}(z)$

Individual Firm Decisions



- For $x \in [\underline{x}(z), \bar{x}(z)]$, firms are constrained

$$k' = x + q_t(z, k', b')b'$$

► Debt Price Schedule

► Policy Rules

Firm-Level Response to Monetary Policy

- Unconstrained firms

$$k' \propto \left(\frac{p_{t+1}^{\frac{1}{1-\nu}} w_{t+1}^{-\frac{\nu}{1-\nu}}}{R_{t+1} - (1 - \delta)} \right)^{\frac{1}{1-\theta}}$$

Firm-Level Response to Monetary Policy

- Unconstrained firms

$$\frac{d \log k'}{d \varepsilon_t^m} = \frac{1}{(1-\theta)(1-\nu)} \left(\frac{d \log p_{t+1}}{d \varepsilon_t^m} - \nu \frac{d \log w_{t+1}}{d \varepsilon_t^m} \right) - \frac{1}{1-\theta} \frac{R_{t+1}}{R_{t+1} - (1-\delta)} \frac{d \log R_{t+1}}{d \varepsilon_t^m}$$

Firm-Level Response to Monetary Policy

- Unconstrained firms

$$\begin{aligned} \frac{d \log k'}{d \varepsilon_t^m} = & \underbrace{\frac{1}{(1-\theta)(1-\nu)} \left(\frac{d \log p_{t+1}}{d \varepsilon_t^m} - \nu \frac{d \log w_{t+1}}{d \varepsilon_t^m} \right)}_{\text{capital revenue} \approx 5\%} \\ & - \underbrace{\frac{1}{1-\theta} \frac{R_{t+1}}{R_{t+1} - (1-\delta)} \frac{d \log R_{t+1}}{d \varepsilon_t^m}}_{\text{intertemporal substitution} \approx 95\%} \end{aligned}$$

Firm-Level Response to Monetary Policy

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- Constrained firms

$$k' = x + q_t(z, k', b')b'$$

Firm-Level Response to Monetary Policy

- Unconstrained firms

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- Constrained firms

$$\frac{d \log k'}{d \varepsilon_t^m} = \frac{d \log x}{d \varepsilon_t^m} \frac{x}{k'} + \frac{d \log q_t(z, k', b') b'}{d \varepsilon_t^m} \frac{q_t(z, k', b') b'}{k'}$$

Firm-Level Response to Monetary Policy

- Unconstrained firms

$$\frac{d \log k'}{d \varepsilon_t^m} = \underbrace{\frac{1}{(1-\theta)(1-\nu)} \left(\frac{d \log p_{t+1}}{d \varepsilon_t^m} - \nu \frac{d \log w_{t+1}}{d \varepsilon_t^m} \right)}_{\text{capital revenue} \approx 5\%} - \underbrace{\frac{1}{1-\theta} \frac{R_{t+1}}{R_{t+1} - (1-\delta)} \frac{d \log R_{t+1}}{d \varepsilon_t^m}}_{\text{intertemporal substitution} \approx 95\%}$$

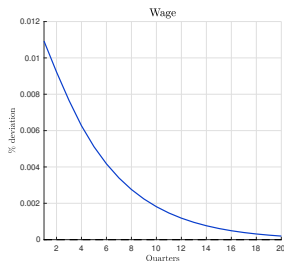
- Constrained firms

$$\frac{d \log k'}{d \varepsilon_t^m} = \underbrace{\frac{d \log x}{d \varepsilon_t^m} \frac{x}{k'}}_{\text{cash flow} > 99\%} + \underbrace{\frac{d \log q_t(z, k', b') b'}{d \varepsilon_t^m} \frac{q_t(z, k', b') b'}{k'}}_{\text{borrowing costs} < 1\%}$$

Distribution of Firm-Level Response to Monetary Policy

$$\frac{d \log k'}{d \varepsilon_t^m} = \underbrace{\frac{d \log x}{d \varepsilon_t^m} \frac{x}{k'}}_{\text{cash flow} > 99\%} + \underbrace{\frac{d \log q_t(z, k', b') b'}{d \varepsilon_t^m} \frac{q_t(z, k', b') b'}{k'}}_{\text{borrowing costs} < 1\%}$$

