Financial Heterogeneity and the Investment Channel of Monetary Policy

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Motivation

- Want to understand the role of financial frictions in shaping the investment channel of monetary policy
- Which firms respond the most to monetary policy?

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- Which firms respond the most to monetary policy?
- Firms more affected by financial frictions:
  - Have steeper marginal cost of investment $\Longrightarrow$ dampen
  - More sensitive to cash flows + collateral values $\Longrightarrow$ amplify (financial accelerator across firms)
- We revisit this question with
  1. New **cross-sectional evidence**
  2. **Heterogeneous firm New Keynesian** model

Our Contributions

Descriptive evidence on heterogeneous responses
using high-frequency shocks and quarterly Compustat

1. Firms with low leverage are more responsive
2. These firms have high credit ratings and "distance to default" which are also associated with more responsive firms

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with financial frictions arising from default risk

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2. Aggregate response depends on distribution of default risk
   - Driven by low-risk firms, which is time-varying

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$\Longrightarrow$ **Default risk dampens response to monetary policy**

Related Literature

1. **Household Heterogeneity and Monetary Policy**
   Doepke and Schneider (2006); Auclert (2015); Werning (2015); Wong (2016); Gornermann, Kuester, Nakajima (2016); Kaplan, Moll, and Violante (2018)

2. **Financial Heterogeneity and Investment**
   Khan and Thomas (2013); Gilchrist, Sim and Zakrajsek (2014); Khan, Senga and Thomas (2016)

3. **Financial Frictions and Monetary Transmission**
   - Gertler, and Gilchrist (1994); Kashyap, Lamont, and Stein (1994); Kashyap and Stein (1995)
   - Bernanke, Gertler, and Gilchrist (1999)

Descriptive Empirical Evidence

Data Sources

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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2. **Firm-level outcomes**: quarterly Compustat
   - Investment $\Delta \log k_{it+1}$: capital stock from net investment
   - Leverage ℓ_{it}: debt divided by total assets

▸ Sample Construction ▸ Summary Statistics ▸ Compustat vs. NIPA

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Merge 1990q1 - 2007q2

Baseline Empirical Specification

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

- Coefficient of interest β: how semi-elasticity of investment w.r.t. monetary policy depends on leverage
- Want to isolate differences due to leverage
  - α_{st}: compare within a sector-quarter
  - Z_{it-1}: conditional on leverage, sales growth, log total assets, current assets share, fiscal quarter dummy
- Standard errors clustered two-way by firm and quarter

Low-Leverage Firms More Responsive

	(1)	(2)	(3)
leverage × ffr shock	-0.93***	-0.73**	
	(0.34)	(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	

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

▸ Extensive Margin ▸ Positive vs. Negative ▸ Path vs. Target ▸ Dynamics

Normalizations:

- Monetary expansion has positive sign ($-\varepsilon_t^m$)
- Standardize leverage over all firms and quarters

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	(1)	(2)	(3)
leverage × ffr shock	-0.93***	-0.73**	-0.74**
	(0.34)	(0.29)	(0.30)
ffr shock			1.38
			(0.99)
Observations	233232	233232	233232
R^2	0.107	0.119	0.104
Firm controls	no	yes	yes
Time sector FE	yes	yes	no
Time clustering	yes	yes	yes

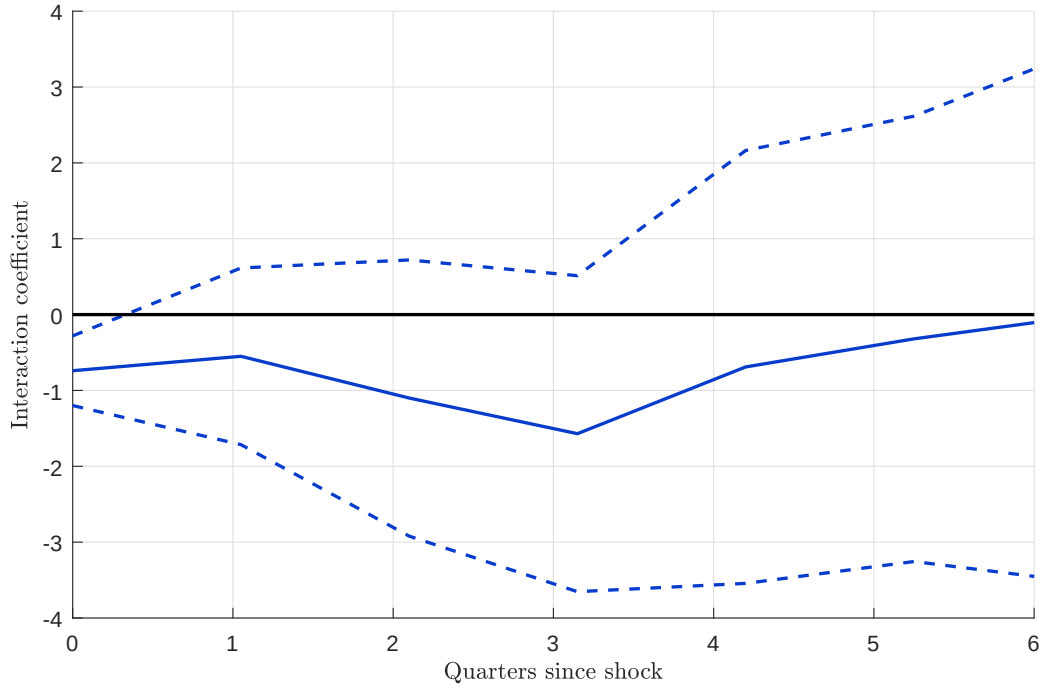
$$\Delta \log k_{it+1} = \gamma \varepsilon_t^m + \beta \ell_{it-1} \varepsilon_t^m + \alpha_i + \Gamma_1' Z_{it-1} + \Gamma_2' Y_t + \varepsilon_{it}$$

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Differences Across Firms Are Short-Lived



$$\log k_{it+h+1} - \log k_{it} = \beta^h \ell_{it-1} \varepsilon_t^m + \alpha_i^h + \alpha_{st}^h + \Gamma^{h\prime} Z_{it-1} + \varepsilon_{it+h}$$

▸ Comparison to Jeenas (2018)

What Drives Heterogeneity in Leverage/Responses?

1. **Heterogeneity in other covariates? No**
   - Not driven by other firm-level covariates, including size ▸ Details
   - Same results instrumenting leverage w/ past leverage ▸ Details

2. **Heterogeneity in collateralizability of assets? No**
   - Results holding using within-firm variation ▸ Details

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2. **Heterogeneity in collateralizability of assets? No**
   - Results holding using within-firm variation ▸ Details

3. **Heterogeneity in default risk? Yes!** ▸ Other Financial Characteristics
   - Low leverage firms have better credit ratings and large distance to default ▸ Details
   - Firms with high ratings or large distance to default are more responsive

Low-Risk Firms More Responsive

	(1)	(2)	(3)	(4)	(5)
leverage × ffr shock	-0.73**				
	(0.29)				
$\mathbb{1}\{\texttt{rating}_{it} \geq AA\}$ × ffr shock		2.50**			
		(1.14)			
dd_{it} × ffr shock			1.56***		
			(0.49)		
Observations	233232	233182	151671		
R^2	0.119	0.119	0.135		
Firm controls	yes	yes	yes		
Time sector FE	yes	yes	yes		
Time clustering	yes	yes	yes		

$$\Delta \log k_{it+1} = \beta_1 \ell_{it-1} \varepsilon_t^m + \beta_2 y_{it-1} \varepsilon_t^m + \alpha_i + \alpha_{st} + \Gamma' Z_{it-1} + \varepsilon_{it}, \quad y_{it} = \mathbb{1}\{\texttt{rating}_{it} \geq AA\} \text{ or } \text{dd}_{it}$$

Normalizations:

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Low-Risk Firms More Responsive

	(1)	(2)	(3)	(4)	(5)
leverage × ffr shock	-0.73**			-0.71**	0.20
	(0.29)			(0.30)	(0.54)
$\mathbb{1}\{\texttt{rating}_{it} \geq AA\}$ × ffr shock		2.50**		2.37**	
		(1.14)		(1.16)	
dd_{it} × ffr shock			1.56***		1.62***
			(0.49)		(0.53)
Observations	233232	233182	151671	233182	151671
R^2	0.119	0.119	0.135	0.119	0.135
Firm controls	yes	yes	yes	yes	yes
Time sector FE	yes	yes	yes	yes	yes
Time clustering	yes	yes	yes	yes	yes

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Robustness of Empirical Results

1. **Monetary policy variable**
   - Interaction with other cyclical variables ▸ Details
   - Instrument user cost with high-frequency shocks ▸ Details
   - Results post 1994 ▸ Details

2. **Leverage variable**
   - Leverage net of current assets ▸ Details
   - Decomposition of leverage ▸ Details

3. **Outcome variable**
   - Stock prices ▸ Details

Heterogeneous Firm New Keynesian Model

Model Overview

1. **Investment block**
   - Heterogeneous firms invest s.t. default risk
   - Intermediary lends resources from household to firms

2. **New Keynesian block**
   - Retailers differentiate output s.t. sticky prices
   - Final good producer combines goods into final output
   - Monetary authority follows Taylor rule (monetary shock)
   - Capital good producer with adjustment costs

3. **Representative household**
   - Owns firms + labor-leisure choice

Heterogeneous Firms

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

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   - If default, value = 0
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3. **Production**: $y_{jt} = z_{jt}(\omega_{jt}k_{jt})^{\theta}n_{jt}^{\nu}$, $\theta + \nu < 1$ at price p_t
   - $\log z_{jt+1} = \rho \log z_{jt} + \varepsilon_{jt+1}^{z}$, $\varepsilon_{jt+1}^{z} \sim N(0, \sigma^2)$
   - $\log \omega_{jt} \sim N(-\sigma_{\omega}^2/2, \sigma_{\omega}^2)$ i.i.d.
     - Undepreciated captial $(1-\delta)\omega_{jt}k_{jt}$

Heterogeneous Firms

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

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   - $\log \omega_{jt} \sim N(-\sigma_{\omega}^2/2, \sigma_{\omega}^2)$ i.i.d.
     - Undepreciated captial $(1-\delta)\omega_{jt}k_{jt}$
4. **Investment**: choose $q_t k_{jt+1}$ and financing b_{jt+1}, d_{jt}
   - External finance b_{jt+1} at price $\mathcal{Q}_t(z_{jt}, k_{jt+1}, b_{jt+1})$
   - Internal finance subject to $d_{jt} \geq 0$

Financial Intermediary

- **Financial intermediary** lends from households to firms
  - No default: get $1/\Pi_{t+1}$ (nominal debt)
  - Default: get up to $\alpha q_{t+1} \omega_{jt+1} k_{jt+1}$ per unit of debt

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$$\mathcal{Q}_t(z,k',b') = \mathbb{E}_t[\Lambda_{t+1}((1 - \mathbb{1}\{\text{default}_{t+1}(z',\omega',\zeta',k',b')\}) \times \frac{1}{\Pi_{t+1}})$$

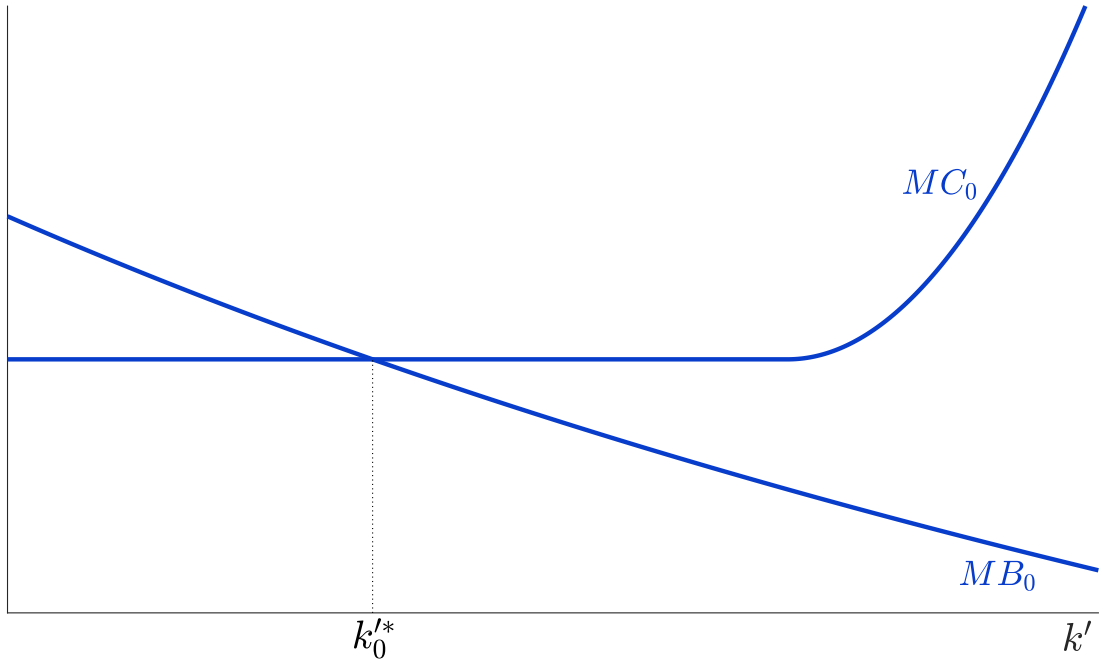
$$+ \mathbb{1}\{\text{default}_{t+1}(z',\omega',\zeta',k',b')\} \times \min\{1, \alpha\frac{q_{t+1}\omega'k'}{b'/\Pi_{t+1}}\})]$$

