Debt Contracts, Investment, and Monetary Policy

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Today

1. Motivation
2. Empirical Framework
3. Model
4. Results
5. Conclusion

Debt Contracts and Monetary Policy

Q How do financial frictions shape monetary policy transmission to firm-level investment?

- e.g. due to **balance sheet features** and **borrowing constraints**

→ Existing answers rely on **liquidation value of firm's asset**

(Kiyotaki and Moore, 1997; Bernanke, Gertler, and Gilchrist, 1999)

- **financial accelerator** literature: misses important feature of the data!
- e.g. prevalence of cash flow based contracts ($\approx 80\%$)

(Lian and Ma, 2021; Drechsel, 2018; Greenwald, 2019)

→ Revisit by embedding **cash flow-based borrowing** in macrofinance model

- which **firm characteristics** play role in the borrowing method selection?
- which firm group is **more sensitive** to monetary policy shocks?
- through which **channel** is monetary policy transmitted?

(Ottonello and Winberry, 2020; Jeenas, 2018; Cloyne, Ferreira, Froemel, and Surico, 2018; Anderson and Cesa-Bianchi, 2020)

This Paper

- **Quantitative Model:** Heterogeneous firm model with financial frictions. State contingent debt limits via limited enforceability.
- **Data:** Merged Compustat, DealScan and CRSP.
- **Empirical Contribution:**
  1. Role of **firm characteristics**
     - **Asset-based** – higher share of pledgeable assets, low Jensen's alpha
     - **Cash flow-based** – higher profitability, low beta
  2. **Asset-based** more **sensitive** → sharper cut in borrowing and investment to a contractionary monetary shock
- **Quantitative Contribution:**
  1. match the behavior via **state contingent contracts**
  2. able to mimic the heterogeneous responsiveness
  3. role of **collateral channel** in heterogeneous sensitivity
     → **cash flow-based borrowers less vulnerable**

Debt Contracts

- **Asset based contracts**
  - **Assets pledged.** Equipment, structures, inventory, receivables + with suitable intangible assets (usage rights, patent etc.)
  - ***Ad-hoc* borrowing limit.** Appraised **liquidation value** of assets pledged.

$$b' \leq \theta q k$$

- **Cash flow based contracts**
  - **Assets pledged.** Claim against the whole company, not particular assets
  - ***Ad-hoc* borrowing limit.** Related to cash flow through **firm valuation**
    - Contractibility issues $\rightarrow$ relative valuation (multiples of **EBITDA**) rather than absolute valuation (DCF) Detour
    - Enforced through legally binding **financial covenants** (mostly **Total debt-to-EBITDA**)

$$b' \leq \phi \pi$$

where π is **EBITDA** and ϕ is multiple

Empirical Framework

Final Dataset

Loan-level info

- Contract Terms
- Financial Covenant
- Collateral

Firm-level info

- Balance Sheet Items
- Income Statement Details

Security-level info

- Stock Returns
- S&P 500 Index
- Incorporation Date

Subset of (Lian and Ma, 2021)

This Paper

▸ Treatment ▸ Capm

Summary Stats

	Asset-based	Cash flow-based
Firm Total Assets ($M)	1679.83	2596.18
Firm Age (years)	32.94	34.73
Firm Leverage	0.32	0.32
Firm Asset Pledgeability	**0.70**	**0.57**
Firm EBITDA	**0.44**	**0.84**
Loan Spread (pp)	2.36	1.99
Loan Maturity (months)	60	60
Stock Jensen's Alpha (x10^{-2})	**-0.54**	**-0.33**
Stock Beta	**1.68**	**1.44**
Total Observations	**8,135**	**55,405**

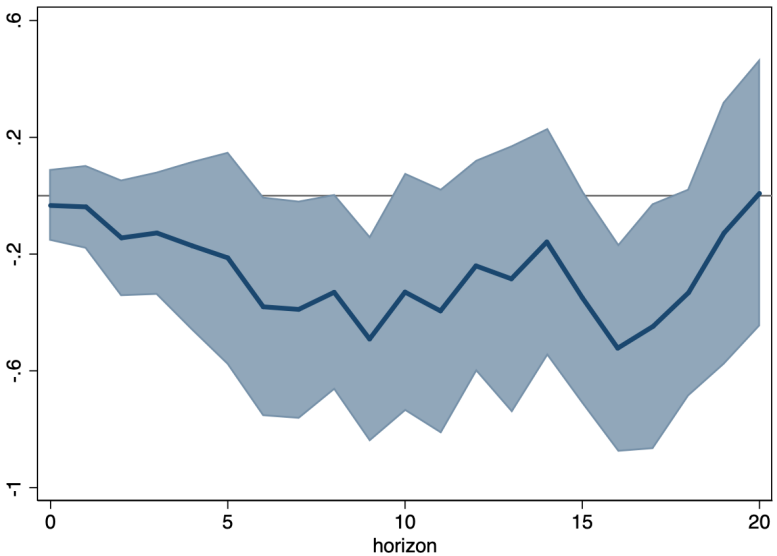
▸ Full Table

Local Projections Specification

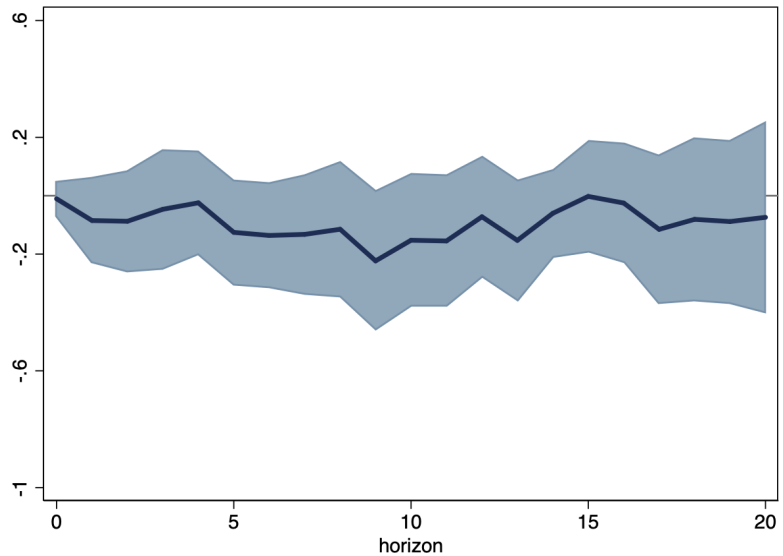
$$y_{j,t+h} - y_{j,t-1} = \alpha_j^h + \beta_1^h \left(\epsilon_t^m \mathcal{I}_{j,t-1}^{Asset}\right) + \beta_2^h \left(\epsilon_t^m \mathcal{I}_{j,t-1}^{Cash}\right) + \sum_{p=1}^{P_Z} \Gamma_p \mathbf{Z}_{j,t-p} + \sum_{p=1}^{P_X} \Gamma_p \mathbf{X}_{t-p} + e_{j,t+h}. \qquad \text{for } h = 1, ..., H \tag{1}$$