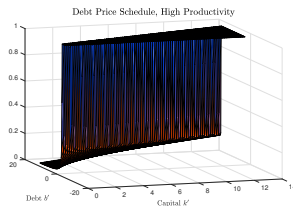
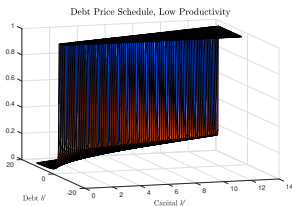
1. Cash-flow effect: $\frac{d \log x}{d \varepsilon_t^m} = \frac{1}{(1-\theta)(1-\nu)} \left(\frac{d \log p_t}{d \varepsilon_t^m} - \nu \frac{d \log w_t}{d \varepsilon_t^m} \right)$



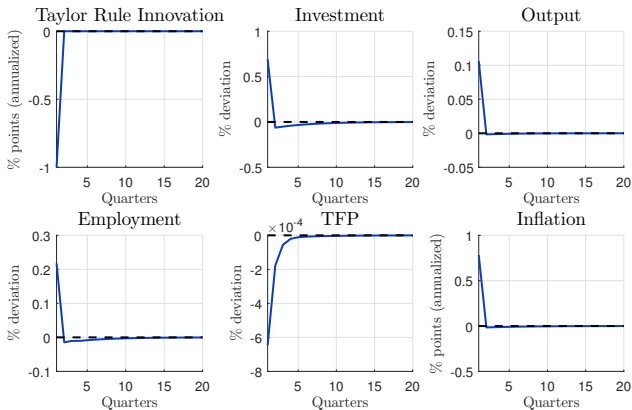
Distribution of Firm-Level Response to Monetary Policy

$$\frac{d \log k'}{d \varepsilon_t^m} = \underbrace{\frac{d \log x}{d \varepsilon_t^m} \frac{x}{k'}}_{\text{cash flow } > 99\%} + \underbrace{\frac{d \log q_t(z, k', b') b'}{d \varepsilon_t^m} \frac{q_t(z, k', b') b'}{k'}}_{\text{borrowing costs } < 1\%}$$

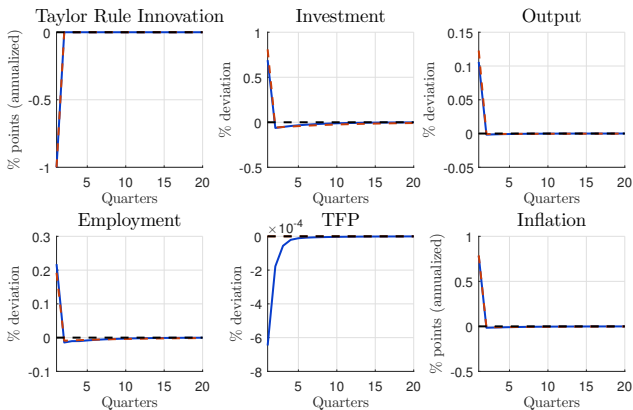
1. **Cash-flow effect:** $\frac{d \log x}{d \varepsilon_t^m} = \frac{1}{(1-\theta)(1-\nu)} \left(\frac{d \log p_t}{d \varepsilon_t^m} - \nu \frac{d \log w_t}{d \varepsilon_t^m} \right)$
2. **Borrowing cost effect:**
 $\frac{d \log q_t(z, k', b') b'}{d \varepsilon_t^m} = -\frac{1}{R_t} \frac{d \log R_t}{d \varepsilon_t^m} + \text{default probs} + \text{new borrowing}$



Aggregate Effect of Monetary Policy

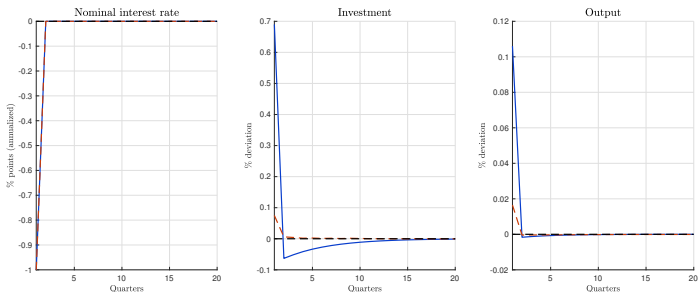


Aggregate Effect of Monetary Policy



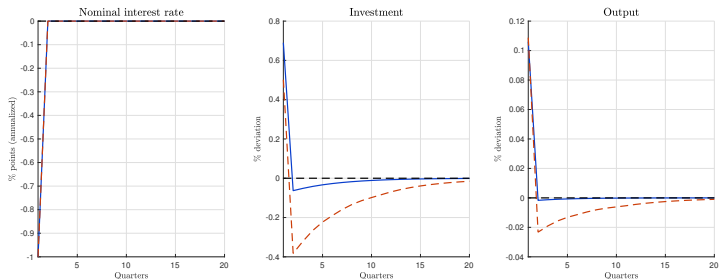
- Full model similar to rep agent benchmark starting from steady state
 - Despite different mechanisms at micro level

