Sectoral Volatility and the Investment Channel of Monetary Policy

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Motivation

Firms' investment is key transmission from monetary policy to real economy.

- Firm heterogeneity shapes the aggregate response in a number of dimensions (Ottonello, Winberry (2020), Jeenas (2019), Cloyne, Ferreira, Froemel, Surico (2019))
- we focus on **firm risk**: dispersion in idiosyncratic productivity shocks

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- idiosyncratic shocks are major source of variation
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Research Question:

how does **dispersion in idiosyncratic shocks** affect the **investment channel** of monetary policy.

$\Rightarrow$ **we construct measures of idiosyncratic risk using firm-level panel data to answer these questions**

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Why is this important?

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- most volatile component of GDP, and strongly procyclical
- most responsive to MP operations

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Our Contributions?

1. **evidence**: idiosyncratic risk in the form of higher dispersion in productivity shocks at the firm-level matters for monetary policy transmission.
2. **explanation**: why monetary policy is weaker in recessions: volatility rises, the extensive margin of business investment is harder to set off, and so the investment channel is weaker. (finding of Tenreyro & Thwaites)

This Paper

Empirics:

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- regression (LP) analysis: interact monetary policy shocks with measures of volatility

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Preview of Findings

- IRFs: **qualitatively** and **economically** significant dampening of investment response to MP when volatility is high
- Moving from the 10th$\rightarrow$90th percentile of sector volatility **approx halves IRF**
- fairly consistent pattern across measures of volatility

Stylized Mechanisms

mechanisms in mind:

Real Options effects

- $k^* = c \cdot z^{\frac{1}{1-\alpha}}$. convexity: expected future dispersion* raises value of waiting (upside)
- harder to trigger the extensive margin **today** due to fixed costs (double-paying)
- Firms freeze investment/hiring decisions, insensitive to prices/policy today

Irreversibility frictions

- dispersion $\rightarrow$ more likely irr. constraint binds (more likely to hit constrained space)
- constrained choice: $k^{cons}_{t+1} = (1-\delta)k_t =$ independent of aggreagate shocks/policy

Nominal Adjustment channel

- becomes relatively more attractive to reset prices than K,N

Empirics

Dataset and Sample Selection

Compustat: quarterly firm panel

- based in US
- trading in USD
- exclude Finance and Real Estate
- sample period limited to 2001-2012 by MPS series

Capital, K: perpetual inventory method to back out stocks

- $K_{it+1} = K_{it} + [X_{it} - \delta_{s,t} K_{it}] = \textit{book value}, \texttt{PPEGT}_{t_0} + \textit{Net Investment}_t$

CapX, X_k: investment expenditures

Labour, N: direct employment (annual) or proxy, COGS (quarterly)

LabX X_n: labour expenses (emp*avg ind wage, annual)

Output Y: revenue only, no P-Q split

Constructing Firms' Productivity

3 approaches to estimating productivity

- **Cost Share**: Cobb-Douglas production function and competitive factor markets:

$$y_{it} = z_{it} + \alpha_{s(i),t} k_{i,t} + (1 - \alpha_{s(i),t}) n_{i,t} \quad \alpha^{k}_{s(i),t} = median \left\{ \frac{X^k_{it}}{X^k_{it} + X^n_{it}} \middle| s(i), t \right\} \tag{1}$$

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- **Control Function** Investment monotonic function of productivity given state X (age, size)

$$I = f(z, X) \Leftrightarrow z = g(I, X) \tag{2}$$

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- **Generalised Method of Moments** AR1 process for TFP, set errors orthogonal to instruments. Relaxes assumptions on factor markets.

$$y_{it} - \rho_s y_{it-1} = \alpha^n_s (n_{it} - \rho_s n_{it-1}) + \alpha^k_s (k_{it} - \rho_s k_{it-1}) + \underbrace{(z_{it} - \rho z_{it-1})}_{\varepsilon_{it}}$$

$$\textit{moment condition:} \quad E(Z\varepsilon) = 0, \textit{instruments: } k_t, k_{t-1}, n_{t-1} \tag{3}$$