- y variable of interest set: investment, borrowing
- ϵ_t^m: monetary policy shock Details
- $\mathbf{Z}$ firm-level control variable set with $P_Z = 1$
  - **Size**, **Age**, **Leverage**, **Current Assets Ratio**, **Tobin's *Q***
- $\mathbf{X}$ aggregate control variable set with $P_X = 4$
  - **GDP**, **Inflation**, **VIX Index**, **Unemployment Rate**

Investment Response



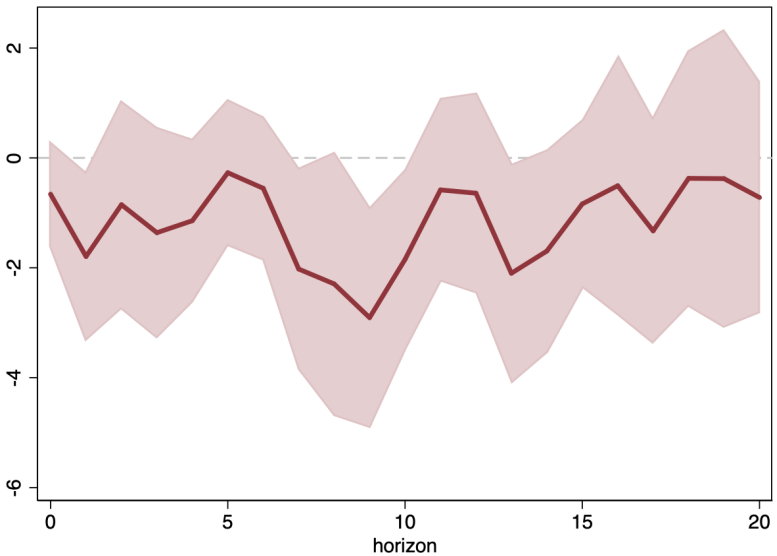
(A) β_1^h: Asset Based Borrowers



(B) β_2^h: Cash-flow Based Borrower

Figure: Response of investment to a contractionary monetary shock

Borrowing Response



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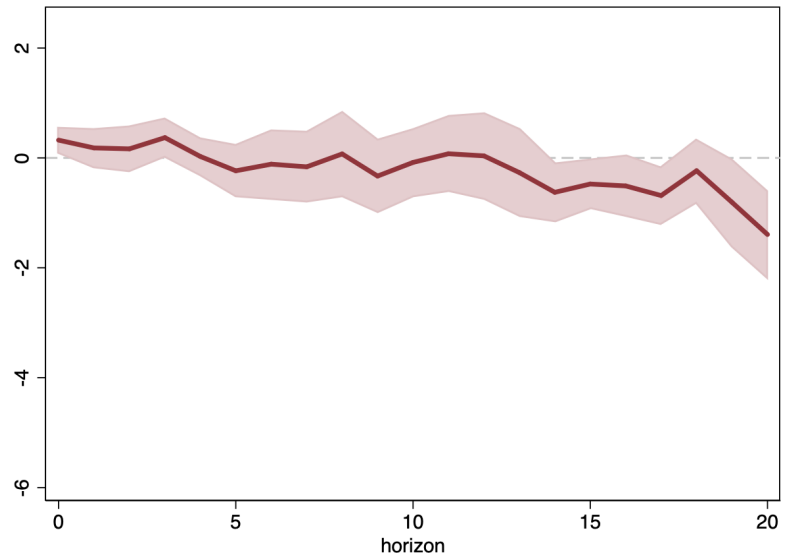
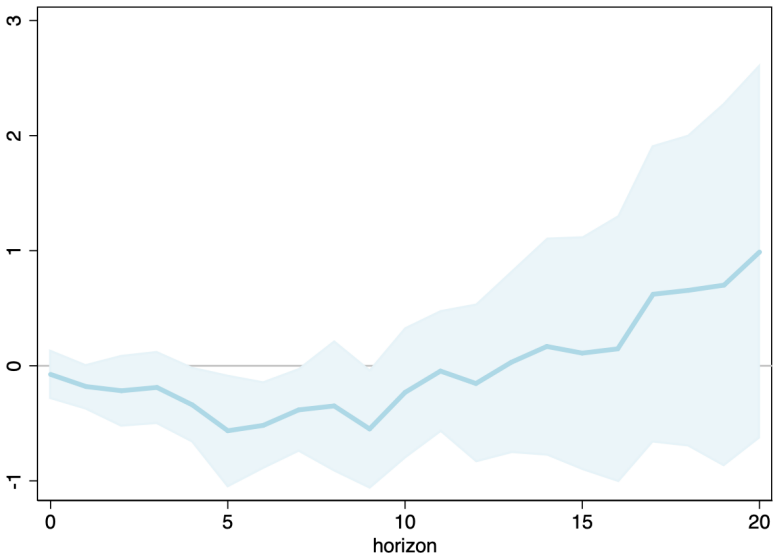


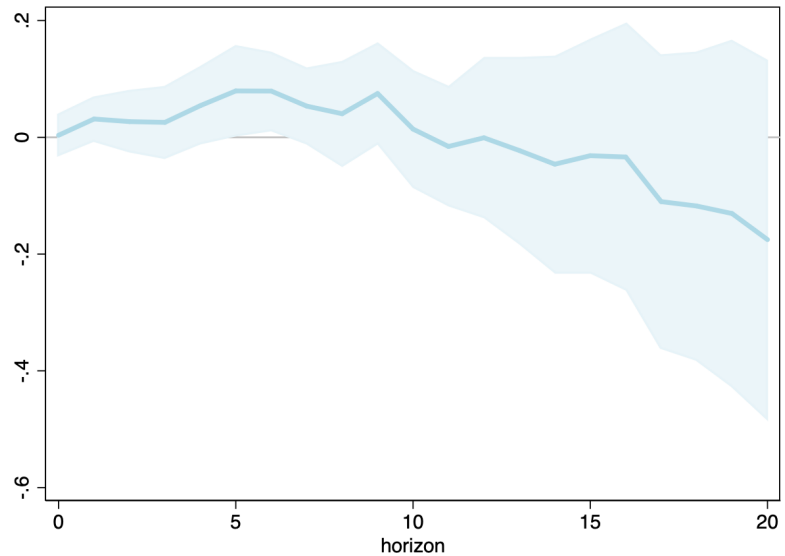
(B) β_2^h: Cash-flow Based Borrower

Figure: Response of borrowing to a contractionary monetary shock

Share Response



(A) β_1^h: Asset Based Borrowers



(B) β_2^h: Cash-flow Based Borrower

Figure: Response of shares to a contractionary monetary shock

Wrap up

Facing **contractionary** monetary shock

- Asset based borrowers experience sharper cut in **investment** and **borrowing**
- Switch from **asset-based** to **cash flow-based** contracts
- **Robustness**
  1. Credit spread response
     ▸ Results
  2. External finance dependence
     ▸ Results
  3. Regional heterogeneity
     ▸ Results
- Asset price channel to explore with a **quantitative model**
  → due to the absence of firm-level **appraised collateral value** data

Model

Model Overview - *I*

- **Heterogenous production firms** ▸ Details
  - Dividend maximizer
  - Choose **labor**, **debt amount**, **capital**, and **debt contract**
  - **Limited enforceability** – *Ex post*, can renege on their promise to repay and breach their contracts
  - Each period a fraction faces **exog. exit shocks** and replaced by new entrants