Monetary Policy Less Powerful in Recessions



- Response to shock after shifting assets down 10% of mean

Monetary Policy Less Powerful After Previous Stimulus



- Response to shock after previous stimulus $\varepsilon_{-1}^m = -.0075$

Conclusion

1. Does effect of monetary policy depend on firms **financial position**?
 - Yes: firms with **low debt** are **more responsive** to shocks
 - Distributional implications of monetary policy for firms
2. Implications for **aggregate transmission mechanism**?
 - **Depends on distribution** of net worth
 - Tractable model for heterogeneous firms and monetary policy

	high frequency	smoothed	sum
mean	-0.0209	-0.0481	-0.0477
median	0	-0.0124	-0.00536
std	0.0906	0.111	0.132
min	-0.463	-0.480	-0.479
max	0.152	0.235	0.261
num	183	79	80

Summary of Final Sample [▶ Back](#)

	$\Delta \log(k)$	$\mathbb{I}\{\frac{i}{k} > \iota\}$	<i>liquidity</i>	<i>debt</i>
mean	0.00868	0.771	0.270	0.228
median	-0.00132	1	0.264	0.183
std	0.0649	0.420	0.497	0.320
bottom 5%	-0.0690	0	-0.0548	0
top 5%	0.120	1	0.702	0.620

Net Leverage [▶ Back](#)

	(1)	(2)	(3)	(4)
net leverage × ffr shock	-0.89** (0.40)	-0.68** (0.33)	-0.61* (0.33)	-0.61*** (0.19)
ffr shock			1.37 (0.99)	1.37*** (0.20)
Observations	233232	233232	233232	233232
R^2	0.112	0.119	0.104	0.104
Firm controls	no	yes	yes	yes
Time sector FE	yes	yes	no	no
Time clustering	yes	yes	yes	no

$$\Delta \log k_{it+1} = \alpha_i + \alpha_{st} + \mathbf{\Gamma}' Z_{it} + \beta x_{it-1} \varepsilon_t^m + \varepsilon_{it}$$

Extensive Margin Measure of Investment [▶ Back](#)

Dependent variable: $\mathbb{1}\{\frac{i_{it}}{k_{it}} \geq 1\%\}$				
	(1)	(2)	(3)	(4)
leverage $\times$ ffr shock	-5.22*** (1.25)	-4.80*** (1.11)	-4.59*** (1.19)	-4.59*** (0.87)
ffr shock			4.01 (4.41)	4.01*** (0.87)
Observations	233232	233232	233232	233232
R^2	0.213	0.217	0.204	0.204
Firm controls	no	yes	yes	yes
Time sector FE	yes	yes	no	no
Time clustering	yes	yes	yes	no

$$\mathbb{1}\{\frac{i_{it}}{k_{it}} \geq 1\%\} = \alpha_i + \alpha_{st} + \mathbf{\Gamma}'Z_{it} + \beta x_{it-1}\varepsilon_t^m + \varepsilon_{it}$$

Pass-Through to Other Rates [▶ Back](#)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ffr shock	2.22*** (0.31)	2.03*** (0.31)	2.18*** (0.35)	1.99*** (0.28)	2.14*** (0.35)	1.64*** (0.37)	1.63*** (0.32)	1.29*** (0.32)
GDP Growth		3.27* (1.94)				2.92 (1.78)		3.02* (1.61)
CPI Inflation			-1.46 (3.47)			1.08 (3.75)		-1.72 (3.59)
VIX				-0.02*** (0.01)		-0.03*** (0.01)		-0.01*** (0.01)
Unemployment Rate					-7.41* (3.87)	-12.79*** (4.24)		-2.99 (4.16)
$L\Delta R_t$							0.53*** (0.10)	0.45*** (0.11)
Constant	0.03 (0.04)	-0.07 (0.08)	0.07 (0.10)	0.43*** (0.13)	0.43* (0.22)	1.12*** (0.33)	0.03 (0.03)	0.41 (0.29)
Observations	71	71	71	71	71	71	70	70
R^2	0.378	0.398	0.379	0.453	0.404	0.536	0.615	0.662

