Do Higher Interest Rates Make The Banking System Safer? Evidence From Bank Leverage

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Bank of Finland and CEPR Joint Conference 2024

Back to Basics and Beyond: New Insights for Monetary Policy Normalisation

Motivation

Paul Samuelson (AER, 1945)

"Simple truths need constant repetition...

1. *The banking system as a whole is not really hurt by an increase in the whole complex of interest rates. It is left tremendously better off by such a change.*
2. *A typical single bank, taken by itself, is not really hurt by an increase in the whole complex of interest rates. It is left better off by such a change."*

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Janet Yellen (2014)

"that low interest rates contribute to increased leverage and reliance on short-term funding points toward some ability of higher interest rates to lessen these vulnerabilities"

Motivation

Theory

Vast theoretical literature predicts contractionary monetary policy makes banks safer through *reducing* bank leverage.

Why Leverage?

Theoretical predictions

(i) Van der Ghote (AEJ:Macro, 2021) / Martin, Medicino, Van der Ghote (ECB DP, 2021)
"This is true in most models . . . By tightening ex ante, monetary policy contributes to reducing credit and, more specifically, leverage"

(ii) Martinez-Miera & Repullo (ARE, 2021) (extending MMR (ECMA, 2017))
"Such [monetary] tightening reduces aggregate investment . . . and reduces bank leverage and risk-taking"

(iii) Drechsler, Savov, Schnabl (JF, 2018)
"Lower nominal rates make liquidity cheaper and raise leverage"

(iv) Dell'Ariccia, Laeven, Marquez (JET, 2014)
"We obtain two main findings. First, a reduction in risk-free interest rates leads banks to increase their leverage."

(v) Angeloni and Faia (JME, 2013)
"The increase in interest rate activates the risk taking channel: bank leverage and risk decline"

(vi) Woodford (NBER WP, 2012)
"It is appropriate to use monetary policy to 'lean against' a credit boom, even if this requires both inflation and the output gap to be below their medium-run target values for a time."

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Limited empirical evidence & minimal discussion of core mechanisms.

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Why this matters

I. Positive: How does monetary policy transmit through banks?
II. Normative: Should monetary policy target financial stability?

Debate

This paper

Research Question

(i) Empirically, how do monetary policy shocks affect bank leverage?

(ii) What mechanism can explain this?

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Summary of Findings

(i) Contrary to claims from much theoretical literature, contractionary MP shocks increase bank leverage: ↑ FFR 1pp ⇒ ↑ bank leverage 5-10%

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(ii) Empirical evidence of a loan-loss mechanism:
MP shock $\Rightarrow$ loan losses $\uparrow$ $\Rightarrow$ profit $\downarrow$ $\Rightarrow$ bank equity $\downarrow$ $\Rightarrow$ leverage $\uparrow$

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(iv) Evidence from micro data consistent with role of floating-rate loans

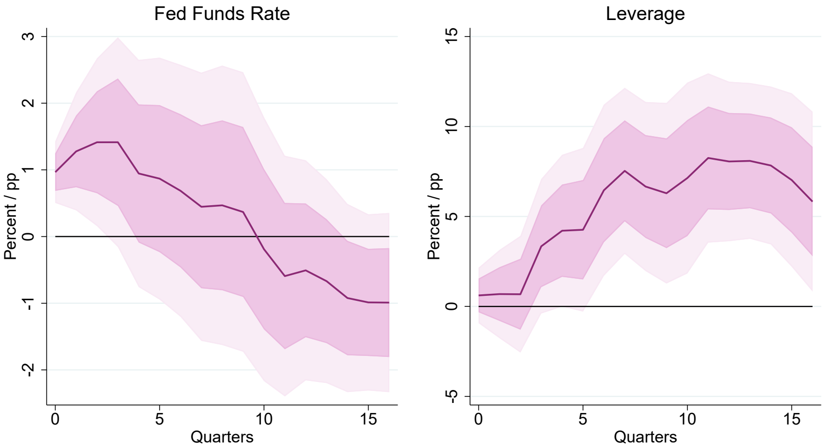
Econometric Approach

For $h = 0, \ldots, H$, I estimate the following series of Jordà local projections using FDIC quarterly data between 1984 and 2006:

$$z_{t+h} = \alpha_h + \sum_{l=0}^{L} \beta_{h,l} Shock_{t-l} + \sum_{m=1}^{M} \gamma_{h,m} z_{t-m} + \sum_{q=2}^{4} \delta_q Quarter_{qt} + \epsilon_{t+h} \qquad (1)$$

- z_{t+h}: variable of interest (e.g., leverage).
- $Shock_{t-l}$: monetary policy shock series
- z_{t-m}: lag-augmentation (see Montiel Olea & Plagborg-Møller (ECMA, 2021)).
- Baseline horizon and lags: $H = L = M = 16$
- IRF is sequence $\{\beta_{h,0}\}_{h=0}^{H}$ which captures the response of z at time $t + h$ to $Shock$ at time t.
- Robustness checks: use alt. definition of leverage, vary lags, include time trends, vary sample periods, and use different MP shock series.

The Response of Bank Leverage



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Definition | Time Periods | Lags | Shocks | Market Leverage

Loan-Loss Mechanism

Contractionary Shock

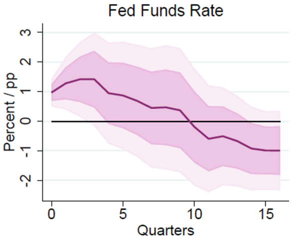
$\Rightarrow$ Leverage $\uparrow$

Loan-Loss Mechanism

Contractionary Shock $\Rightarrow$ Loans Passed Due $\uparrow$ $\Rightarrow$ Loan Losses $\uparrow$

$\Rightarrow$ Profits $\downarrow$ $\Rightarrow$ Book Equity $\downarrow$ $\Rightarrow$ Leverage $\uparrow$

Loan-Loss Mechanism



⇒ Loans Passed Due ↑

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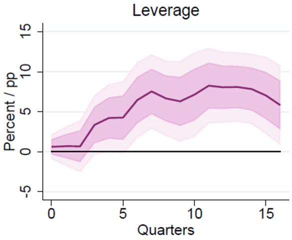
⇒ Profits ↓

⇒ Book Equity ↓



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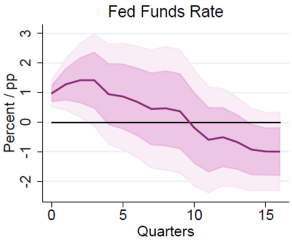

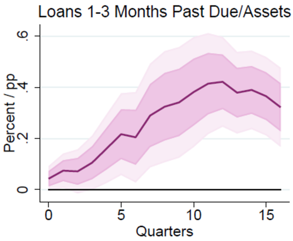

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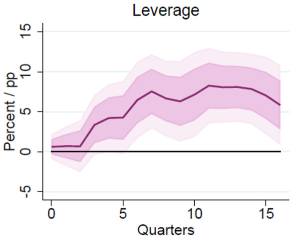

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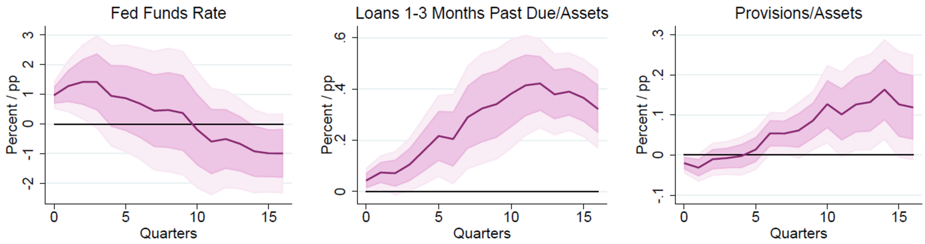