An Equilibrium of this Model Satisfies

1. **Heterogeneous firms** choose investment $k'_t(z, \omega, k, b)$, financing $b'_t(z, \omega, k, b)$, and default decision
2. **Financial intermediaries** price default risk $\mathcal{Q}_t(z, k', b')$
3. **Firm entry** with shifted initial distribution ▸ Details
4. **Retailers and final good producer** generate Phillips Curve ▸ Details
5. **Monetary authority** follows Taylor rule ▸ Details
6. **Capital good producer** generates capital price q_t ▸ Details
7. **Household** supplies labor N_t and generates SDF w/ Λ_{t+1} ▸ Details

Channels of Investment Response to Monetary Policy

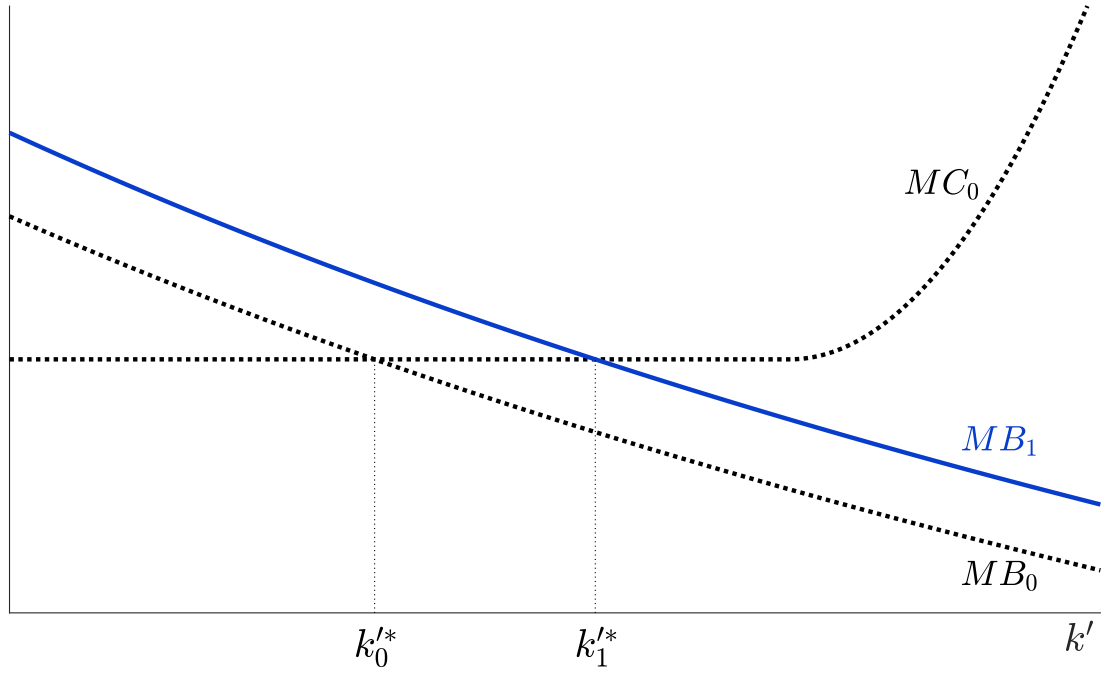
Risk-Free Firms' Response



$$q_t = \frac{1}{R_t}\left(\mathbb{E}_t\left[\text{MRPK}_{t+1}(z', k')\right] + \frac{\mathbb{C}ov_t(\text{MRPK}_{t+1}(z', k'), 1 + \lambda_{t+1}(z', k', b'))}{\mathbb{E}_t[1 + \lambda_{t+1}(z', k', b'))]}\right)$$

$$\text{MRPK}_{t+1}(z', k') = \frac{\partial}{\partial k'}\left(\max_{n'} p_{t+1} z' (\omega' k')^{\theta} (n')^{\nu} - w_{t+1} n' + q_{t+1}(1-\delta)\omega' k'\right)$$

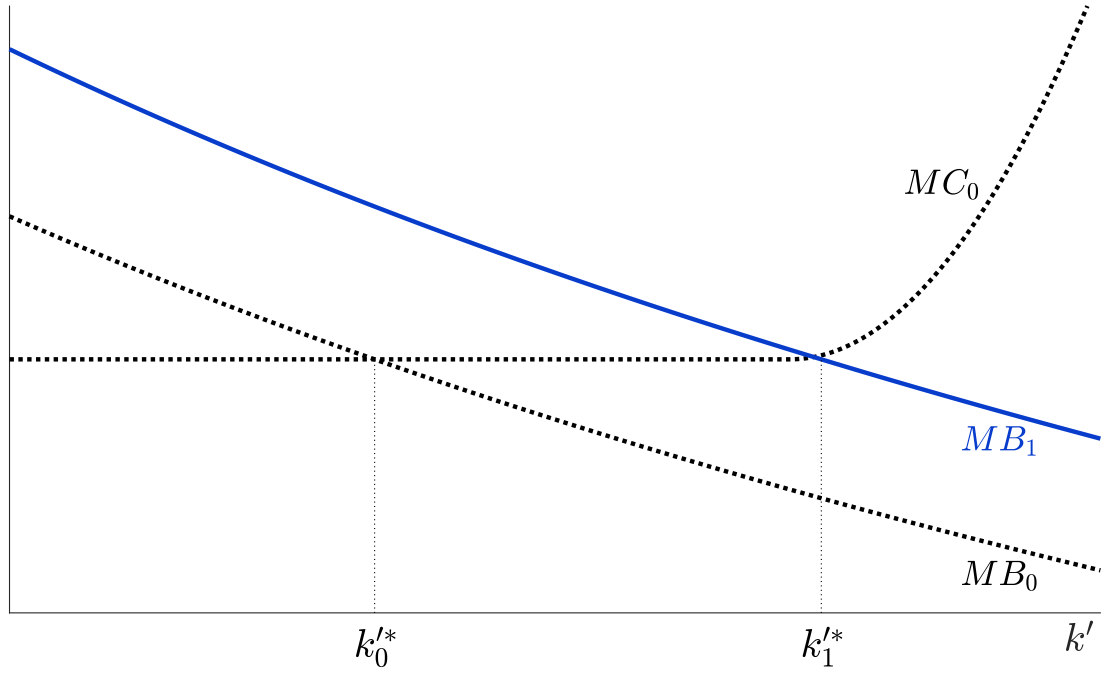
Risk-Free Firms' Response: Discount Rate Falls



$$q_t = \frac{1}{R_t}\left(\mathbb{E}_t\left[\text{MRPK}_{t+1}(z', k')\right] + \frac{\mathbb{C}ov_t(\text{MRPK}_{t+1}(z', k'), 1 + \lambda_{t+1}(z', k', b'))}{\mathbb{E}_t[1 + \lambda_{t+1}(z', k', b'))]}\right)$$

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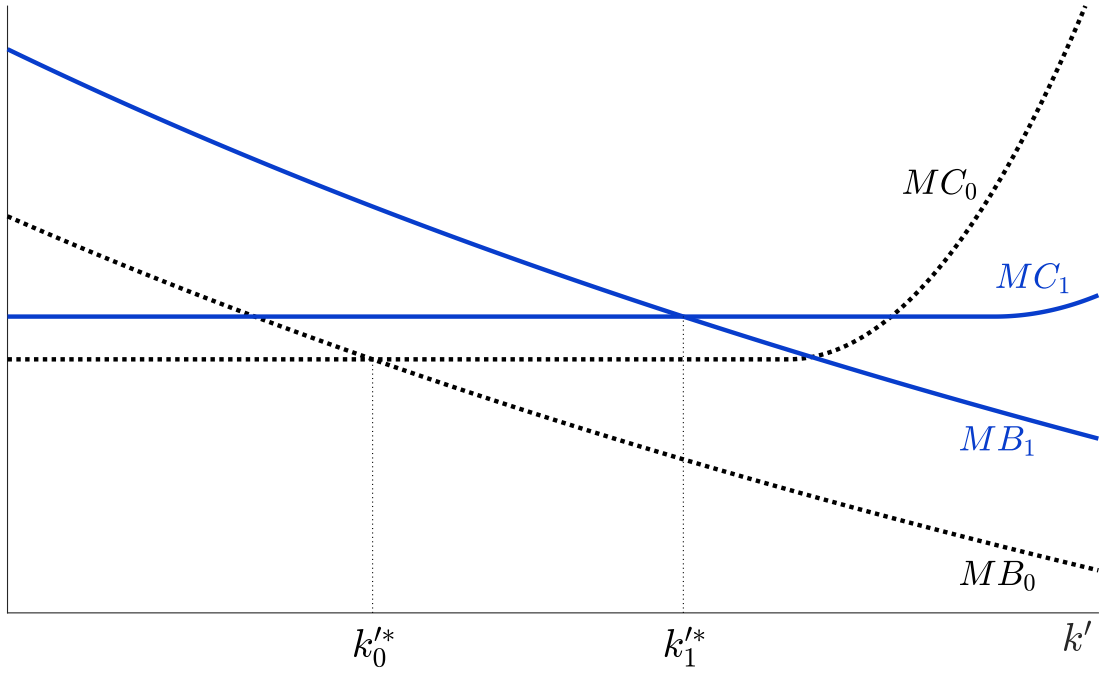
Risk-Free Firms' Response: Future Revenue Rises



$$q_t = \frac{1}{R_t}\left(\mathbb{E}_t\left[\text{MRPK}_{t+1}(z', k')\right] + \frac{\mathbb{C}ov_t(\text{MRPK}_{t+1}(z', k'), 1 + \lambda_{t+1}(z', k', b'))}{\mathbb{E}_t[1 + \lambda_{t+1}(z', k', b'))]}\right)$$

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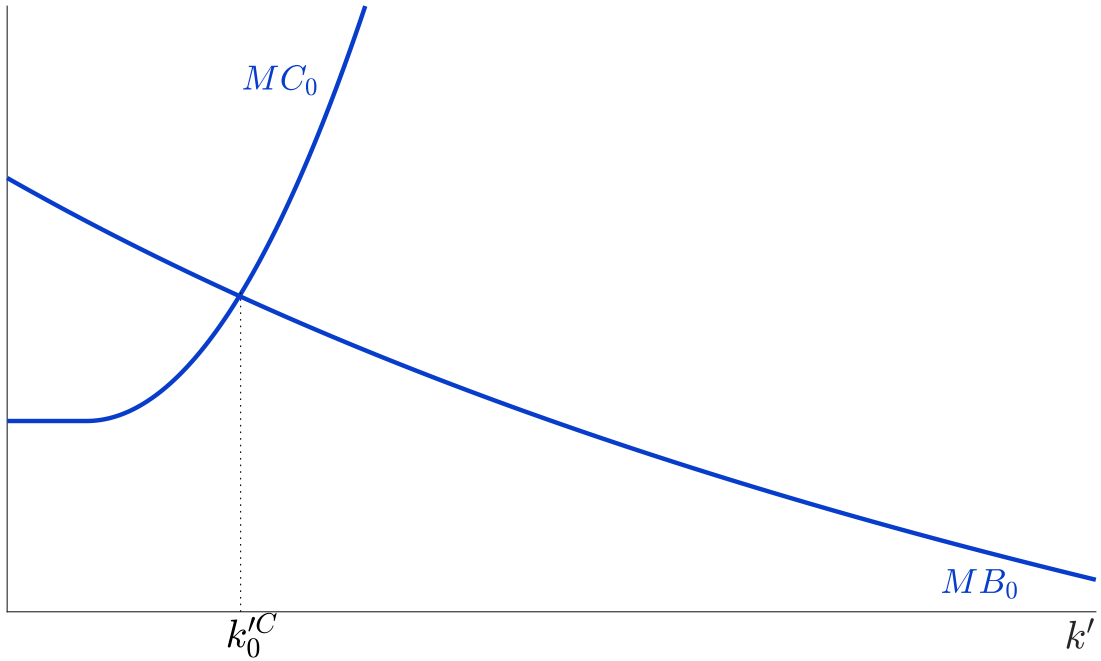
Risk-Free Firms' Response: Price of Capital Rises



$$q_t = \frac{1}{R_t}\left(\mathbb{E}_t\left[\text{MRPK}_{t+1}(z', k')\right] + \frac{\mathbb{C}ov_t(\text{MRPK}_{t+1}(z', k'), 1 + \lambda_{t+1}(z', k', b'))}{\mathbb{E}_t[1 + \lambda_{t+1}(z', k', b'))]}\right)$$