Dependent variable: $\Delta \log k_{it+1}$				
	(1)	(2)	(3)	(4)
leverage $\times$ ffr shock	-0.52 (0.49)	-0.56 (0.44)	-0.66 (0.45)	-0.66** (0.26)
ffr shock			-0.05 (1.54)	-0.05 (0.29)
Observations	185805	185805	185805	185805
R^2	0.120	0.131	0.116	0.116
Firm controls	no	yes	yes	yes
Time sector FE	yes	yes	no	no
Time clustering	yes	yes	yes	no

Dependent variable: $\mathbb{1}\{\frac{l_{it}}{k_{it}} > 1\%\}$

	(1)	(2)	(3)	(4)
leverage × ffr shock	-2.59 (1.95)	-2.51 (1.79)	-2.63 (1.97)	-2.63** (1.12)
leverage	-0.02*** (0.00)	-0.02*** (0.00)	-0.02*** (0.00)	-0.02*** (0.00)
ffr shock			-2.85 (6.34)	-2.85** (1.26)
Observations	185805	185805	185805	185805
R^2	0.229	0.234	0.219	0.219
Firm controls	no	yes	yes	yes
Time sector FE	yes	yes	no	no
Time clustering	yes	yes	yes	no

Decomposition with Extensive Margin [▶ Back](#)

Dependent variable: $\mathbb{1}\{\frac{i_{it}}{k_{it}} > 1\%\}$

	(1)	(2)	(3)	(4)	(5)
ST debt $\times$ ffr shock	-4.98*** (1.14)		-5.10*** (1.17)		
LT debt $\times$ ffr shock		-1.45 (1.09)	-1.67 (1.09)		
leverage $\times$ ffr shock				-4.74*** (1.13)	
other liab $\times$ ffr shock				-3.54 (2.93)	
Observations	233232	233232	233232	233211	233211
R^2	0.217	0.216	0.217	0.217	0.216
Firm controls	yes	yes	yes	yes	yes

Robustness: Interaction with Cyclical Variables [▶ Back](#)

	Dependent variable: $\Delta \log k_{it+1}$				
	(1)	(2)	(3)	(4)	(5)
leverage $\times$ ffr shock	-0.81*** (0.29)	-0.72** (0.28)	-0.73** (0.29)	-0.87*** (0.29)	-0.95*** (0.30)
leverage $\times$ dlog gdp	-0.05 (0.08)				-0.06 (0.07)
leverage $\times$ dlog cpi		-0.07 (0.09)			-0.07 (0.09)
leverage $\times$ ur			0.00 (0.00)		0.00 (0.00)
leverage $\times$ vix				0.00* (0.00)	0.00* (0.00)
Observations	233232	233232	233232	233232	233232
R^2	0.119	0.119	0.119	0.119	0.119
Firm controls	yes	yes	yes	yes	yes

Robustness: Interaction with Cyclical Variables [▶ Back](#)

	Dependent variable: $\mathbb{1}\{\frac{i_{it}}{k_{it}} > \iota\}$				
	(1)	(2)	(3)	(4)	(5)
leverage $\times$ ffr shock	-4.86*** (1.19)	-4.73*** (1.08)	-4.77*** (1.11)	-5.26*** (1.10)	-5.17*** (1.15)
leverage $\times$ dlog gdp	-0.04 (0.29)				-0.11 (0.28)
leverage $\times$ dlog cpi		-0.54 (0.41)			-0.56 (0.43)
leverage $\times$ ur			-0.00 (0.00)		-0.00 (0.00)
leverage $\times$ vix				0.00 (0.00)	0.00 (0.00)
Observations	233232	233232	233232	233232	233232
R^2	0.217	0.217	0.217	0.217	0.217
Firm controls	yes	yes	yes	yes	yes

Robustness: Interaction with Sales Growth [▶ Back](#)

Dependent variable: $\Delta \log k_{it+1}$				
	(1)	(2)	(3)	(4)
sales_growth $\times$ ffr shock	-0.03 (0.27)	-0.11 (0.26)		
sales_growth $\times$ target shock			-0.12 (0.29)	-0.24 (0.28)
sales_growth $\times$ path shock			-1.61* (0.89)	-1.51* (0.90)
Observations	233232	233232	227652	227652
R^2	0.105	0.106	0.107	0.108
Firm controls	no	yes	no	yes

$$\Delta \log k_{it+1} = \alpha_i + \alpha_{st} + \mathbf{\Gamma}' Z_{it} + \beta y_{it-1} \epsilon_t^m + \epsilon_{it}$$

Robustness: Instrument Leverage [▶ Back](#)