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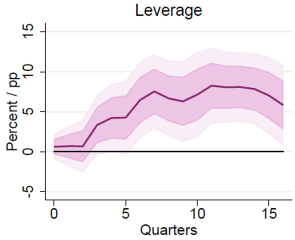

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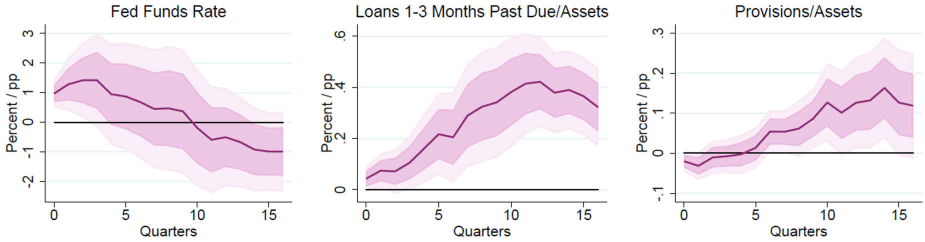

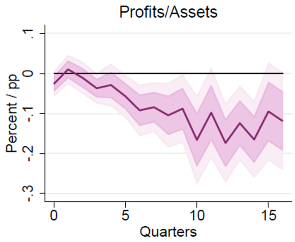

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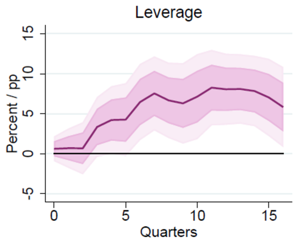

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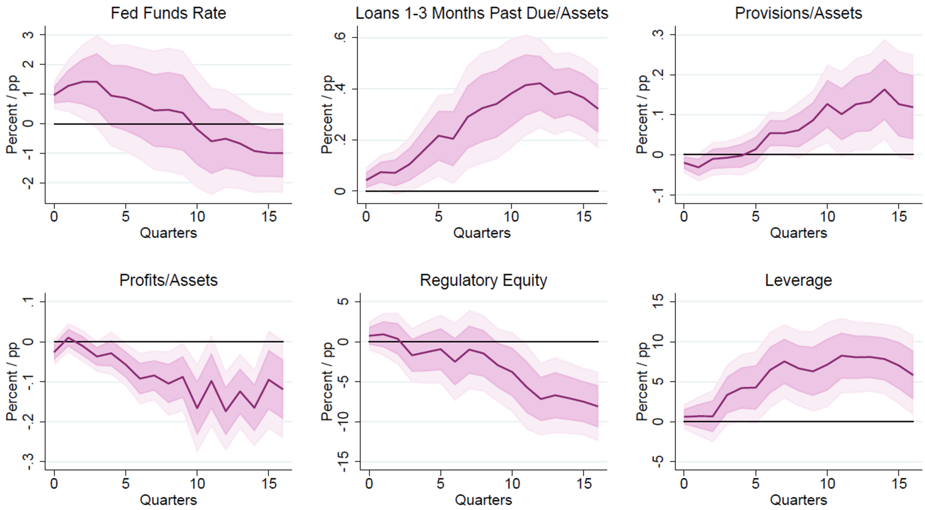
Loan-Loss Mechanism

Write-Offs Decomposition



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Inspecting the two key links the mechanism

How important is my mechanism?

1. loan-losses $\uparrow \Rightarrow$ profit $\downarrow$
2. profit $\downarrow \Rightarrow$ leverage $\uparrow$

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1. Loan-Losses to Profits

$$\frac{\text{Net Interest Income}}{\text{Assets}} + \frac{\text{Net Noninterest Income}}{\text{Assets}} + \frac{\text{Other Income}}{\text{Assets}} - \frac{\text{Provisions}}{\text{Assets}} = \frac{\text{Profits}}{\text{Assets}}$$