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Risky Firms' Response

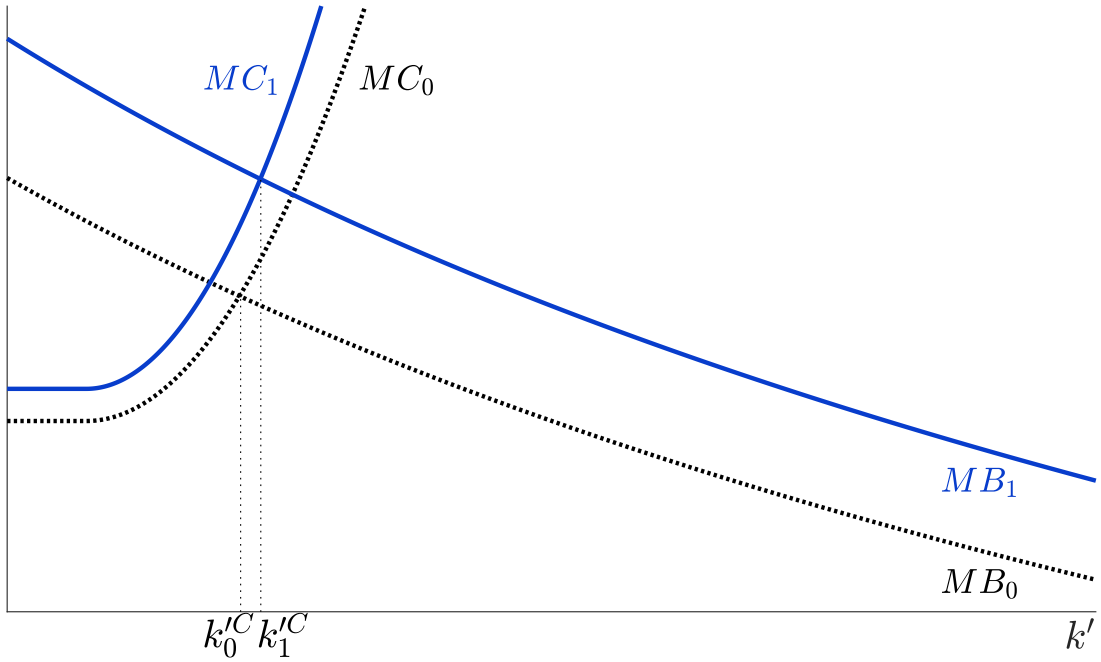


$$\left(q_t - \varepsilon_{R,k'}\frac{b'}{k'}\right)\frac{R_t^{sp}(z,k',b')}{1-\varepsilon_{R,b'}} = \frac{1}{R_t}\left(\mathbb{E}_t\left[\text{MRPK}_{t+1}(z',k')\right] + \frac{\mathbb{C}ov_t(\text{MRPK}_{t+1}(z',k'), 1+\lambda_{t+1}(z',k',b'))}{\mathbb{E}_t[1+\lambda_{t+1}(z',k',b'))]}\right)$$

$$d = 0 \implies q_t k' = \max_n p_t z(\omega k)^\theta n^\nu - w_t n - b - \xi + q_t(1-\delta)\omega k + \frac{1}{R_t(z,k',b')}b'$$

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Risky Firms' Response: Previous Channels

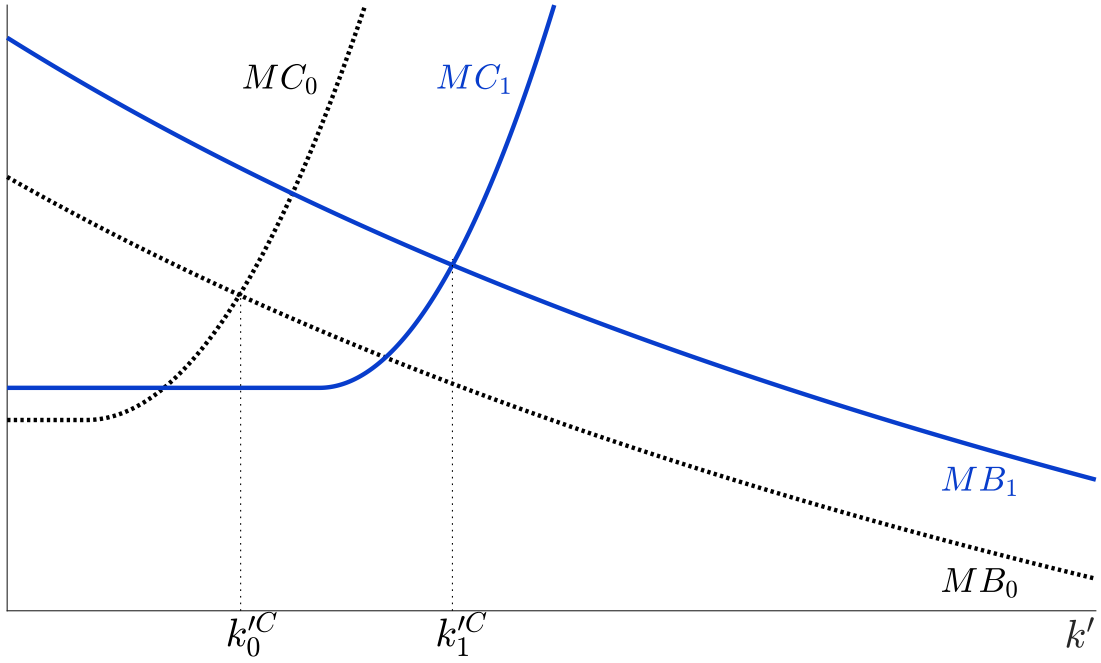


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Risky Firms' Response: Cash Flow Rises

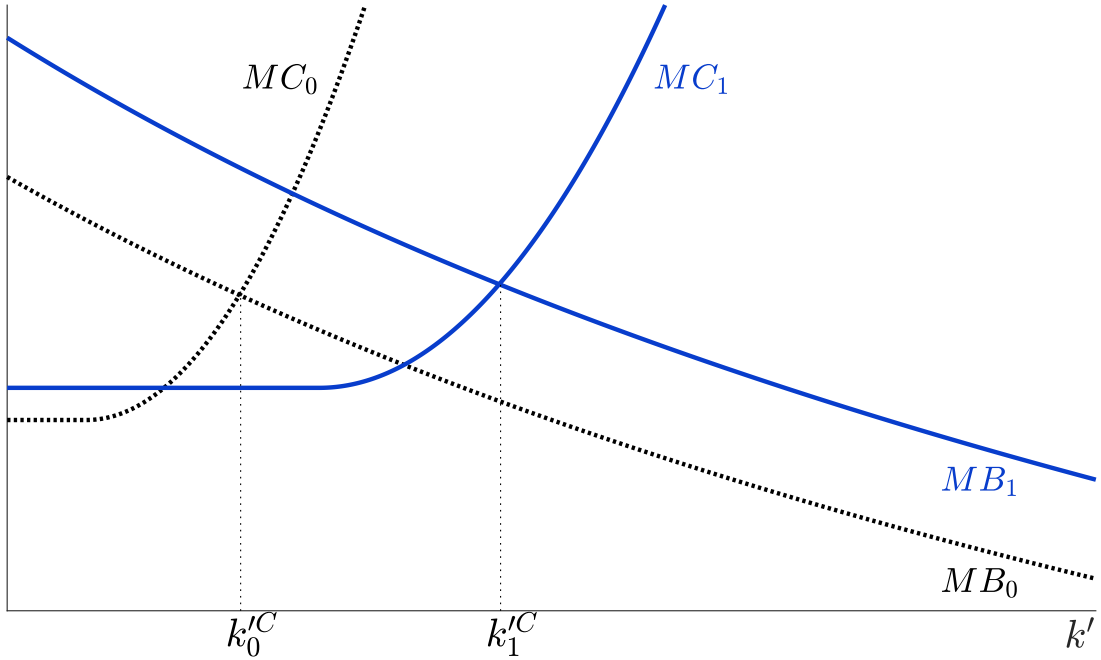


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Risky Firms' Response: Recovery Value Rises

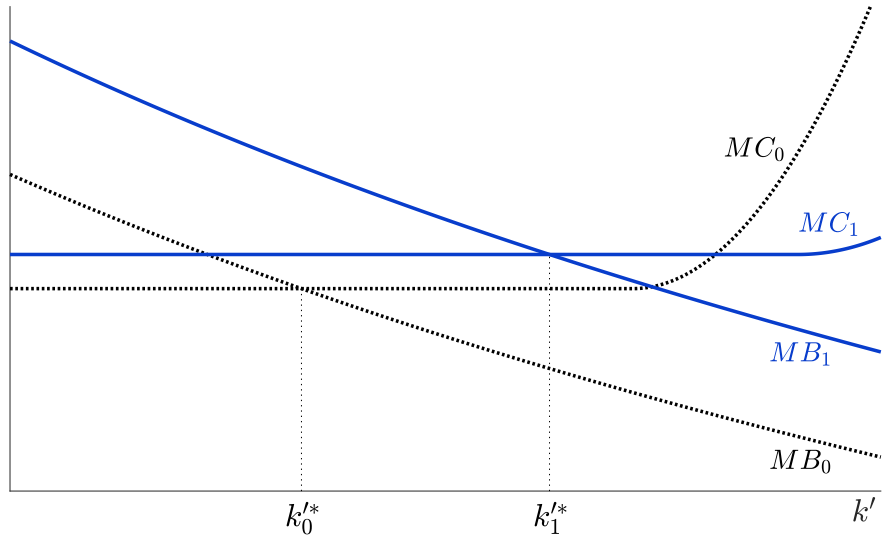


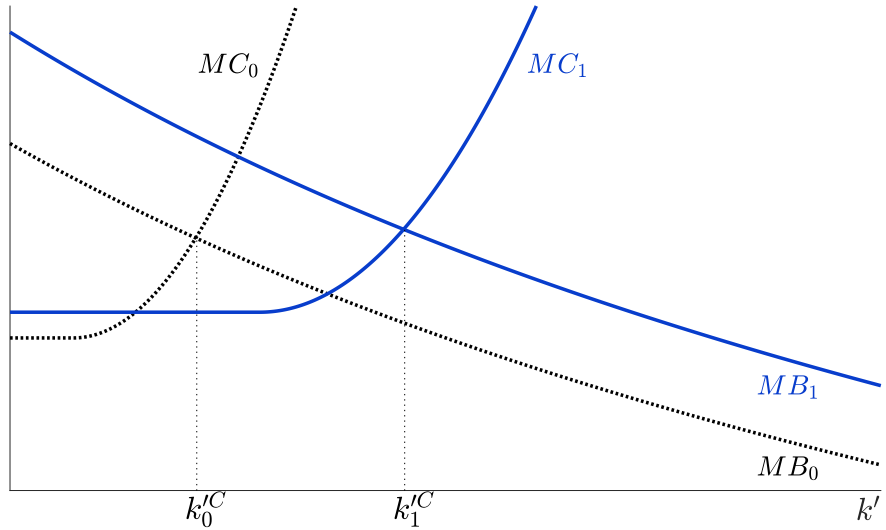
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$$R_t^{sp}(z,k',b') = \text{Prob}\left(\text{default}_{t+1}(z',k',b')\right)\left(1 - \min\{1, \alpha\frac{q_{t+1}\omega' k'}{b'/\Pi_{t+1}}\}\right)$$

Which Is More Responsive? Quantitative Question





Calibration

Overview of Calibration

- **Fix** subset of parameters to standard values Details
- **Choose** parameters governing idiosyncratic shocks, financial frictions, and lifecycle to match empirical targets

Parameters to be Computed

Parameter	Description	Value
Idiosyncratic shock processes		
ρ	Persistence of TFP	
σ	SD of innovations to TFP	
σ_ω	SD of capital quality	
Financial frictions		
ξ	Operating cost	
α	Loan recovery rate	
Firm lifecycle		
m	Mean shift of entrants' prod.	
s	SD shift of entrants' prod.	
k_0	Initial capital	
π_d	Exogeneous exit rate	