    ▸ Timing
- **Financial intermediary** ▸ Details
  - Determines the state contingent borrowing limits by ensuring repayment
  - Collects deposits from households and lends firms.
  - Offers two forms of contracts
    - Asset-based
    - Cash flow-based
- **Capital good producers** ▸ Details
  - Buy existing capital to produce new aggregate capital subject to an adjustment cost
  - Time varying capital price

Model Overview - *II*

- **Household** Details
  - Representative
  - Owns all production entities and the financial intermediary in the economy
  - Choose **consumption**, **labor**, **risk free saving instrument**, and **firm share**
- **Retailers** Details
  - Converts to differentiated good
  - Sets price subject to Rotemberg
- **Final good producer** Details
  - Bundles differentiated goods into the final good
- **Monetary authority** follows Taylor rule

Timing of events

1. The **entrant** firms with a mass of **exiting incumbents** enter to the economy with initial **capital** stock k_0, and zero **debt** $b_0 = 0$
2. Idiosyncratic **productivity shock** and exogenous **exit shock** reveal
3. Production
4. Firms repurchase all outstanding debt. **Exiting firms** also liquidates entire **capital** holdings, and pays the remaining funds as **dividend** to the households.
5. Conditional on survival, firms decide the following **simultaneously**
   - new **capital** k' with price q
   - new **debt** b'
   - contract type (*i.e.* **asset-based** or **cash flow-based**)
6. The remaining funds (if any) are distributed to the household as **dividend**

◂ Go Back

Heterogeneous Production Firm

- **Net worth** (nw) is the total amount of resources available to the firm

$$nw = \max_{l} pzk^{\theta}l^{\nu} - wl + q(1-\delta)k - b - \Phi \tag{2}$$

- Firm purchasing new **capital** (k') by acquiring new **debt** (b') with an optimal **debt contract type** (χ')

$$v_t(z, nw; \chi) = \max_{k', b'; \chi'} \quad nw - q_t k' + \mathcal{Q}_t b' + \mathbb{E}_t[\Lambda_{t+1}(\pi_d n\hat{w}_{t+1}(z', k', b') + (1-\pi_d)v_{t+1}(z', n\hat{w}_{t+1}(z', k', b'); \chi'))] \tag{3}$$

subject to

- non-negativity constraint on **dividends** $\rightarrow nw - q_t k' + \mathcal{Q}_t b' \geq 0$
- **debt contract** (χ') terms hold

Debt Contracts

- Firm chooses one of the contracts $\rightarrow \chi_{t+1}^{Asset}(\gamma; q), \chi_{t+1}^{Cash}(\gamma; \pi)$

  where $\gamma = \{z', n\hat{w}_{t+1}(z', k', b')\}$

- Financial intermediary specify the borrowing limits to be the smallest number to satisfy the below inequalities
  - **Asset-based contract** yields $b' \leq \bar{b}(z, nw, k', q)$

$$v_{t+1}^{Asset}\left(z', n\hat{w}_{t+1}\left(z', k', b'\right)\right) \geq v_{t+1}^{Asset}\left(z', n\hat{w}_{t+1}\left(z', (1-\Theta)k', 0\right)\right) \quad \forall z' \quad (4)$$

  - **Cash flow-based contract** yields $b' \leq \bar{b}(z, nw, k', \pi)$

$$\begin{aligned} v_{t+1}^{Cash}\left(z', n\hat{w}_{t+1}\left(z', k', b'\right)\right) \geq & v_{t+1}^{Cash}\left(z', n\hat{w}_{t+1}\left(z', k', 0\right)\right) \\ & - W_{t+1}\left(z', n\hat{w}_{t+1}\left(z', k', b'\right)\right) \end{aligned} \quad (5)$$

  where

$$W_{t+1}\left(z', n\hat{w}_{t+1}\left(z', k', b'\right)\right) = \varphi[\underbrace{p_{t+1}z'\left(k'\right)^{\theta}\left(l'\right)^{\nu} - w_{t+1}l'}_{\approx \pi}] \quad \forall z'$$

◂ Go Back

Results

Calibration

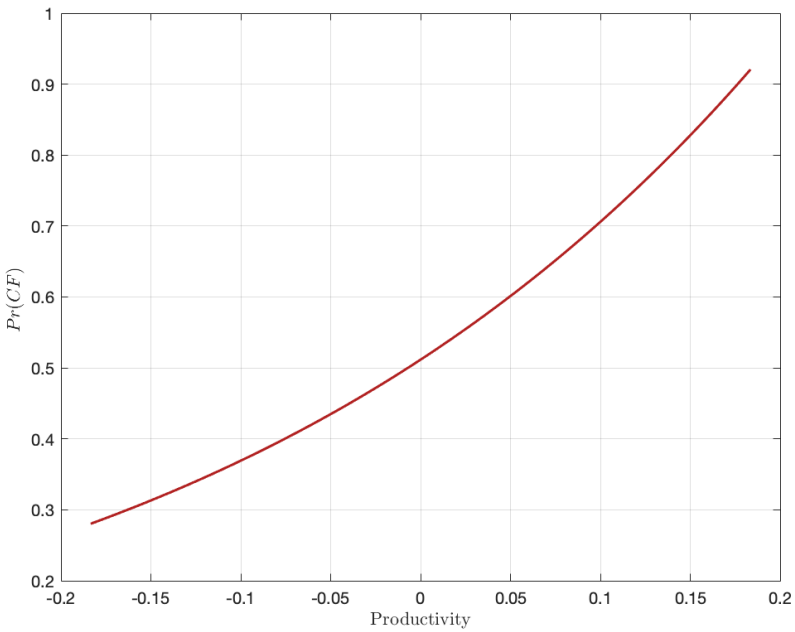
- No equilibrium default
- ρ_z and σ_z of the $AR(1)$ idiosyncratic productivity shock process to match
  - Average investment rate
  - Dispersion of investment rate
- Calibrate recoverability parameter Θ, EBITDA multiple φ, and the operating cost Φ to match
  - Shares of asset based and cash flow based borrowers
  - Fraction of firms with positive debt
  - Mean of gross leverage ratio
- Standard calibration for the remaining parameters