Firm Risk: Volatility of idiosyncratic shocks

sector specific AR(1) process:

$$(z_{it} - \rho_s z_{it-1} - X_{it-1}\beta_s - f_i - \lambda_{s,t}) = \varepsilon_{it} \tag{4}$$

baseline volatility: 2nd moment

$$volatility : v_s = sd\left(\varepsilon_{it}|s\right) \tag{5}$$

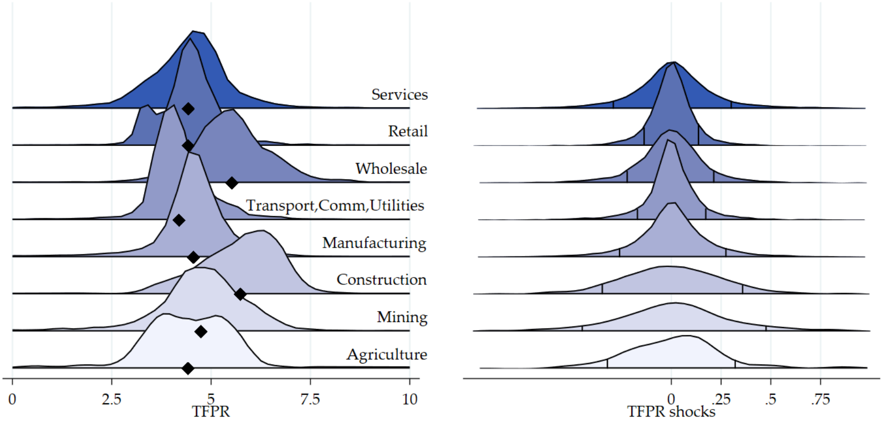
$$v_{s,y} = sd\left(\varepsilon_{it}|s, y(t)\right) \tag{6}$$

(also compute other moments, e.g. IQR, 90-10 ratio, as robustness)

$$\textit{sector specific AR(1) process: } (z_{it} - \rho_s z_{it-1} + X_{it-1}\beta_s + f_i + \lambda_{s,t}) = \varepsilon_{it} \tag{7}$$

(a) TFPR levels, z

(b) Shocks, ε



LP Regressions

Direct Effect: Investment Response to Fed Tightening

- regress Investment on Miranda-Agrippino Ricco (AEJ macro 2021) high-frequency shocks

$$\Delta_{h+1} log\ k_{it+h} = f_i + \lambda_{\mathbf{SIC1}(s),\mathbf{y}(t+h)} + \beta_h^m \epsilon_t^m + \delta_h' \mathbf{X}_{ist-1} + u_{ist+h} \tag{8}$$

Investment response (ppts) at	(1) +4 quarters	(2) +8qtrs	(3) +12qtrs
Fed Tightening (1ppt)	-0.0194	-0.0503**	-0.0172
	(0.0157)	(0.0208)	(0.0211)
Firm FE	Yes	Yes	Yes
Industry-2digit × Year FE	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes
Observations	188277	171377	156508
R2	0.0305	0.0284	0.0343

Standard errors in parentheses, clustered at firm and quarter levels.

covars: size, sales gr, financial conditions, tobinq, dividend, leverage, fiscal qtr

Simple Volatility-MP Interaction Specification

$$\Delta_{h+1} log\ k_{i,s,t+h} = f_i + \left(\beta_h + \gamma_h v_{s,y(t)-1}\right)\epsilon^m_t + \delta'_h \mathbf{X}_{ist-1} + u_{ist+h} \tag{9}$$

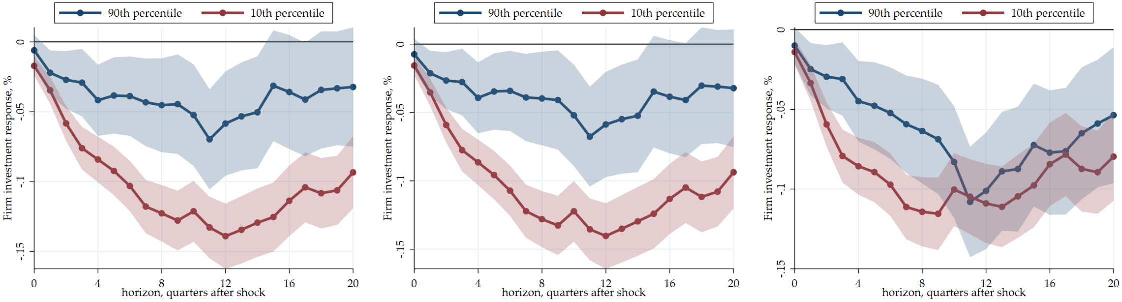


Figure 1: Implied IRFs at high and low volatility

twoway-clustered SEs at (firm,quarter) levels.