Choose labor disutility Ψ to ensure steady state employment = 0.6

Empirical Targets

Moment	Description	Data	Model
Investment behavior (annual)			
$\sigma\left(\frac{i}{k}\right)$	SD investment rate	33.7%	
Financial behavior (annual)			
$\mathbb{E}$ [default rate]	Mean default rate	3.00%	
$\mathbb{E}$ [credit spread]	Mean credit spread	2.35%	
$\mathbb{E}[b/k]$	Mean gross leverage ratio	34.4%	
Firm Growth (annual)			
$\mathbb{E}[n_1]/\mathbb{E}[n]$	Rel. size of age 1 firms	28%	
$\mathbb{E}[n_2]/\mathbb{E}[n]$	Rel. size of age 2 firms	36%	
Firm Exit (annual)			
$\mathbb{E}$ [exit rate]	Mean exit rate	8.7%	
$\mathbb{E}[M_1]/\mathbb{E}[M]$	Share of firms at age 1	10.5%	
$\mathbb{E}[M_2]/\mathbb{E}[M]$	Share of firms at age 2	8.1%	

Empirical Targets

Moment	Description	Data	Model
Investment behavior (annual)			
$\sigma\left(\frac{i}{k}\right)$	SD investment rate	33.7%	31.8%
Financial behavior (annual)			
$\mathbb{E}$ [default rate]	Mean default rate	3.00%	2.01%
$\mathbb{E}$ [credit spread]	Mean credit spread	2.35%	2.54%
$\mathbb{E}[b/k]$	Mean gross leverage ratio	34.4%	33.6%
Firm Growth (annual)			
$\mathbb{E}[n_1]/\mathbb{E}[n]$	Rel. size of age 1 firms	28%	42%
$\mathbb{E}[n_2]/\mathbb{E}[n]$	Rel. size of age 2 firms	36%	66%
Firm Exit (annual)			
$\mathbb{E}$ [exit rate]	Mean exit rate	8.7%	7.88%
$\mathbb{E}[M_1]/\mathbb{E}[M]$	Share of firms at age 1	10.5%	7.4%
$\mathbb{E}[M_2]/\mathbb{E}[M]$	Share of firms at age 2	8.1%	6.1%

Parameters to be Computed

Parameter	Description	Value
Idiosyncratic shock processes		
ρ	Persistence of TFP	0.86
σ	SD of innovations to TFP	0.03
σ_ω	SD of capital quality	0.04
Financial frictions		
ξ	Operating cost	0.02
α	Loan recovery rate	0.91
Firm lifecycle		
m	Mean shift of entrants' prod.	2.92
s	SD shift of entrants' prod	1.11
k_0	Initial capital	0.46
π_d	Exogeneous exit rate	0.02

Choose labor disutility Ψ to ensure steady state employment = 0.6

Overview of Calibration

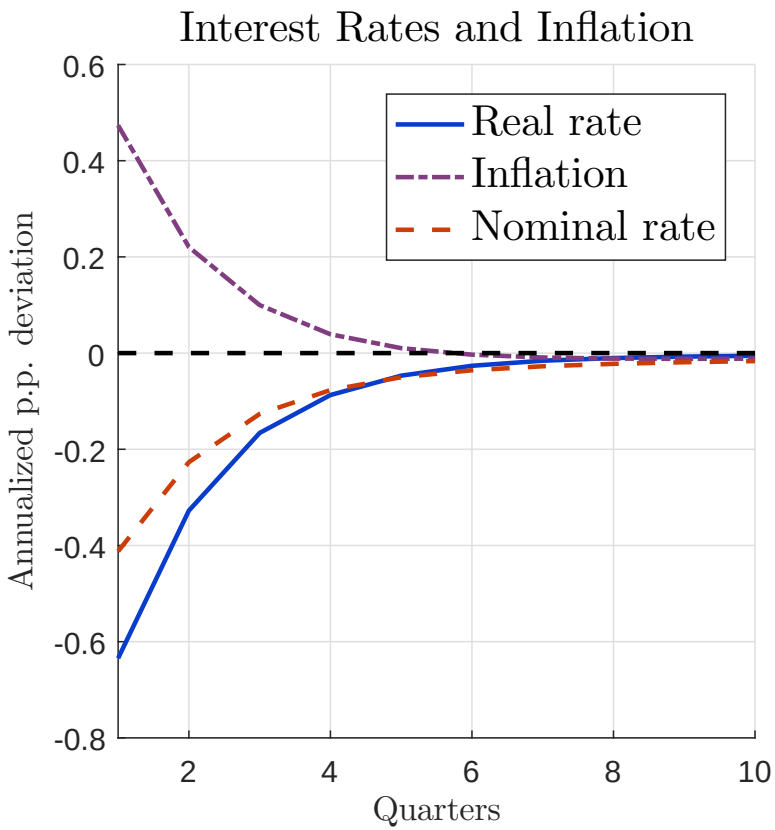
- **Fix** subset of parameters to standard values ▸ Details
- **Choose** parameters governing idiosyncratic shocks, financial frictions, and lifecycle to match empirical targets

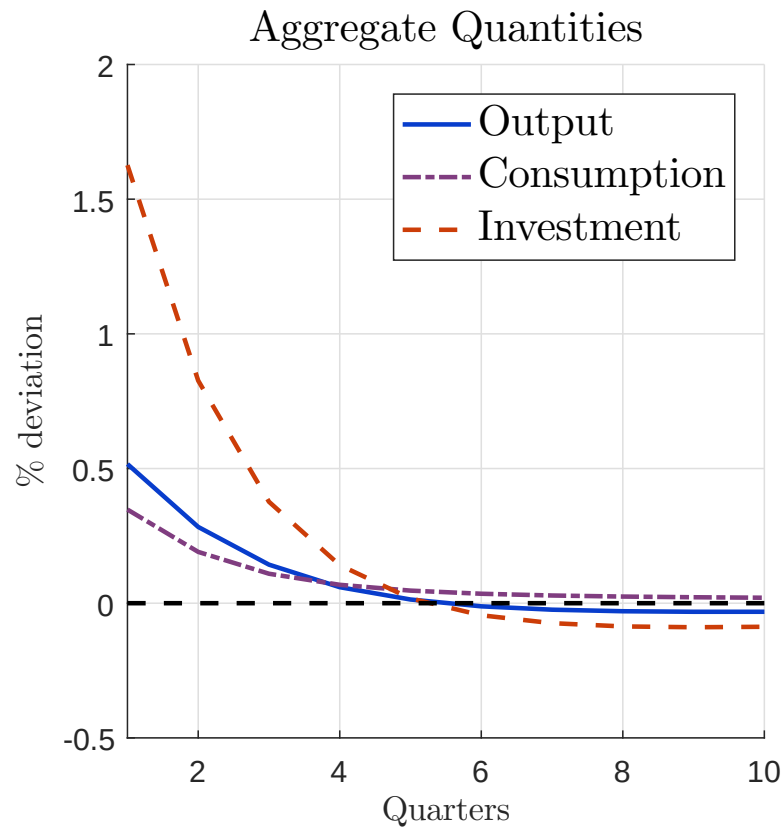
Overview of Calibration

- **Fix** subset of parameters to standard values ▸ Details
- **Choose** parameters governing idiosyncratic shocks, financial frictions, and lifecycle to match empirical targets
- **Analyze** sources of financial heterogeneity ▸ Details
  1. Lifecycle dynamics
  2. Productivity shocks
- **Verify** model (roughly) matches untargetted statistics
  1. Lifecycle dynamics ▸ Details
  2. Distribution of investment and leverage ▸ Details
  3. Investment-cash flow sensitivity ▸ Details

Quantitative Analysis of Monetary Transmission Mechanism

Aggregate Monetary Transmission Mechanism





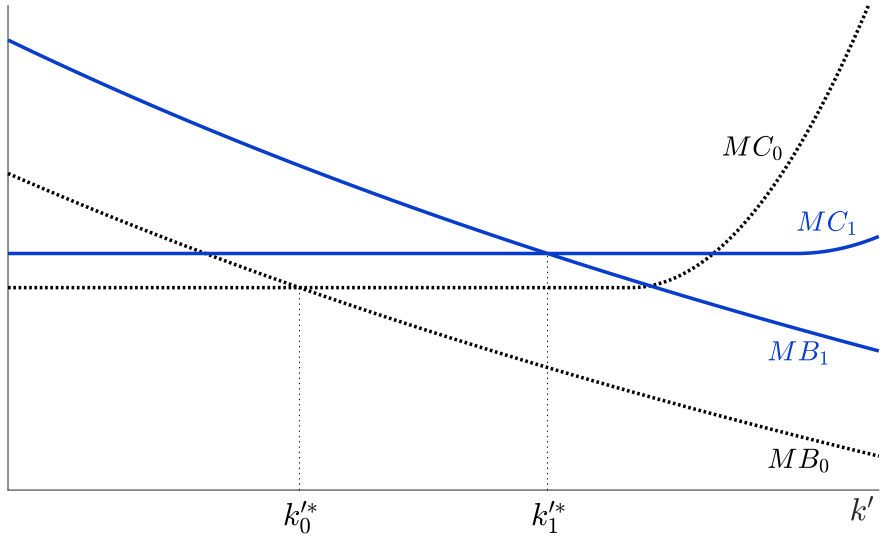
- Peak responses in line with VARs (CEE 2005)
- Not designed to generate hump-shaped responses

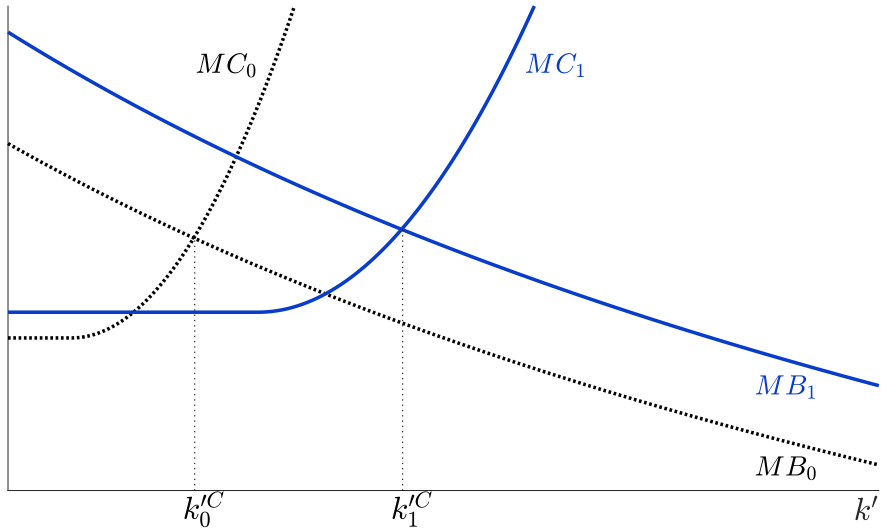
Heterogeneous Responses Consistent with Data

	Model		**Data**	
	(1)	(2)	(1)	(2)
leverage × ffr shock	−1.193	−0.955	−0.94***	−0.73***
			(0.33)	(0.29)
R^2	0.151	0.216	0.107	0.119
Time FE	yes	yes	yes	yes
Firm controls	no	yes	no	yes

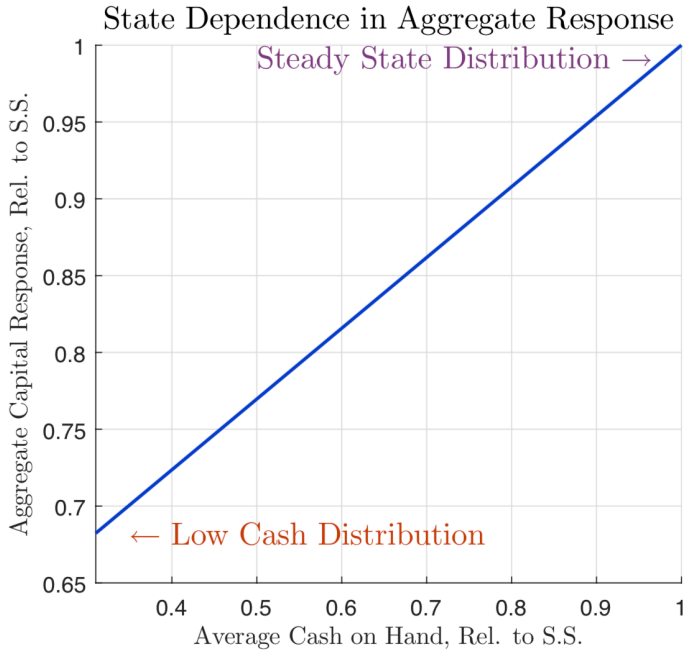
$$\Delta \log k_{it+1} = \beta \ell_{it-1} \varepsilon_t^m + \alpha_i + \alpha_{st} + \Gamma' Z_{it-1} + \varepsilon_{it}$$

Heterogeneous Responses Consistent with Data





Aggregate Effect Depends on Distribution of Risk



Back of the envelope calculation:

- Fix investment response across state space
- Vary initial distribution of cash on hand:

$$\mu(z,x) = \omega \underbrace{\mu_{\text{normal}}(z,x)}_{\text{s.s.}} + (1-\omega) \underbrace{\mu_{\text{bad}}(z,x)}_{\text{s.s., low prod.}}$$

Conclusion

Financial Heterogeneity and Investment Channel

Default risk dampens response of investment to monetary policy

Financial Heterogeneity and Investment Channel

Default risk dampens response of investment to monetary policy

1. **Which firms respond the most?**
   - Firms with low leverage and high credit ratings
   - Indicates default risk is key to micro response

2. **Implications for aggregate transmission?**
   - Low-risk firms drive aggregate response
   - Suggests that aggregate effect depends on distribution of default risk

Appendix

Constructing Investment

1. Start with firms' reported level of plant, property, and equipment (`ppegtq`) as firms' initial value of capital
2. Compute differences of net plant, property, and equipment (`ppentq`) to get net investment
3. Interpolate missing values when missing a single quarter in the data
4. Compute gross investment using depreciation rates of Fixed Asset tables from NIPA at the industry level
5. Trim the data: extreme values and short spells

Back

Sectoral Controls

Sectors considered:

1. Agriculture, Forestry, And Fishing: `sic` < 10
2. Mining: `sic` $\in [10, 14]$
3. Construction: `sic` $\in [15, 17]$
4. Manufacturing: `sic` $\in [20, 39]$
5. Transportation, Communications, Electric, Gas, And Sanitary Services: `sic` $\in [40, 49]$
6. Wholesale Trade: `sic` $\in [50, 51]$
7. Retail Trade: `sic` $\in [52, 59]$
8. Services: `sic` $\in [70, 89]$

Sectors not considered:

1. Finance, Insurance, and Real Estate: `sic` $\in [60, 67]$
2. Public Administration: `sic` $\in [91, 97]$

Back

Firm-Level Heterogeneity Variables

1. Leverage: Ratio of total debt (`dlcq`+`dlttq`) to total assets (`atq`).
2. Net leverage: Subtract current assets (`actq`) net of other current liabilities (`lctq`) from debt liabilities to total assets .
    - Current assets consists of cash and other assets expected to be realized in cash within the next 12 months.
    - Current liabilities are those due within one year.
3. Real Sales Growth: log-differences in sales (`saleq`) deflated using CPI.
4. Size: Log of total assets.

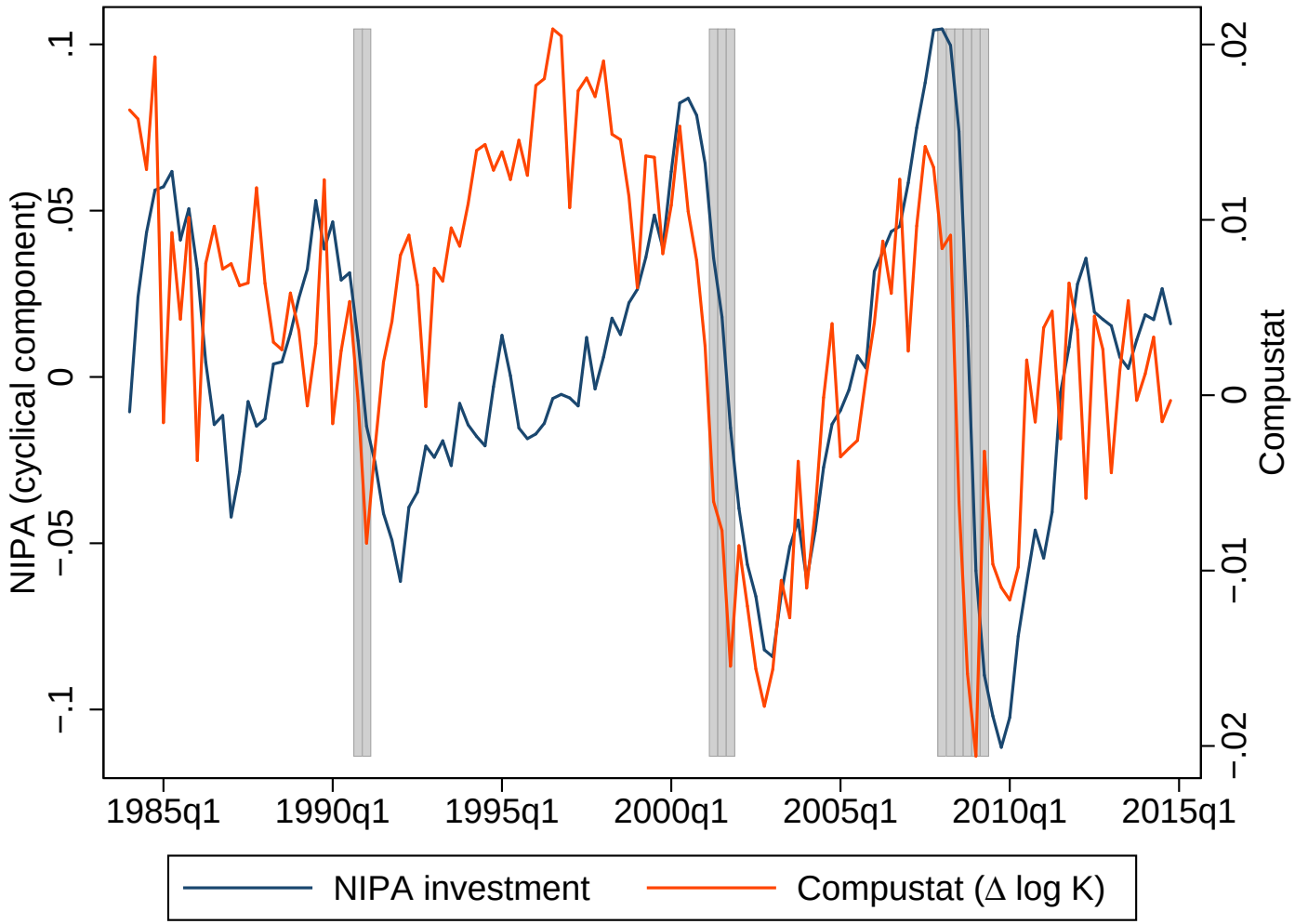
▸ Back

Monetary Shocks

Back

	high frequency	smoothed	sum
mean	-0.0185	-0.0429	-0.0421
median	0	-0.0127	-0.00509
std	0.0855	0.108	0.124
min	-0.463	-0.480	-0.479
max	0.152	0.233	0.261
num	164	71	72

Investment: Compustat and NIPA



Back

Extensive Margin Measure of Investment

Back

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

	(1)	(2)	(3)
leverage × ffr shock	-5.22***	-4.80***	-4.59***
	(1.25)	(1.11)	(1.19)
ffr shock			4.01
			(4.41)
Observations	233232	233232	233232
R^2	0.213	0.217	0.204
Firm controls	no	yes	yes
Time sector FE	yes	yes	no
Time clustering	yes	yes	yes

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

Expansionary vs. Contractionary Shocks

Back

Dependent variable: $\Delta \log k_{it+1}$		
	(1)	(2)
leverage × ffr shock	-0.74***	
	(0.28)	
leverage × pos ffr shock		-0.93**
		(0.36)
leverage × neg ffr shock		0.10
		(0.77)
Observations	239579	239579
R^2	0.118	0.118
Firm controls	yes	yes

Target vs. Path Decomposition

▸ Back

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

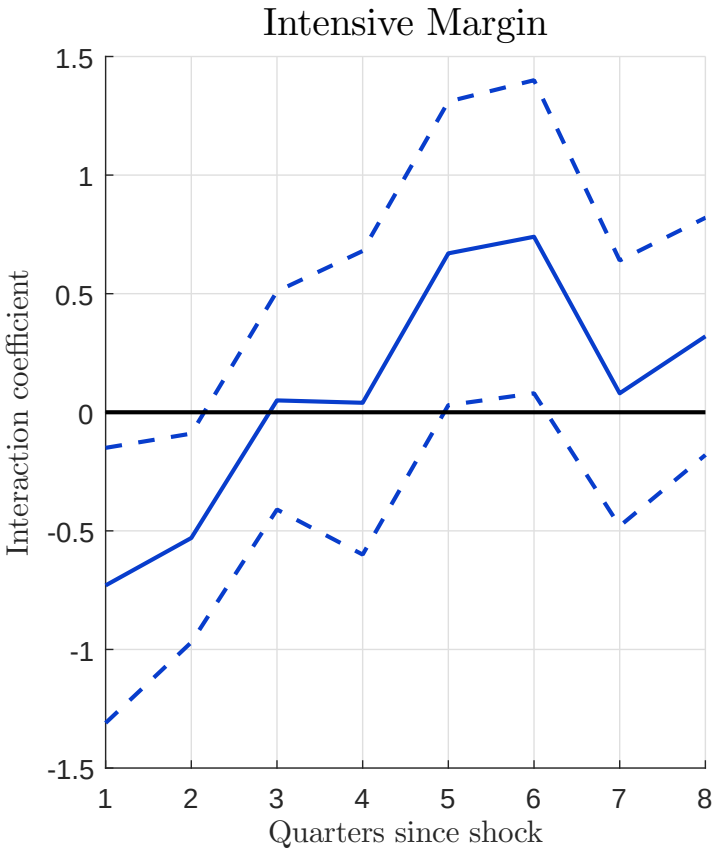
$$\Delta \log k_{it+1} = \alpha_i + \alpha_{s,t} + \Gamma' Z_{it-1} + \beta_1 \ell_{it-1} \varepsilon_t^{\text{m,target}} + \beta_2 \ell_{it-1} \varepsilon_t^{\text{m,path}} + \varepsilon_{it}$$

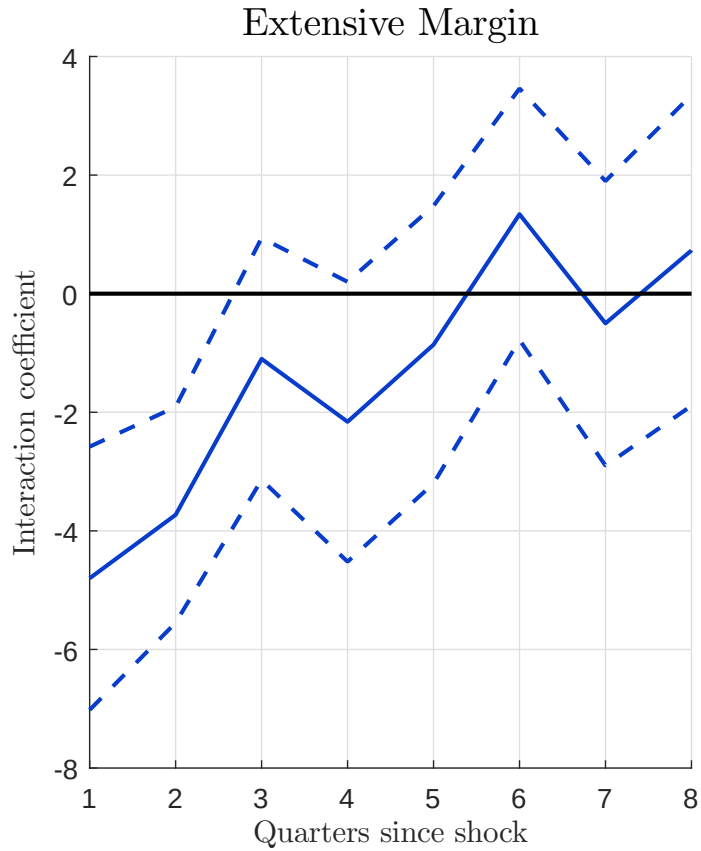
$\varepsilon_t^{\text{m,target}}$ and $\varepsilon_t^{\text{m,path}}$ following Gurkanyak, Sack, and Swanson (2005)

▸ Post-1994 ▸ Expansionary vs. Contractionary Shocks

Dynamics of Differences Short-Lived

Back



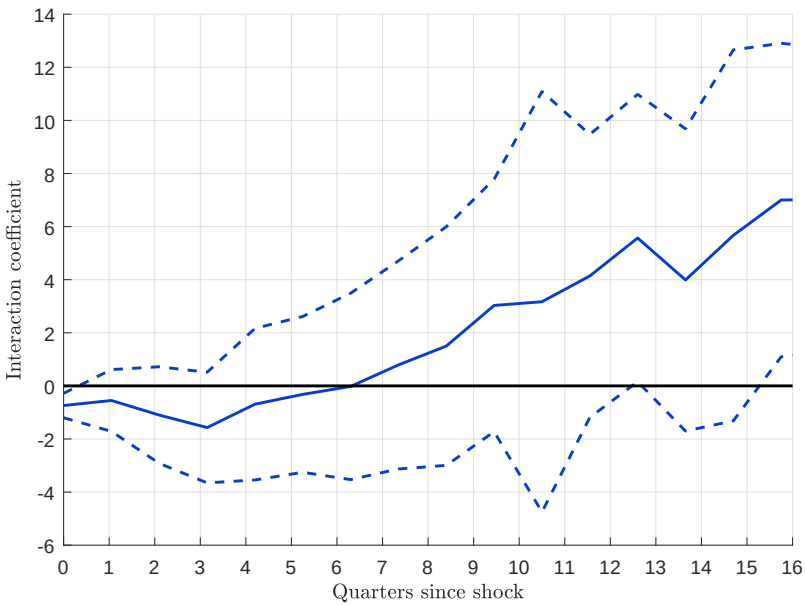


$$\Delta \log k_{it+j} = \beta_j \ell_{it-1} \varepsilon_t^m + \alpha_i^j + \alpha_{st}^j + \Gamma^{j\prime} Z_{it-1} + \varepsilon_{it}$$