▸ Model Fit

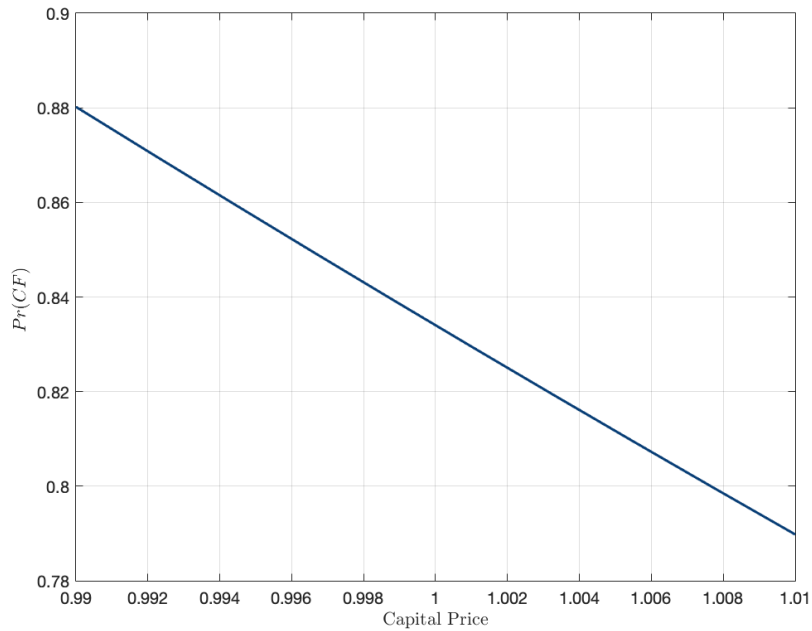
Contract Choice

- A panel of firms simulated

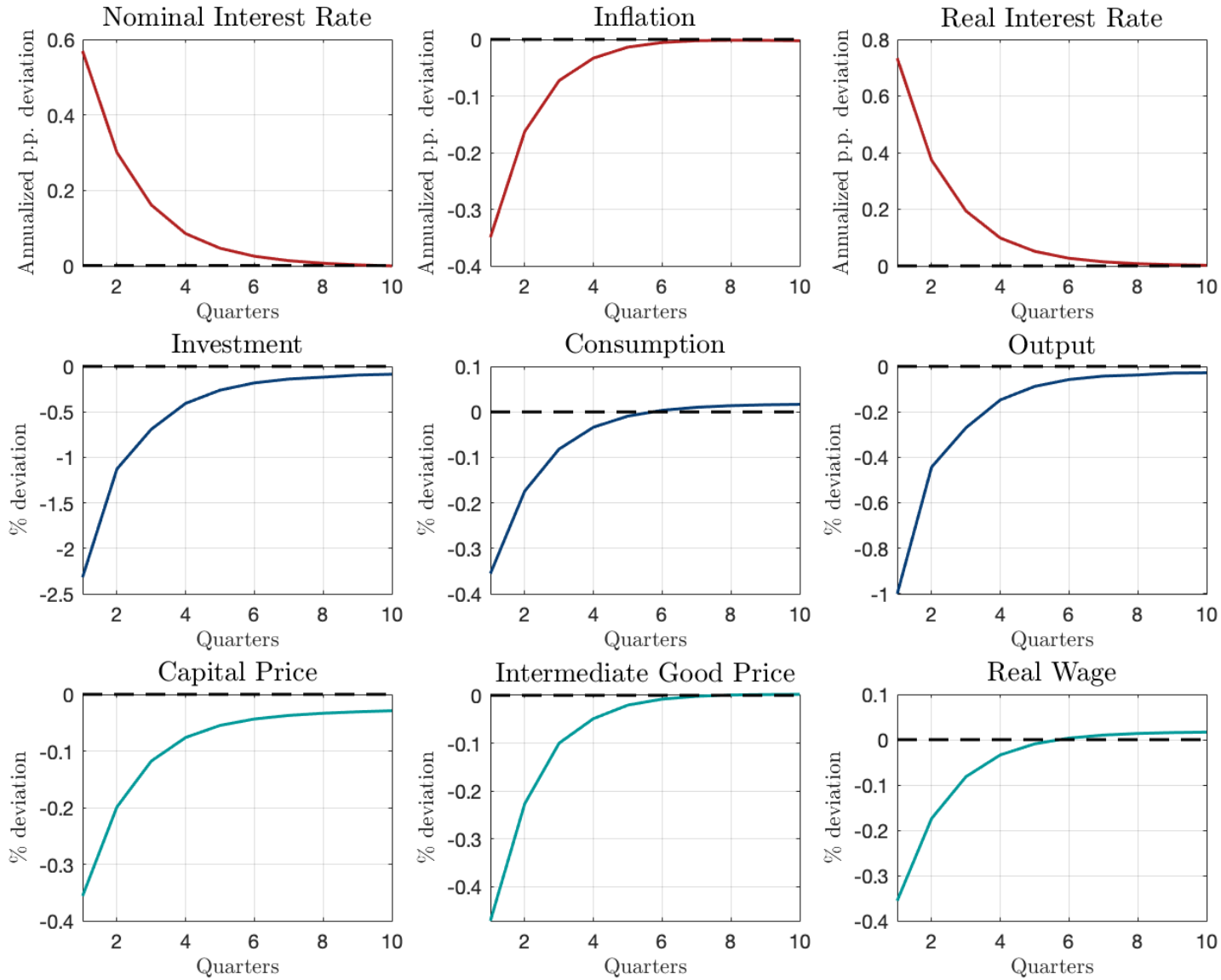
(A) Productivity



(B) Capital Price



Aggregate Responses to a Contractionary Monetary Shock



Share Response

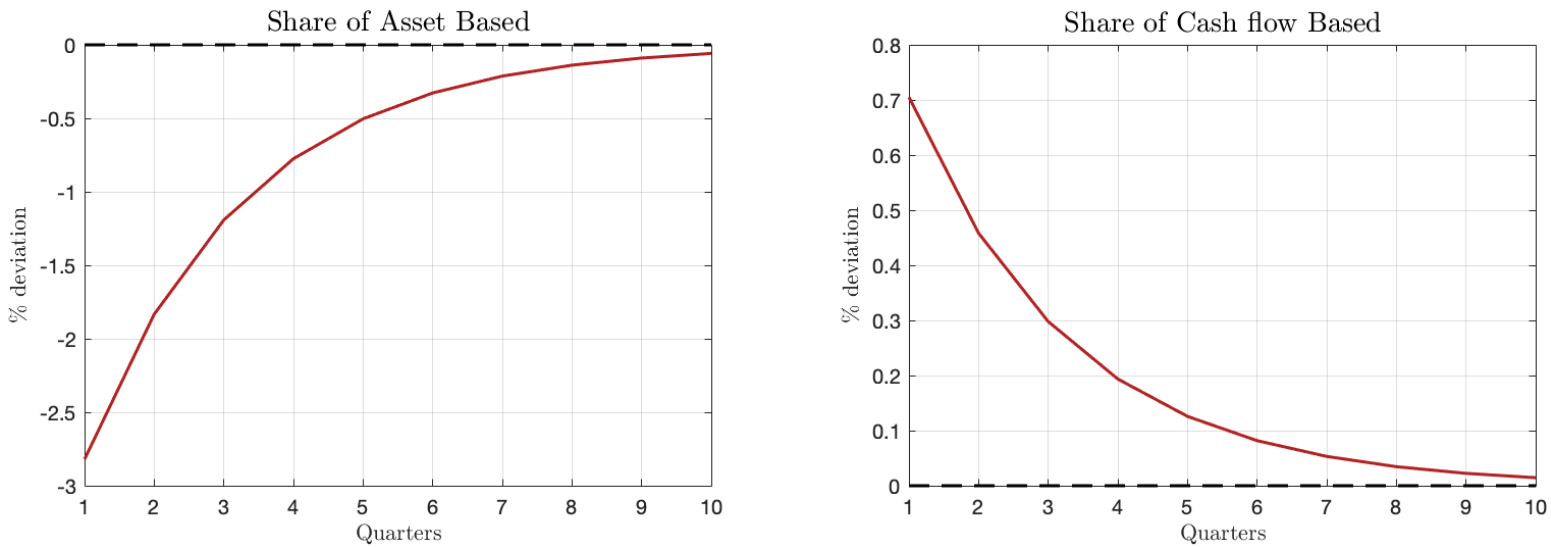
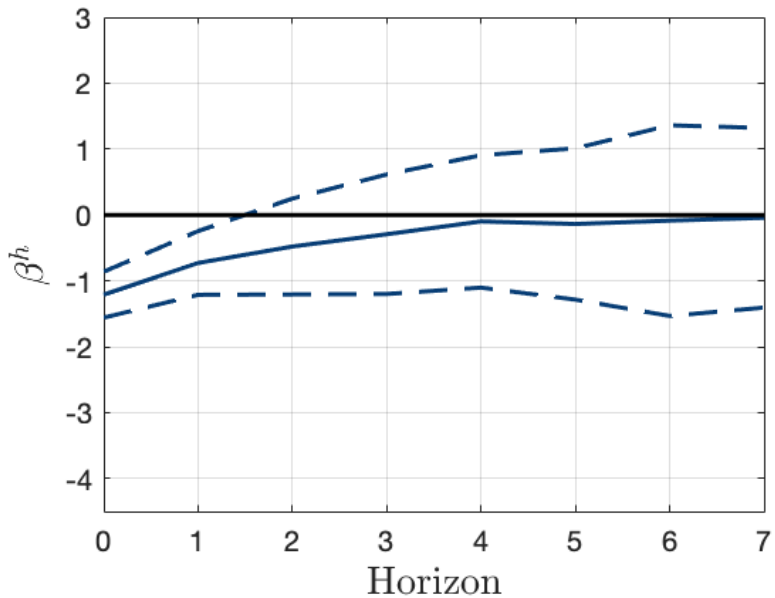