Full specification local projections:

$$\Delta_{h+1} log\ k_{it+h} = f_i + \lambda_{\texttt{SIC1}(s),t+h} + \left(\beta_h + \beta_h^m \epsilon_t^m\right) vol_{s,y(t)-1} + \left(\delta_h' + \epsilon_t^m \delta_h^{m\prime}\right) \mathbf{X}_{ist-1} + u_{ist+h} \tag{10}$$

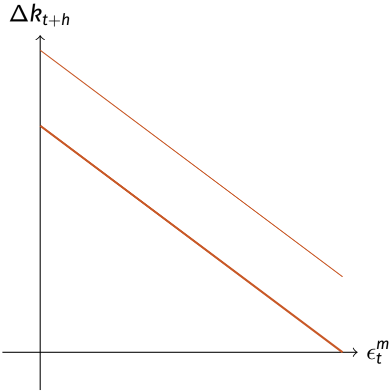
Variables:

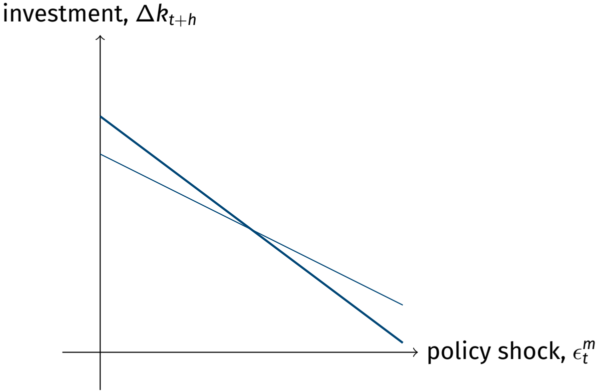
- ϵ_t^m: high-frequency identified monetary policy shock (Miranda-Agrippino & Ricco)
- v_s: sector volatility ($v_{s,y-1}$)
- covars: size, age, leverage, liquidity, dividend status, tobin q; firm and industry-quarter effects.

Structure

- linear ϵ_t^m term is absorbed in 1-digit industry non-parametric time trends
- shifters ($\beta_h, \delta_h, f, \lambda$) take care of *level effects* on investment
- wedges (β_h^m, δ_h^m) allows *differential slopes* wrt volatility and covariates

$$\Delta_{h+1} log\ k_{it+h} = f_i + \lambda_{\texttt{SIC1(s)},t+h} + \left(\beta_h + \beta_h^m \epsilon_t^m\right) v_{s,y(t)-1} + \left(\delta_h' + \epsilon_t^m \delta_h^{m\prime}\right) \mathbf{X}_{ist-1} + u_{ist+h} \tag{11}$$





Full Interaction Specification

$$\Delta_{h+1} log\ k_{i,s,t+h} = f_i + \lambda_{\mathtt{SIC1}(s),t+h} + \left(\beta_h + \beta_h^m \epsilon_t^m\right) \mathbf{v}_{s,y(t)-1} + \left(\delta_h' + \epsilon_t^m {\delta^m}'_h\right) \mathbf{X}_{ist-1} + u_{ist+h} \tag{12}$$

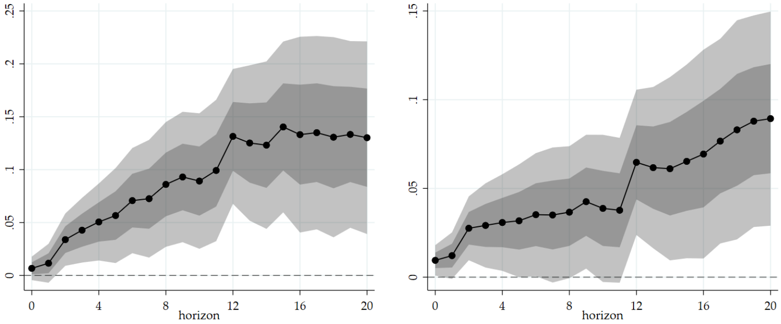


Figure 2: Cost Share Volatility (L) time-pooled (R) time-varying

twoway-clustered SEs at (firm,quarter) levels.

Further Results / Ongoing

Qualitatively similar story across

- Cost Share, Control Function, GMM
- Time-invariant dispersion vs time-varying
- Other faster-moving quarterly proxies (sales growth volatility, VIX)

...under construction

- quarterly TFPR and volatility based on CAPX and COGS for LABX
- discriminate between channels?
    - intangible-rich firms cut back inv more wrt volatility? (irreversibility)
    - higher persistence in v makes it easier to predict dispersion, less wait-and-see? (real options)

To Conclude

Main takeaway:

- dispersion of idio. productivity shocks key determinant of firm investment channel of monetary policy

Policy implications:

- monetary policy is weaker when idio. volatility is high, typically in recessions

Thanks for your attention!

Comments and feedback welcome:

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