Comparison to Jeenas (2018) ▸ Back

Replicating Jeenas (2018)'s Result

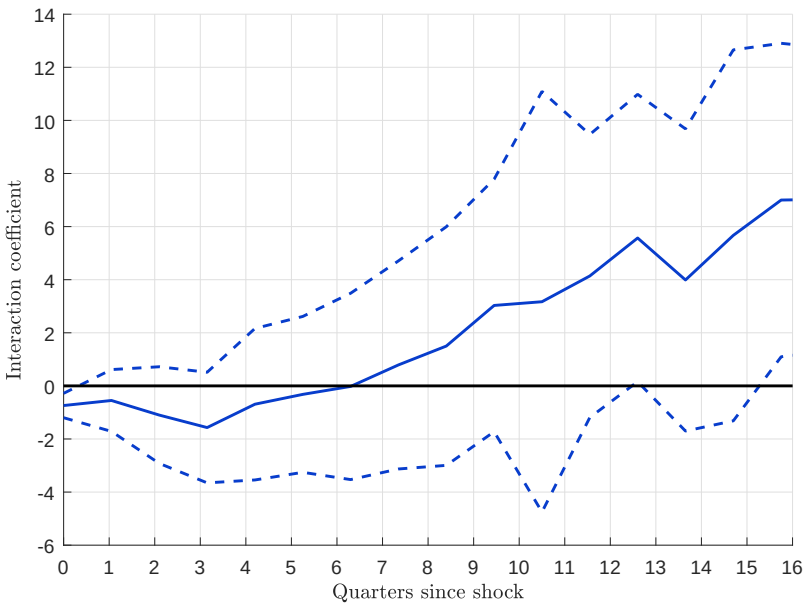
$$\log k_{it+h+1} - \log k_{it} = \beta^h \ell_{it-1} \varepsilon_t^m + \alpha_i^h + \alpha_{st}^h + \Gamma^{h\prime} Z_{it-1} + \varepsilon_{it+h}$$

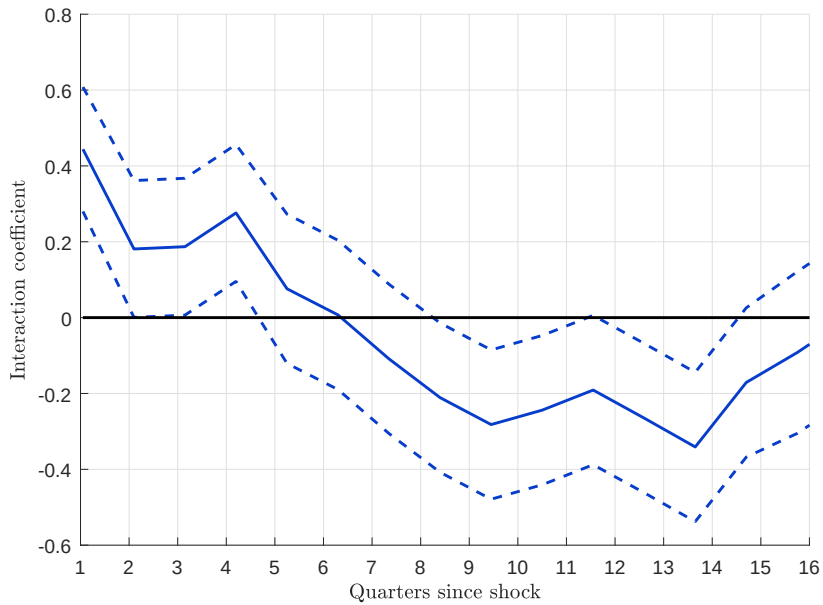


Comparison to Jeenas (2018) ▸ Back

Replicating Jeenas (2018)'s Result

$$\log k_{it+h+1} - \log k_{it} = \beta^h \ell_{it-1} \varepsilon_t^{\mathrm{m}} + \alpha_i^h + \alpha_{st}^h + \Gamma^{h\prime} Z_{it-1} + \varepsilon_{it+h}$$

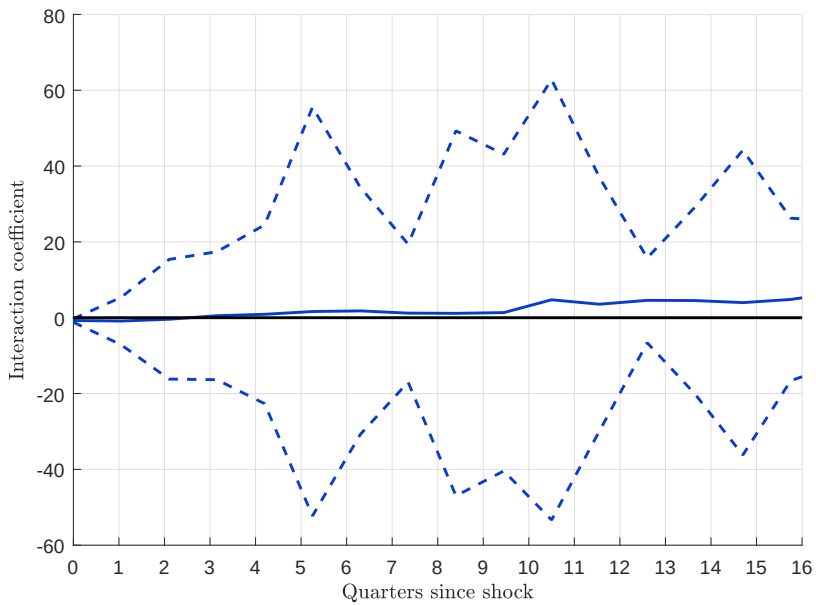


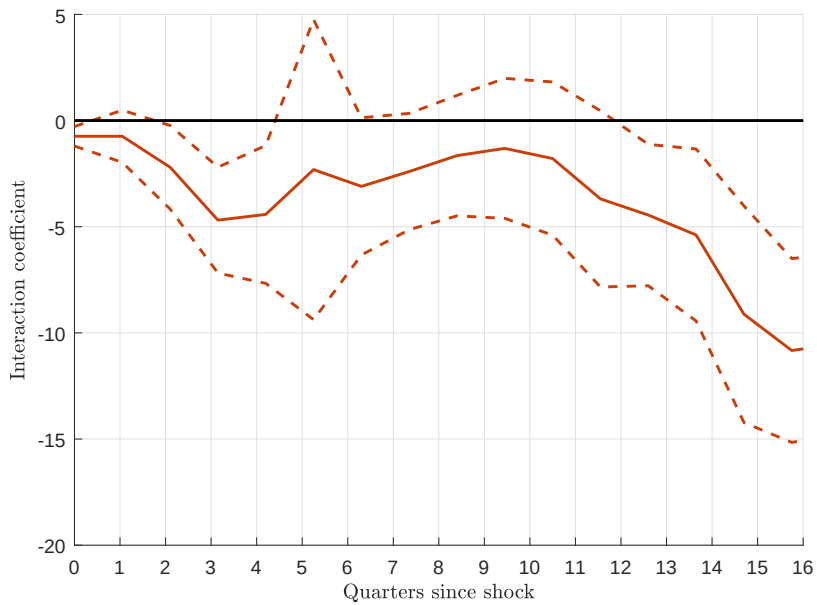


Comparison to Jeenas (2018) ▸ Back

Controlling for Autocorrelation

$$\log k_{it+h+1} - \log k_{it} = \beta^h \ell_{it-1} \varepsilon^{\mathrm{m}}_t + \widetilde{\beta}^h \ell_{it-1} \varepsilon^{\mathrm{m}}_{t+h} + \alpha^h_i + \alpha^h_{st} + \Gamma^{h\prime} Z_{it-1} + \varepsilon_{it+h}$$





Comparison to Jeenas (2018) ▸ Back

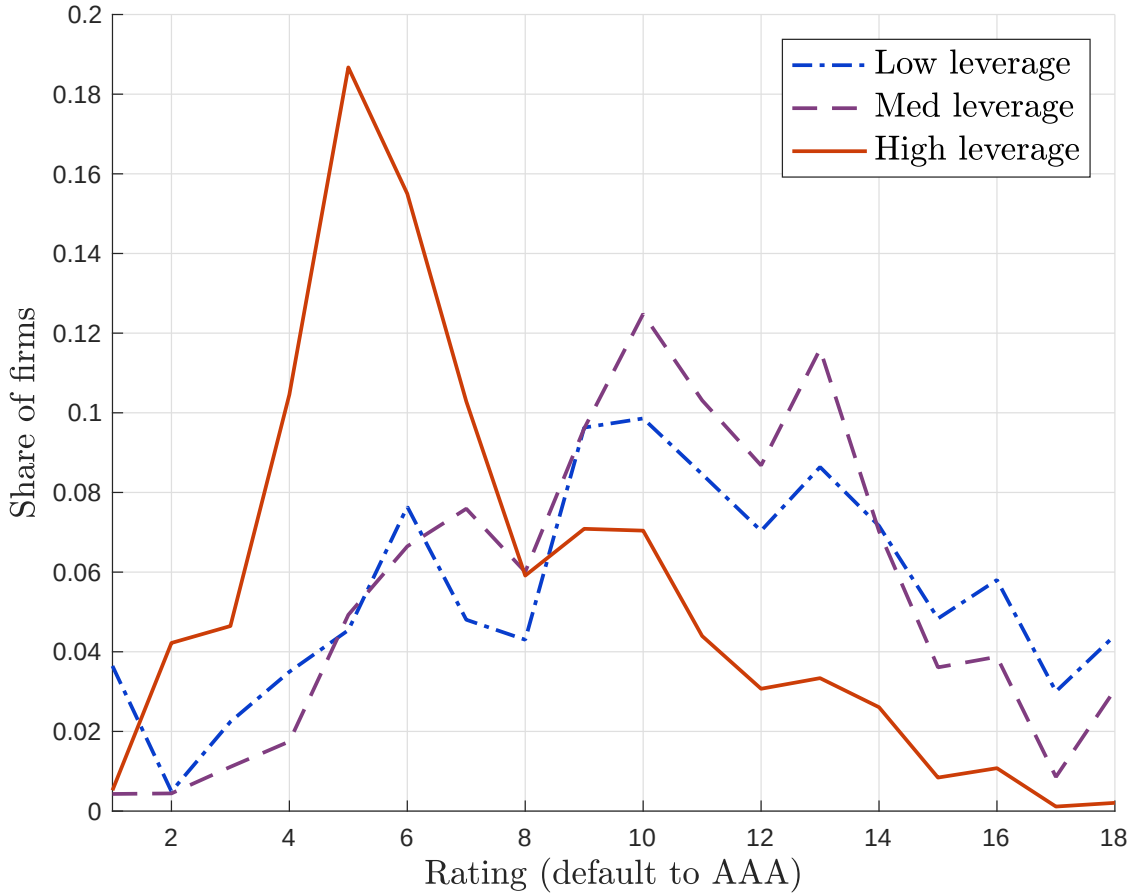
Controlling for Autocorrelation

	(1)	(2)	(3)	(4)	(5)	(6)
leverage × ffr shock	-0.74**	-0.56*	-0.90***	-1.10***	-0.45	-0.68
	(0.28)	(0.32)	(0.30)	(0.31)	(0.37)	(0.43)
Observations	239522	217222	209521	199336	178118	158642
R^2	0.118	0.124	0.123	0.122	0.122	0.124
Firm controls	yes	yes	yes	yes	yes	yes
Time sector FE	yes	yes	yes	yes	yes	yes
Time clustering	yes	yes	yes	yes	yes	yes
Lag included		1	2	4	8	12

$$\Delta \log k_{it+1} = \beta \ell_{it-1} \varepsilon_t^m + \widetilde{\beta} \ell_{it-1} \varepsilon_{t-h}^m + \alpha_i + \Gamma_1' Z_{it-1} + \Gamma_2' Y_t + \varepsilon_{it}$$