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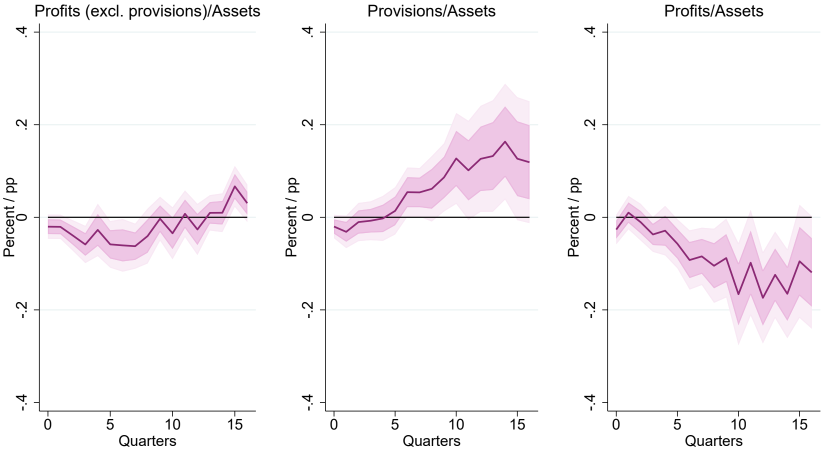

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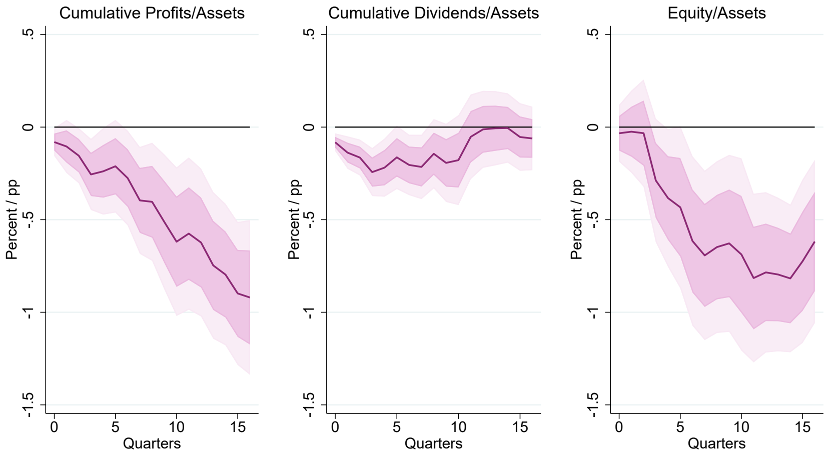

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$\Rightarrow$ My mechanism explains most of the response of leverage

$\Rightarrow$ But why do contractionary MP shocks increase loan losses?

What is causing loan losses?

Two potential reasons for loan losses:

(1) ↑ FFR: higher costs on floating-rate (or short-term fixed-rate) loans reduces ability to repay

(2) ↓ GDP: lower borrower income reduces ability to repay

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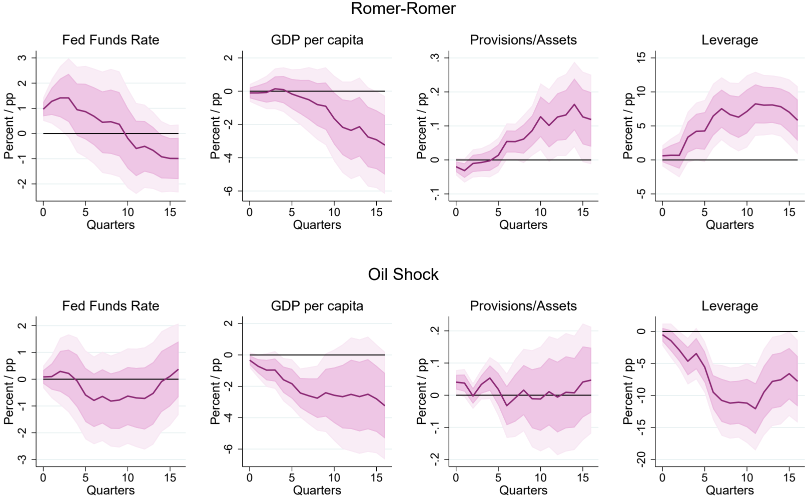
Empirical Test: If loan losses only respond to MP shock, then floating-rate loans are likely an important channel.