	(1)	(2)
leverage $\times$ ffr shock	-1.02*** (0.24)	-0.61* (0.32)
Observations	230654	225753
Instrument	1q lag	4q lag
Firm controls, Time-Sector FE	yes	yes

Robustness: Instrument Real Rate [▶ Back](#)

	(1)	(2)
leverage $\times$ ffr	-0.33*** (0.07)	-0.26*** (0.07)
Observations	233232	233232
R^2		
Firm controls	no	yes

Robustness: Alternative Time Aggregation [▶ Back](#)

	(1)	(2)	(3)	(4)
leverage $\times$ ffr shock (sum)	-0.89*** (0.33)	-0.79*** (0.28)	-0.79*** (0.29)	-0.79*** (0.17)
ffr shock (sum)			1.02 (0.82)	1.02*** (0.18)
Observations	236296	236296	236296	236296
R^2	0.106	0.118	0.103	0.103
Firm controls	no	yes	yes	yes
Time sector FE	yes	yes	no	no
Time clustering	yes	yes	yes	no

$$\Delta \log k_{it+1} = \alpha_i + \alpha_{st} + \mathbf{\Gamma}' Z_{it} + \beta x_{it-1} \varepsilon_t^m + \varepsilon_{it}$$

Expansionary vs. Contractionary Shocks for Extensive Margin

[▶ Back](#)

Dependent variable: $\mathbb{1}\{\frac{j_{it}}{k_{it}} > 1\%\}$		
	(1)	(2)
leverage $\times$ ffr shock	-4.80*** (1.11)	
leverage $\times$ pos ffr shock		-5.48*** (1.36)
leverage $\times$ neg ffr shock		-1.86 (3.28)
Observations	233232	233232
R^2	0.217	0.217
Firm controls	yes	yes

Expansionary vs. Contractionary Shocks [▶ Back](#)

Dependent variable: $\Delta \log k_{it+1}$		
	(1)	(2)
leverage $\times$ ffr shock	-0.73** (0.29)	
leverage $\times$ pos ffr shock		-0.90** (0.37)
leverage $\times$ neg ffr shock		0.05 (0.75)
Observations	233232	233232
R^2	0.119	0.119
Firm controls	yes	yes

Expansionary vs. Contractionary Shocks [▶ Back](#)

Dependent variable: $\mathbb{1}\{\frac{\dot{l}_{it}}{k_{it}} > 1\%\}$		
	(1)	(2)
leverage $\times$ ffr shock	-4.80*** (1.11)	
leverage $\times$ pos ffr shock		-5.48*** (1.36)
leverage $\times$ neg ffr shock		-1.86 (3.28)
Observations	233232	233232
R^2	0.217	0.217
Firm controls	yes	yes

Path vs. Target Decomposition After 1994 [▶ Back](#)

Dependent variable: $\Delta \log k_{it+1}$			
	(1)	(2)	(3)
leverage $\times$ ffr shock	-0.56 (0.44)		
leverage $\times$ target shock		-1.01 (0.61)	-1.00* (0.54)
leverage $\times$ path shock		1.58 (1.47)	1.67 (1.29)
Observations	185805	180225	180225
R^2	0.131	0.123	0.134
Firm controls	yes	no	yes

Path vs. Target Decomposition After 1994 [▶ Back](#)

	Dependent variable: $\mathbb{1}\left\{\frac{i_{i,t}}{k_{i,t}} > 1\%\right\}$		
	(1)	(2)	(3)
leverage $\times$ ffr shock	-2.51 (1.79)		
leverage $\times$ target shock		-4.99* (2.55)	-4.72* (2.38)
leverage $\times$ path shock		3.61 (5.28)	3.36 (4.95)
Observations	185805	180225	180225
R^2	0.234	0.231	0.236
Firm controls	yes	no	yes

Differences Stronger For Inventory Investment [▶ Back](#)

Dependent variable: $\Delta \log \text{inventories}_{it+1}$

	(1)	(2)	(3)	(4)
leverage $\times$ ffr shock	-2.44** (1.05)	-2.67** (1.07)		
leverage $\times$ target shock			-2.77* (1.55)	-3.19** (1.53)
leverage $\times$ path shock			2.87 (3.71)	2.36 (3.81)
Observations	191889	191889	185253	185253
R^2	0.054	0.056	0.055	0.057
Firm controls	no	yes	no	yes

$$\Delta \log \text{inventories}_{it+1} = \alpha_i + \alpha_{st} + \Gamma' Z_{it} + \beta x_{it-1} \epsilon_t^m + \epsilon_{it}$$

Debt Price Schedule [▶ Back](#)