Low-Leverage Firms Better Rated

Back



- Also true conditional on firm characteristics Details
- Also true for distance to default Details

Low-Leverage Firms Further From Default

Back

- Measure **distance to default** dd_{it} following Merton (1974)
  1. Use firms' market value to infer value of assets
  2. Use value of assets + assumptions on shocks to get probability of default

- Schaefer and Strebulaev (2008) show that dd_{it} accounts for default-risk component of corporate bond spreads

- Unconditional correlation with leverage $= -0.42$

Reality Check From Daily Stock Prices

Back

Dependent variable: $\frac{\Delta p_{it+1}}{p_{it}}$			
	(1)	(2)	(3)
leverage × ffr shock	-8.22***	-8.22**	-6.12*
	(3.82)	(3.82)	(3.33)
ffr shock			6.22**
			(1.88)
Observations	32274	32274	32274
R^2	0.128	0.128	0.073
Firm controls	no	yes	yes
Time sector FE	yes	yes	no
Time clustering	yes	yes	yes

$$\frac{\Delta p_{it+1}}{p_{it}} = \beta \ell_{it-1} \varepsilon_t^{\mathrm{m}} + \alpha_i + \alpha_{st} + \Gamma' Z_{it-1} + \varepsilon_{it}$$

Decomposition by Leverage

Back

Dependent variable: $\Delta \log k_{it+1}$

	(1)	(2)	(3)	(4)
ST debt × ffr shock	-0.54**		-0.58**	
	(0.25)		(0.25)	
LT debt × ffr shock		-0.38	-0.43	
		(0.27)	(0.28)	
leverage × ffr shock				-0.70**
				(0.29)
other liab × 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

Net Leverage

Back

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

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

Demeaning Leverage Within Firm

Back

	(1)	(2)	(3)
leverage × shock	-0.95**	-0.77**	-0.75**
	(0.42)	(0.36)	(0.35)
ffr shock			1.38
			(1.00)
Observations	239523	239523	239523
R^2	0.106	0.118	0.103
Firm controls	no	yes	yes
Time sector FE	yes	yes	no
Time clustering	yes	yes	yes

$$\Delta \log k_{it+1} = \beta(\ell_{it-1} - \mathbb{E}_i[\ell_{it-1}])\varepsilon_t^m + \alpha_i + \alpha_{st} + \Gamma' Z_{it-1} + \varepsilon_{it}$$

Results Post-1994

Back

Dependent variable: $\Delta \log k_{it+1}$

	(1)	(2)	(3)	(4)
leverage × ffr shock	-0.52	-0.56	-0.66	-0.66**
	(0.49)	(0.44)	(0.45)	(0.26)
ffr shock			-0.05	-0.05
			(1.54)	(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

Robustness: Interaction with Cyclical Variables

Back

Dependent variable: $\Delta \log k_{it+1}$

	(1)	(2)	(3)	(4)	(5)
leverage × ffr shock	-0.85***	-0.73***	-0.74***	-0.83***	-0.96***
	(0.29)	(0.27)	(0.28)	(0.28)	(0.31)
leverage × dlog gdp	-0.08				-0.08
	(0.08)				(0.07)
leverage × dlog cpi		-0.05			-0.06
		(0.09)			(0.09)
leverage × ur			0.00		0.00
			(0.00)		(0.00)
leverage × vix				0.00	0.00
				(0.00)	(0.00)
Observations	239579	239579	239579	239579	239579
R^2	0.118	0.118	0.118	0.118	0.118
Firm controls	yes	yes	yes	yes	yes

Robustness: Interaction with Firm Characteristics

Back

Dependent variable: $\Delta \log k_{it+1}$

	(1)	(2)	(3)	(4)	(5)		
leverage × ffr shock	-0.73**		-0.78**		-0.72**		-0.70**
	(0.29)		(0.31)		(0.29)		(0.29)
sales growth × ffr shock		-0.06	-0.07				
		(0.26)	(0.26)				
future sales growth × ffr shock				-0.51	-0.48		
				(0.39)	(6.97)		
size × ffr shock						0.35	0.38
						(0.29)	(0.28)
Observations	233182	221451	233182	233182	221451	233182	233182
R^2	0.119	0.120	0.116	0.118	0.122	0.116	0.119
Firm controls	yes	yes	yes	yes	yes	yes	yes
Time sector FE	yes	yes	yes	yes	yes	yes	yes
Time clustering	yes	yes	yes	yes	yes	yes	yes

$$\Delta \log k_{it+1} = \beta_1 \ell_{it-1} \varepsilon_t^m + \beta_2 y_{it-1} \varepsilon_t^m + \alpha_i + \alpha_{st} + \Gamma' Z_{it} + \varepsilon_{it}$$

Robustness: Interaction with Financial Characteristics

Back

Dependent variable: $\Delta \log k_{it+1}$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
leverage × ffr shock	-0.74**		-0.73**		-0.76**		-0.74**
	(0.28)		(0.28)		(0.29)		(0.28)
size × ffr shock		0.35	0.37***				
		(0.31)	(0.07)				
cash flows × ffr shock				0.24	0.28		
				(0.54)	(1.34)		
$\mathbb{I}\{\text{dividends} > 0\}$× ffr shock						0.13	0.39
						(0.58)	(4.83)
Observations	239523	239523	239523	237890	237890	239232	239232
R^2	0.118	0.115	0.118	0.120	0.122	0.116	0.118
Firm controls	yes	yes	yes	yes	yes	yes	yes
Time sector FE	yes	yes	yes	yes	yes	yes	yes
Time clustering	yes	yes	yes	yes	yes	yes	yes

$$\Delta \log k_{it+1} = \beta_1 \ell_{it-1} \varepsilon_t^m + \beta_2 y_{it-1} \varepsilon_t^m + \alpha_i + \alpha_{st} + \Gamma' Z_{it} + \varepsilon_{it}$$

Robustness: Instrument Leverage

Back

	(1)	(2)
leverage × ffr shock	-0.74	-2.36**
	(1.27)	(0.94)
Observations	230112	221326
R^2		
Firm controls, Time-Sector FE	yes	yes
Instrument	4q lag	8q lag

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

Robustness: Instrument Leverage

Back

First Stage

	(1)	(2)
L4 leverage × ffr shock	0.20	
	(0.25)	
L8 leverage × ffr shock		0.82**
		(0.34)
Observations	230033	221232
R^2	0.226	0.244
Firm controls, Time-Sector FE	yes	yes
Instrument	4q lag	8q lag

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

Robustness: Corporate Bond Yields

Back

	(1)	(2)
leverage × AAA yield	-0.28***	
	(0.07)	
leverage × BAA yield		-0.88**
		(0.35)
Observations	238127	221326
R^2		
Firm controls, Time-Sector FE	yes	yes
Instrument	leverage × shock	leverage × shock

Robustness: Instrument Real Rate

Back

	(1)
leverage $\times$ Δ ffr	0.80***
	(0.13)
Observations	238127
R^2	
Firm controls, Time-Sector FE	yes
Instrument	leverage $\times$ shock

Robustness: Alternative Time Aggregation

Back

	(1)	(2)	(3)	(4)
leverage × ffr shock (sum)	-0.89***	-0.79***	-0.79***	-0.79***
	(0.33)	(0.28)	(0.29)	(0.17)
ffr shock (sum)			1.02	1.02***
			(0.82)	(0.18)
Observations	236296	236296	236296	236296
R^2	0.106	0.117	0.103	0.103
Firm controls	no	yes	yes	yes
Time sector FE	yes	yes	no	no
Time clustering	yes	yes	yes	no

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

Low-Leverage Firms Better Rated

Back

	(1)	(2)	(3)	(4)
leverage	-0.09***	-0.04***	-0.09***	-0.04***
	(0.01)	(0.01)	(0.02)	(0.01)
sales_growth	-0.01***	-0.00***	-0.01**	-0.00
	(0.00)	(0.00)	(0.00)	(2.21)
size $(t-1)$	0.28***	0.11***	0.28***	0.11
	(0.02)	(0.03)	(0.02)	(2.48)
share current assets	0.01	0.04***	0.02	0.04
	(0.01)	(0.01)	(0.01)	(5.33)
Observations	49201	49166	49201	49166
R^2	0.261	0.826	0.282	0.828
Firm controls	yes	yes	yes	yes
Firm FE	no	yes	no	yes
Time sector FE	no	no	yes	yes

$$\mathbb{1}\{\mathbf{rating}_{it} \geq A\} = \alpha_i + \alpha_{st} + \Gamma' Z_{it-1} + \varepsilon_{it}$$

Path vs. Target Decomposition After 1994 ▸ Back

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

Path vs. Target Decomposition for Expansionary and Contractionary Shocks

Back

Dependent variable: $\Delta \log k_{it+1}$

	(1)	(2)	(3)	(4)
leverage × ffr shock	-0.74***			
	(0.28)			
leverage × pos ffr shock		-0.93**		
		(0.36)		
leverage × neg ffr shock		0.10		
		(0.77)		
leverage × target shock			-1.23***	
			(0.41)	
leverage × path shock			1.50	
			(1.68)	
leverage × pos target shock				-1.38**
				(0.64)
leverage × pos path shock				2.74
				(2.97)
leverage × neg target shock				-1.02
				(1.15)
leverage × neg path shock				-0.14
				(3.36)
Observations	239579	239579	233729	233729
R^2	0.118	0.118	0.119	0.119
Firm controls	yes	yes	yes	yes

Firm Entry

Back

- Firms exit due to exit shocks and default

- One new entrant for each exiting firm

  1. Draw productivity z_{jt} from shifted distribution

$$\log z_{jt} \sim N\left(-m\frac{\sigma}{\sqrt{1-\rho^2}}, s^2\frac{\sigma^2}{1-\rho^2}\right)$$

  2. Draw capital quality ω_{jt} from ergodic distribution
  3. Endowed with k_0 units of capital and $b_0 = 0$ units of debt

  $\Longrightarrow$ incumbent w/ initial state $(z_{jt}, \omega_{jt}, k_0, 0)$

Retailers and Final Good Producer

Back

- Monopolistically competitive retailers
  - Technology: $\tilde{y}_{it} = y_{it} \implies$ real marginal cost $= p_t$
  - Set price $\tilde{p}_{it}$ s.t. quadratic cost $-\frac{\varphi}{2}\left(\frac{\tilde{p}_{it}}{\tilde{p}_{it-1}} - 1\right)^2 Y_t$

- Perfectly competitive final good producer
  - Technology: $Y_t = \left(\int \tilde{y}_{it}^{\frac{\gamma-1}{\gamma}} di\right)^{\frac{\gamma}{\gamma-1}} \implies P_t = \left(\int \tilde{p}_{it}^{1-\gamma} di\right)^{\frac{1}{1-\gamma}}$

- Implies New Keynesian Phillips Curve

$$\pi_t = \frac{\gamma - 1}{\varphi} \log \frac{p_t}{p^*} + \beta \mathbb{E}_t \left[\pi_{t+1}\right]$$

The Rest of the Model

Back

- Monetary authority follows Taylor rule

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

- Capital good producer with technology

$$K_{t+1} = \Phi\left(\frac{I_t}{K_t}\right) K_t + (1-\delta)K_t \implies q_t = 1/\Phi'\left(\frac{I_t}{K_t}\right) = \left(\frac{I_t/K_t}{\delta}\right)^{\frac{1}{\phi}}$$

- Representative household with preferences

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

  - Owns firms $\implies \Lambda_{t+1} = \beta \frac{C_t}{C_{t+1}}$
  - Labor-leisure choice $\implies w_t C_t^{-1} = \Psi$
  - Euler equation for bonds $\implies 1 = \beta R_t^{\text{nom}} \mathbb{E}_t \left[\frac{\Lambda_{t+1}}{\Pi_{t+1}}\right]$

Model-Implied Investment-Cash Flow Sensitivity

Back

	Model		**Data**	
cash flow	1.08	0.18	0.021	0.021
Tobin's q		0.15		0.008

$$\frac{i_{it}}{k_{it}} = \alpha_i + \alpha_1 \frac{\pi_{it-1}}{k_{it}} + \alpha_2 q_{it} + \varepsilon_{it}$$