Figure: Investment response to contractionary monetary shock

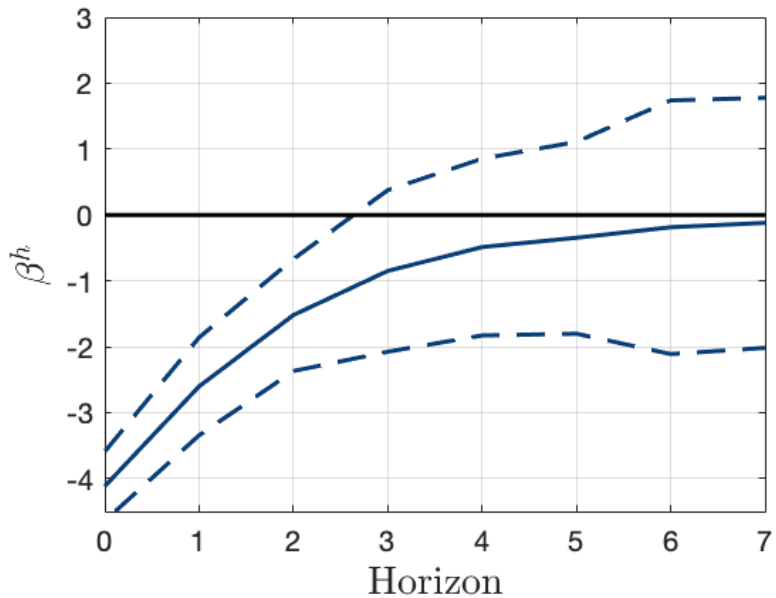
Differential Responses

- Represents the **relative** response of **asset-based** to **cash flow-based** borrowers

(a) Investment



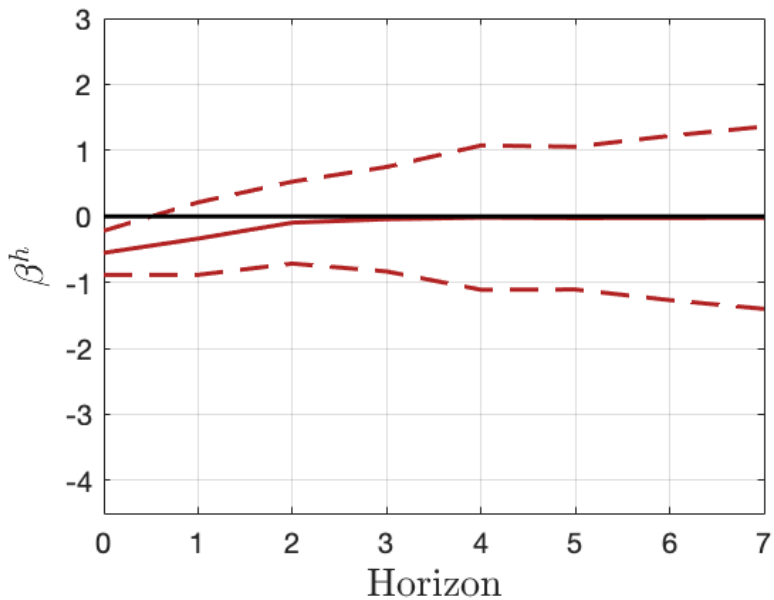
(b) Borrowing



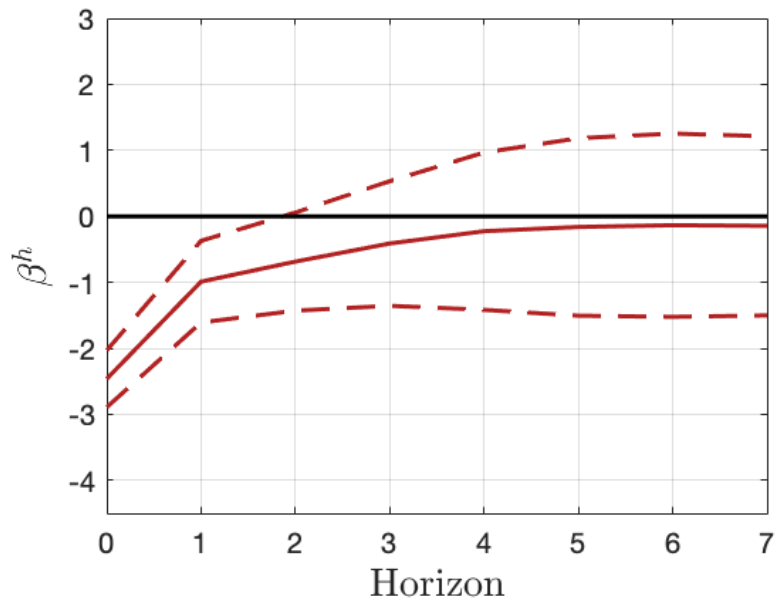
Differential Responses when $\Delta q = 0$

- Asset price switched off by making capital price adjustment flexible $\rightarrow \phi = 0$
- **Time-invariant** capital price, $q_t = \bar{q}$ for all t