Suggestive driver of loan losses



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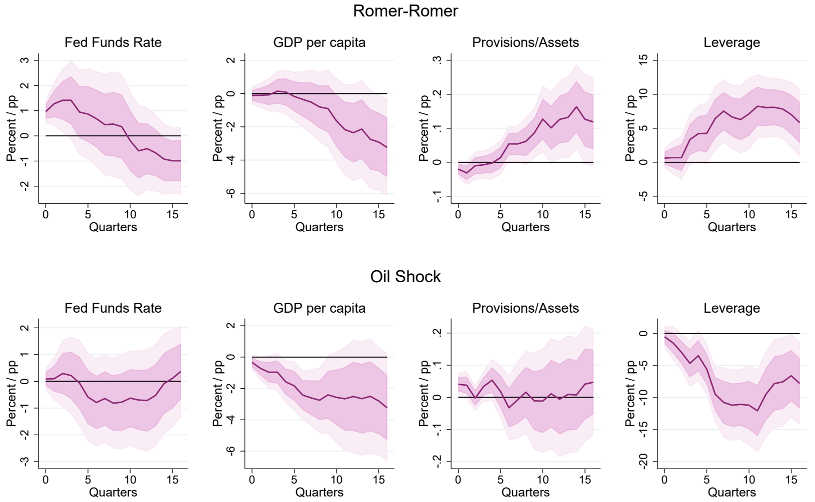

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⇒ ↑ FFR is important: potential role for floating-rate loans

A different way of modelling banks: *risk transformation*

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$\Rightarrow$ Key tension in the model when interest rates rise:

(A) Higher net interest income due to floating-rate loans ($\uparrow$ profits)
(B) Higher loan losses due to loan-loss mechanism ($\downarrow$ profits)

$\Rightarrow$ Net impact on profits (and subsequently leverage) depends on (A) vs (B)

Model Details

Mapping the model to the data

Empirical Test:

Do Net Interest Income, Loan Losses, and Profits of banks with a high floating share respond differently to MP shocks than banks with a low floating share?

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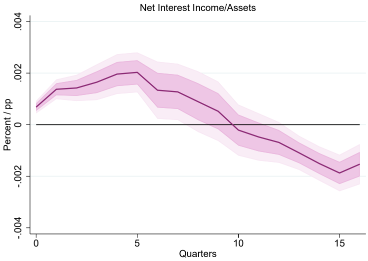
Model Prediction:

$\{\beta_{h,0}^{(3)}\}_{h=0}^{H}$ and $\{\beta_{h,0}^{(1)} + \beta_{h,0}^{(3)} \cdot FloatShare_{i,t}\}_{h=0}^{H}$ for $h = 0 \ldots 16$ show that in response to a MP shock, a bank with a higher floating share should:

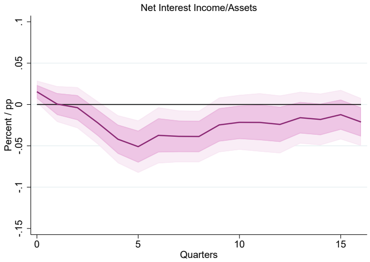
1. Have higher net interest income (less interest rate risk)
2. Have higher provisions (more credit risk)