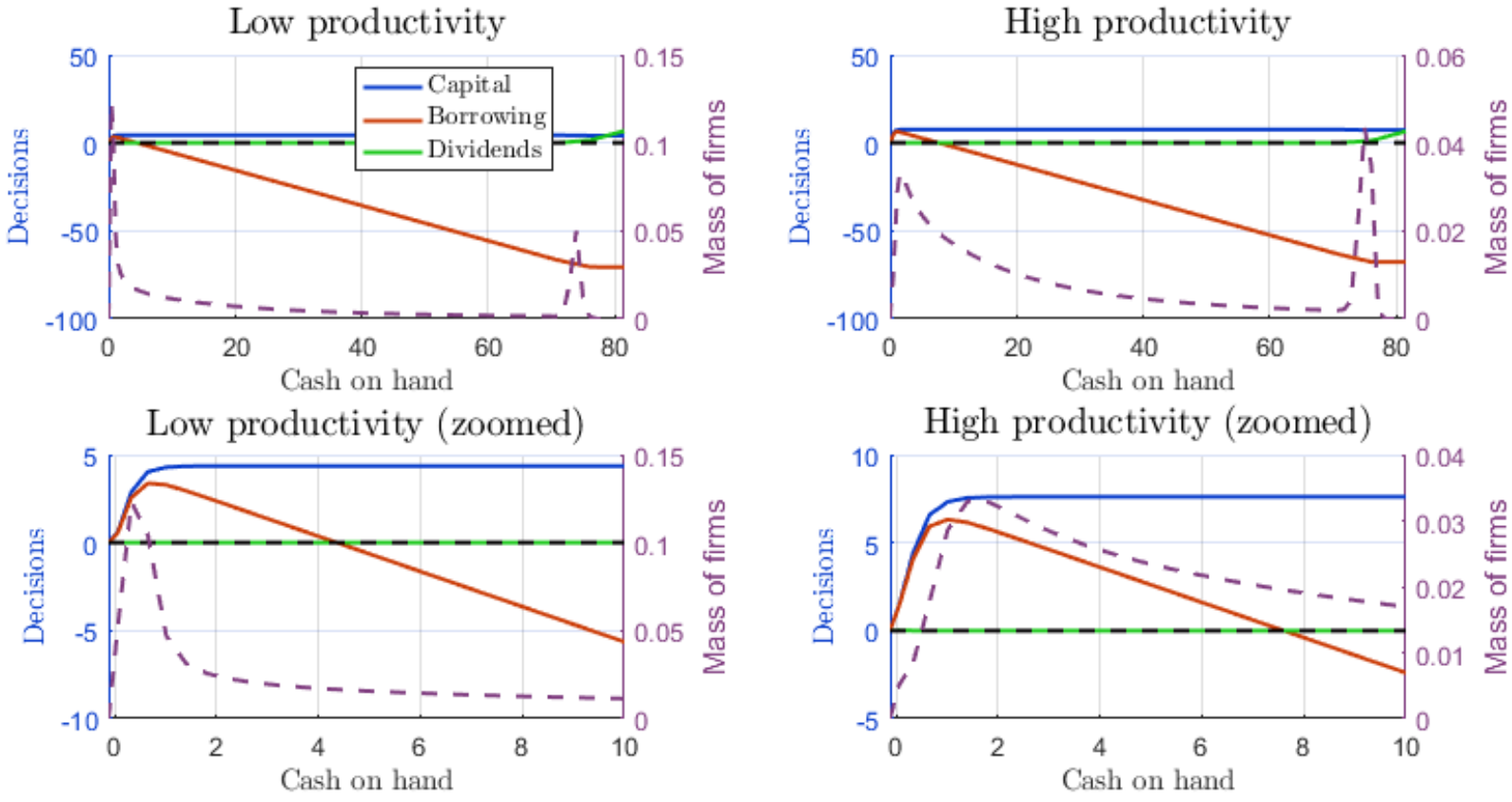
Fixed Parameters

Back

Parameter	Description	Value
Household		
β	Discount factor	0.99
Firms		
ν	Labor coefficient	0.64
θ	Capital coefficient	0.21
δ	Depreciation	0.026
New Keynesian Block		
ϕ	Aggregate capital AC	4
γ	Demand elasticity	10
φ_π	Taylor rule coefficient	1.25
φ	Price adjustment cost	90

Steady State Decision Rules

Back

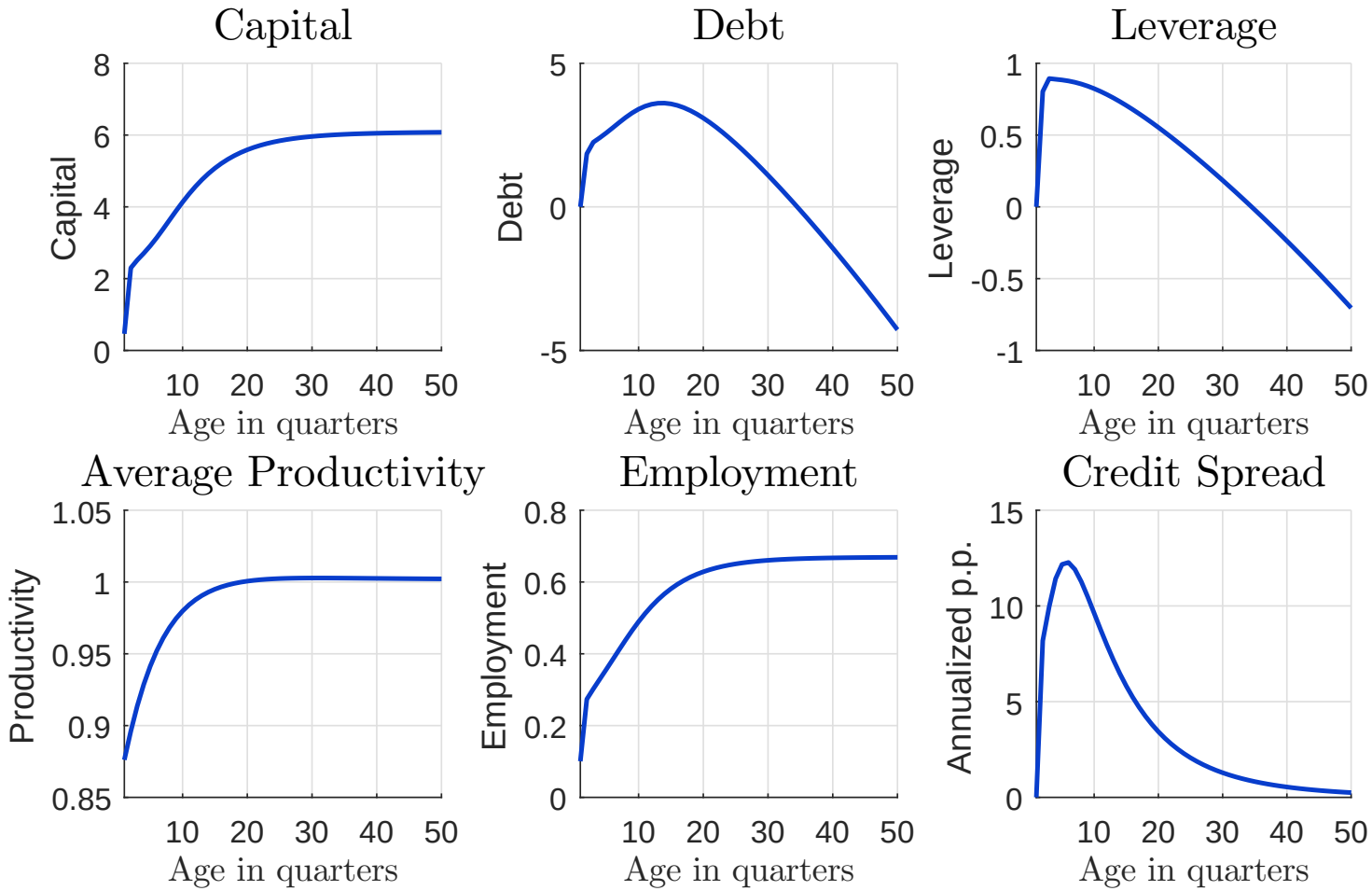


Two key sources of **financial heterogeneity**

1. Lifecycle dynamics
2. Productivity shocks

Firm Lifecycle Dynamics

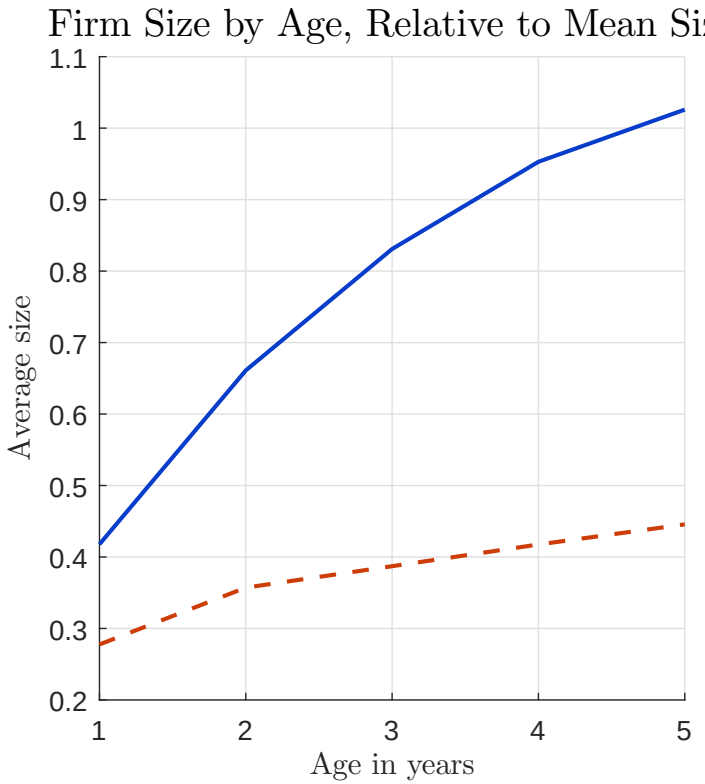
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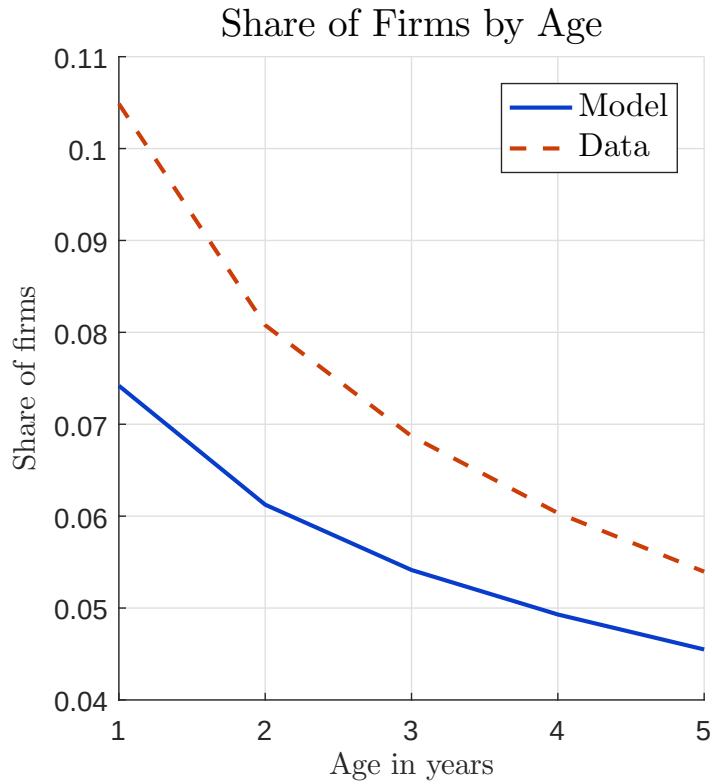


- Young firms riskier than average
- But default risk spread out over large set of firms

Firm Lifecycle Dynamics in the Model and Data

Back





- Firms growth more quickly than in data
  - Data features other sources of lifecycle dynamics
- Age-dependence of exit rates in line with data

Financial Heterogeneity in the Model and Data

Back

Investment and leverage heterogeneity

Moment	Description	Data	Sel. Model	Full Model
Investment heterogeneity (annual LRD)				
$\mathbb{E}\left[\frac{i}{k}\right]$	Mean investment rate	12.2%	8.83%	20.6%
$\sigma\left(\frac{i}{k}\right)$	SD investment rate (calibrated)	33.7%	31.8%	38.5%
$\rho\left(\frac{i}{k}, \frac{i}{k_{-1}}\right)$	Autocorr investment rate	0.058	-0.26	-0.26
Leverage heterogeneity (quarterly Compustat)				
$\sigma\left(\frac{b}{k}\right)$	SD leverage ratio	36.4%	76.4%	77.0%
$\rho\left(\frac{b}{k}, \frac{b}{k_{-1}}\right)$	Autocorr leverage ratio	0.94	0.92	0.95
Joint investment and leverage (quarterly Compustat)				
$\rho\left(\frac{i}{k}, \frac{b}{k}\right)$	Corr. of leverage and investment	-0.08	-0.16	-0.02

Measured investment-cash flow sensitivity

	Without cash flow		**With cash flow**	
	Data	*Model*	*Data*	*Model*
Tobin's q	0.01***	0.06	0.01***	0.02
cash flow			0.02***	0.08
R^2	0.097	0.065	0.104	0.086