(A) Investment



(B) Borrowing



Conclusion

- Novel model capturing key empirical facts about corporate debt limits and investigating the active channel on the monetary policy transmission.
  - Role of firm characteristics
  - Facing **contractionary** monetary shock
    - Asset based borrowers are more responsive
- Asset price channel to explore with a quantitative model
  $\rightarrow$ macrofinance + **cash flow-based borrowing limit**
  - **Cash flow-based** borrowers are less vulnerable to collateral channel via asset price fluctuations
    - **Financial accelerator** mostly effective on asset based borrowers
    - Raises monetary policy concern $\rightarrow$ fighting inflation, but watchful on the asset-based borrowers
- **Further work.**
  - Role of banks
  - Implications for **quantitative easing**
    $\rightarrow$ also transmits through asset prices

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Detour: Firm Valuation - I

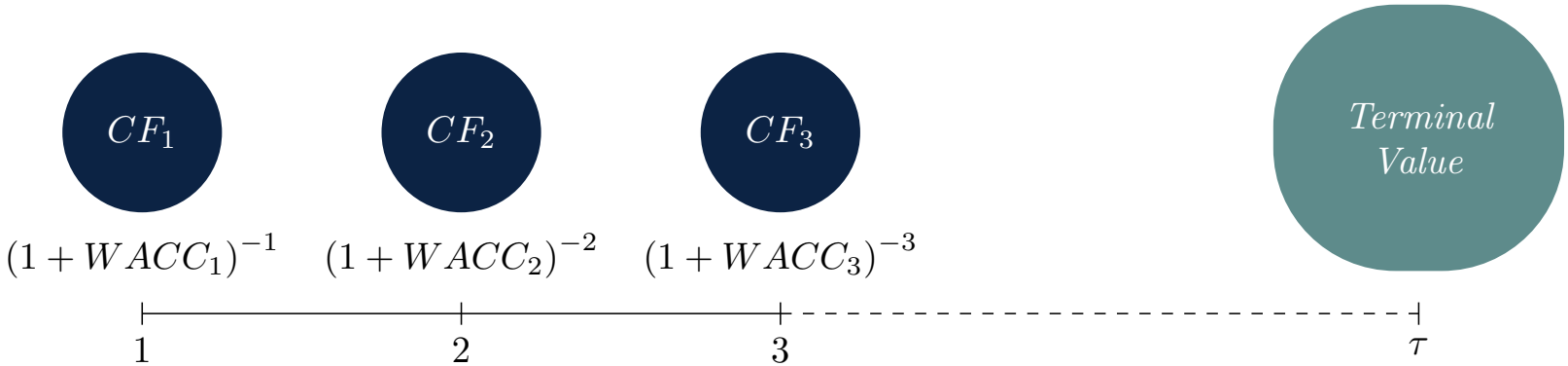


Figure: Discounted Cash flow Analysis

where terminal value is defined as $TV = \frac{CF}{WACC-g}$

- Contractibility issues
  - Cash flow values
  - Years until terminal value
  - WACC
  - Steady state growth rate, g

Go Back

Detour: Firm Valuation - II

- Relative Valuation
  - Comparables or multiple analysis
- Contractibility issues
  - Appropriate measure: P/E or V/EBITDA
  - Choosing the comparable firms
  - Relative value not intrinsic

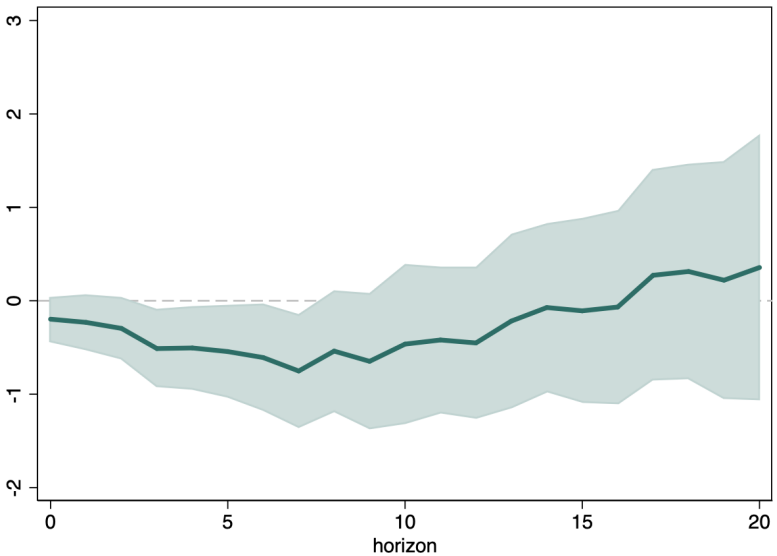
Go Back

Monetary Policy Shocks

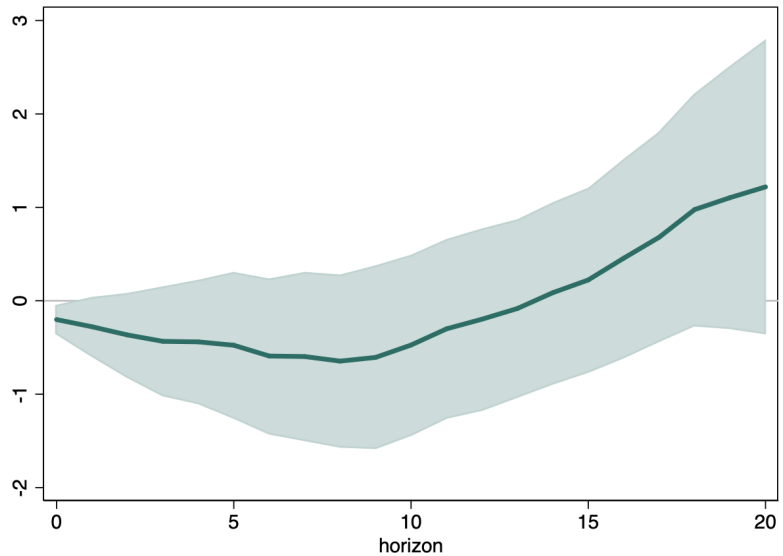
- Identification via (Gürkaynak, Sack, and Swanson, 2005)
- Robustness check via (Nakamura and Steinsson, 2018)

◂ Go Back

Credit Spread Response



(A) β_1^h: Asset Based Borrowers



(B) β_2^h: Cash-flow Based Borrower

Figure: Response of credit spread to a contractionary monetary shock

External Finance Dependence

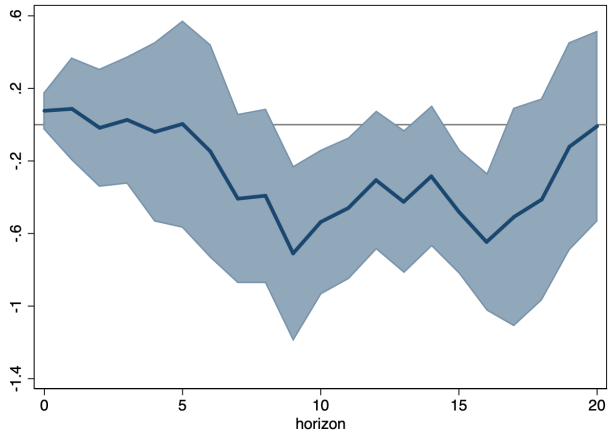
Following (Rajan and Zingales, 1998)

$$ExFin = \frac{\text{Capital Expenditures} - \text{Cash Flow from Operations}}{\text{Capital Expenditures}} \tag{6}$$

and run the Local Projections variant

$$\begin{aligned} y_{j,t+h} - y_{j,t-1} = \alpha_j^h + \sum_{x \in \{\chi\}} \beta_x^h \left(\epsilon_t^m \mathcal{I}_{j,t-1}^x\right) + \\ \sum_{p=1}^{P_Z} \Gamma_p \mathbf{Z}_{j,t-p} + \sum_{p=1}^{P_X} \Gamma_p \mathbf{X}_{t-p} + e_{j,t+h}. \end{aligned} \tag{7}$$

External Finance Dependence - *Low*



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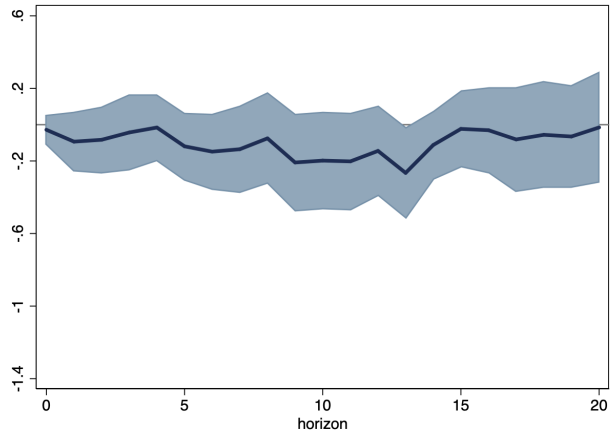
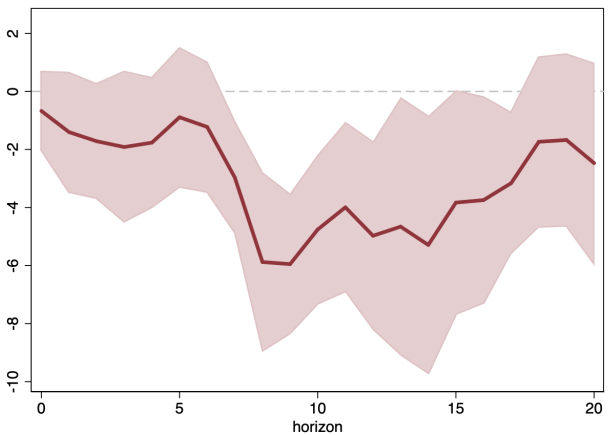
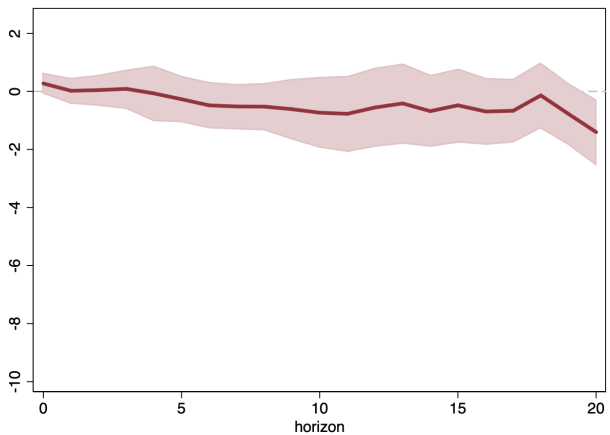


(B) β_2^h: Cash-flow Based Borrower



(C) β_1^h: Asset Based Borrowers



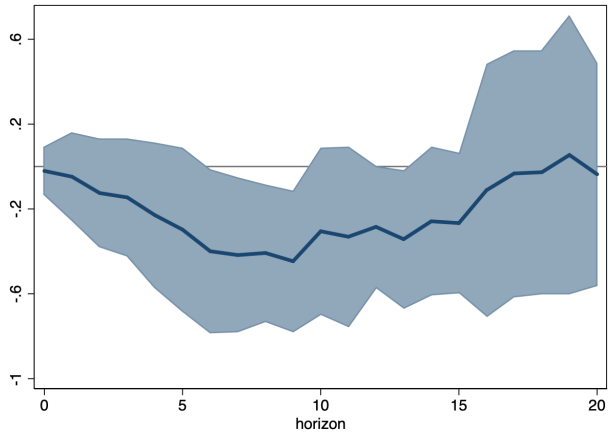
(D) β_2^h: Cash-flow Based Borrower

Regional Heterogeneity

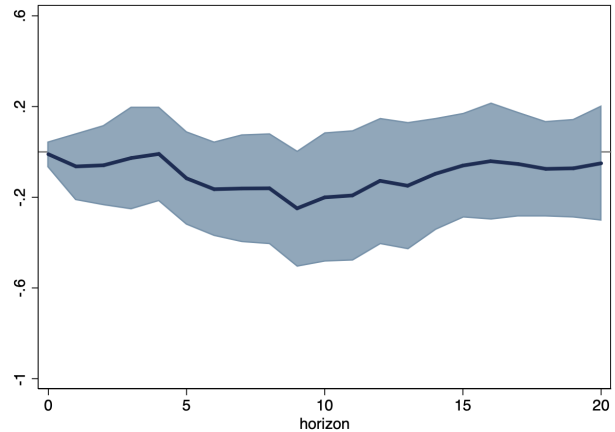
Following (Bahaj, Pinter, Foulis, and Surico, 2019), an alternative specification with **Regional Dummy** to capture the regional response of real estate prices

$$y_{j,t+h} - y_{j,t-1} = \alpha_j^h + \gamma_l^h + \beta_1^h \left(\epsilon_t^m \mathcal{I}_{j,t-1}^{Asset}\right) + \beta_2^h \left(\epsilon_t^m \mathcal{I}_{j,t-1}^{Cash}\right) + \sum_{p=1}^{P_Z} \Gamma_p \mathbf{Z}_{j,t-p} + \sum_{p=1}^{P_X} \Gamma_p \mathbf{X}_{t-p} + e_{j,t+h}. \tag{8}$$

Regional Heterogeneity



(A) β_1^h: Asset Based Borrowers



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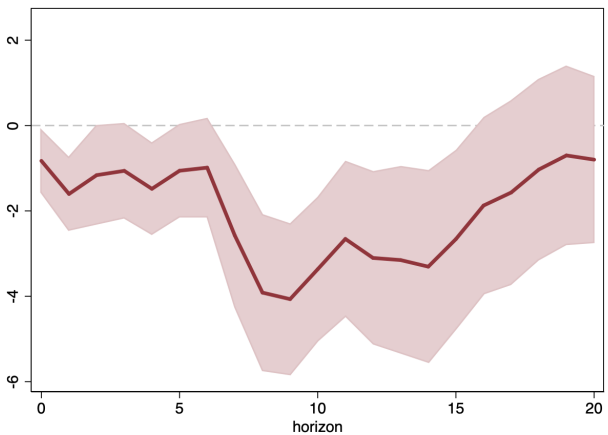

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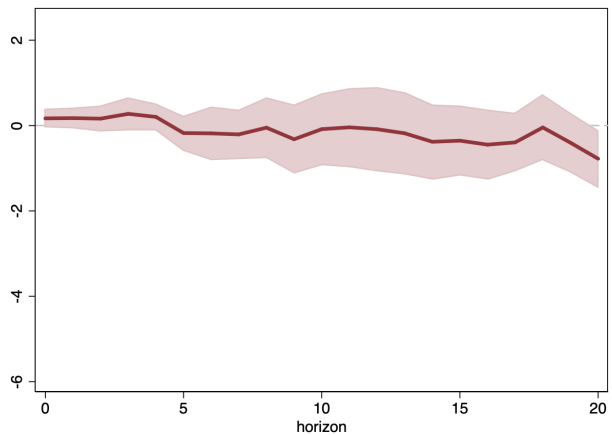

(D) β_2^h: Cash-flow Based Borrower

DealScan

- **Basics**
  - Detailed **syndicated loan** database from 1997Q1 - 2017Q3
  - **Wide-format** data with unit of observation is **loan facility**

- **Real life practices**
  - Syndication occurs when a loan falls outside the **risk tolerance** of a bank
    - Each member bank share the risk → only exposed to their portion
  - One **master** agreement for the entire syndicate → organized by the consortium leader governing the loan shares and its terms.
    - Terms can change among lenders except the debt covenant

- **Data Treatment**
  - Covenant info at the **package** level including several loan facilities.
    - First layer aggregation: **facility** → **package**
    - Second layer aggregation: **package** → **firm**
  - Merged with **Compustat** by (Chava and Roberts, 2008) linking file

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CAPM Specification

$$r_{j,t-\tau} - r_{f,t-\tau} = \alpha_j^\tau + \beta_j^\tau \left(r_{m,t-\tau} - r_{f,t-\tau}\right) + e_{j,t-\tau} \qquad (9)$$
$$\tau = 0, 1, \ldots, \mathrm{T}$$

- **Correlation** measure
- A **separate** time series regression for each firm
- Monthly data from **CRSP**
- **Rolling regressions** using a window of 36-months (following the literature and real life practices)
- r_j, r_f, and r_m is stock return, risk-free rate, and S&P 500 index return
- Yield time series for α_j **(Jensen's alpha)** and β_j **(Stock Beta)**
  - Merged with **Compustat** $\rightarrow$ **alpha** and **beta** for each firm-quarter observations

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Summary Stats (Full)

Asset-based

	Mean	SD	P25	Median	P75
Firm Total Assets ($M)	1679.83	3708.59	167.66	527.41	1514.06
Firm Age (years)	32.94	31.86	11.75	21.50	39.50
Firm Leverage	0.32	0.24	0.14	0.28	0.46
Firm Asset Pledgeability	**0.70**	**0.19**	**0.59**	**0.74**	**0.85**
Firm EBITDA	0.44	1.60	0.02	0.10	0.39
Loan Spread (pp)	2.36	0.95	1.75	2.25	2.75
Loan Maturity (months)	53.62	23.41	36.00	60.00	60.00
Stock Jensen's Alpha (x10^{-2})	-0.54	3.39	-2.00	-0.30	1.15
Stock Beta	**1.68**	**1.06**	**0.99**	**2**	**2.2**
Total Observations	8,135				

Cash flow-based

	Mean	SD	P25	Median	P75
Firm Total Assets ($M)	2596.18	4659.20	378.98	973.15	2419.20
Firm Age (years)	34.73	35.05	11.25	22.25	44.25
Firm Leverage	0.32	0.25	0.16	0.29	0.44
Firm Asset Pledgeability	0.57	0.23	0.40	0.59	0.75
Firm EBITDA	**0.84**	**1.82**	**0.10**	**0.30**	**0.84**
Loan Spread (pp)	1.99	1.15	1.25	1.75	2.50
Loan Maturity (months)	59.16	18.37	57.00	60.00	60.00
Stock Jensen's Alpha (x10^{-2})	**-0.33**	**2.80**	**-1.39**	**-0.10**	**0.97**
Stock Beta	1.44	0.99	0.82	1	1.89
Total Observations	55,405				

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Household

- Owns all production entities in the economy
- Choose **consumption**, **labor**, **risk free saving instrument**, and **firm share**
- Representative household solves the below problem

$$V(a,\eta) = \max_{c,l,a',\eta'} \quad \log c + \psi l + \beta V(a',\eta') \tag{10}$$

subject to

$$\begin{aligned} c + a' + \int_{\mathbf{S}} \rho\left(nw', z'\right) \eta'\left(nw', z'\right) = wl + (1+r)a + \Psi_P + \iota \\ + \int_{\mathbf{S}} \rho\left(nw, z\right) \eta\left(nw, z\right) \end{aligned} \tag{11}$$

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Financial Intermediary

- Pass-through
- Offers two forms of debt contracts
- Collects deposits D from households and lends B to firms. Λ^h is the stochastic discount factor of the financial intermediary's owner (*i.e.* households).

$$V_F(D, B) = \max_{D', B'} \quad D' - B' + \Lambda^h V_F(D', B') \tag{12}$$

subject to

$$D' - B' \leq (1 + r^B)B - (1 + r^D)D \tag{13}$$

- Optimality requires: $r^B = r^D$

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New Keynesian Components

- **Retailers:**
  - Continuum of retailers.
  - Each retailer produces a differentiated variety $\tilde{y}_{j,t}$ by using heterogeneous production firm j's good $y_{j,t}$ as its only input:

$$\tilde{y}_{j,t} = y_{j,t} \tag{14}$$

  - Have market power $\rightarrow$ can set a relative price, $\tilde{p}_{j,t}$ for their variety by paying the quadratic price adjustment cost: $\frac{\varphi}{2}\left(\frac{\tilde{p}_{it}}{\tilde{p}_{it-1}} - 1\right)^2 Y_t$
- **Final Good Producer:**
  - Representative
  - Produces final good by using differentiated varieties, $\tilde{y}_{j,t}$ by below production technology

$$Y_t = \left(\int \tilde{y}_{it}^{\frac{\gamma-1}{\gamma}} \, \mathrm{d}i\right)^{\frac{\gamma}{\gamma-1}} \tag{15}$$

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Capital Good Producer

- New capital is produced by a perfectly competitive capital good producer. With this agent, model is able to create a time varying price of capital
- Buys already installed capital, $(1-\delta)K_t$, adds new investment, I_t , and generate new installed capital, K_{t+1} for the next period
- Corresponding law of motion for capital

$$K_{t+1} = \phi\left(\frac{I_t}{K_t}\right) I_t + (1-\delta)K_t \tag{16}$$

- Profit maximization pins down the relative price of capital as

$$q_t = \frac{1}{\phi'\left(\frac{I_t}{K_t}\right)} \tag{17}$$

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Calibration Targets and Model Fit

Moment	Description	Data	Model
k_0	Initial capital	0.25	0.27
$\frac{b}{k}$	Gross Leverage Ratio	0.42	0.47
Share (b_A)	Fraction of asset based to total debt	0.16	0.16
Share (b_C)	Fraction of cash flow based to total debt	0.84	0.84
Share ($b > 0$)	Firms with positive debt	0.81	0.63
$\mathbb{E}\left(\frac{i}{k}\right)$	Average investment rate	0.23	0.21
$\sigma\left(\frac{i}{k}\right)$	SD investment rate	0.45	0.48

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