Net Interest Income Impulse Response Functions

Interaction Effect



Low Floating Share



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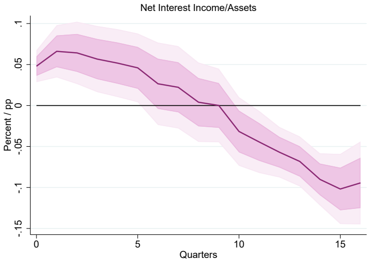
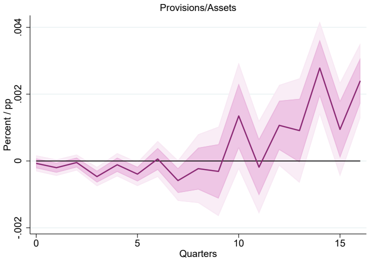


Loan-Loss Provisions Impulse Response Functions

Interaction Effect



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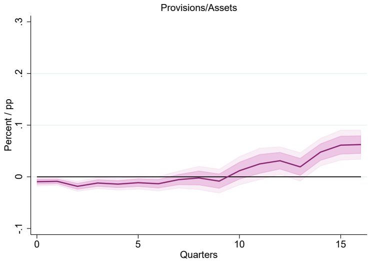

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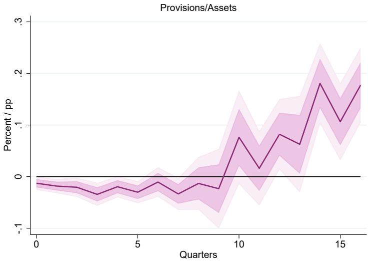

Profits Impulse Response Functions

Understanding Losses

Interaction Effect

Low Floating Share

High Floating Share

Conclusion

Contributions

1. Show that contractionary MP shocks increase bank leverage
2. Propose and empirically validate a mechanism that can explain this result: the loan-loss mechanism
3. Develop a different way of modelling banks that explains this mechanism through risk transformation and floating-rate loans
4. Show that empirical evidence using micro data is consistent with the role of floating-rate loans in the model

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Take-away

⇒ Contractionary monetary policy can have unintended consequences for bank vulnerability through floating-rate loans

⇒ If the goal is to reduce bank leverage, use macroprudential policy and let monetary policy focus on price stability

A brief primer on bank leverage

Definition

Intuitively, leverage captures a bank's reliance on debt. Formally,

$$\text{Leverage} = \frac{\text{Assets}}{\text{Equity}}$$

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Why do we care?

- Externalities (e.g., fire-sales, moral hazard)
- Propagation and amplification of shocks (financial accelerator)

$\Rightarrow$ Financial crisis highlighted the problems arising from excess leverage

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Post-Crisis Response

(i) Policy: Regulations across the world restricting bank leverage

(ii) Research: Rush to build models which incorporate financial frictions

Back

Different Definition of Leverage

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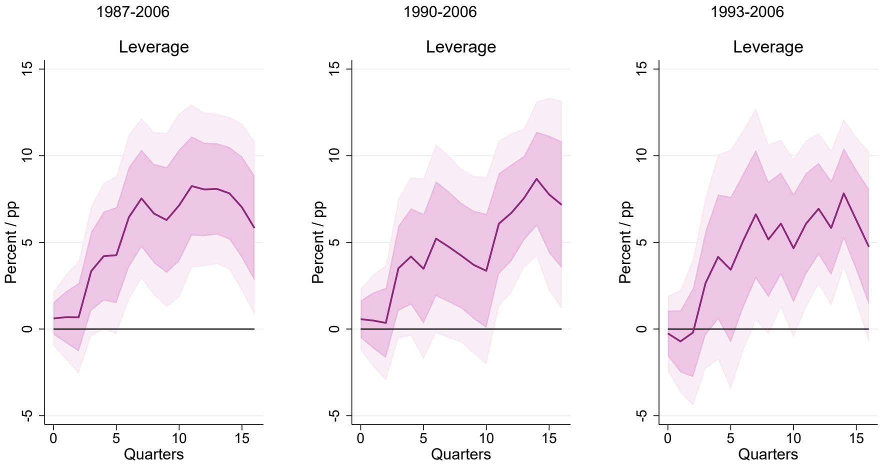
Different Time Periods



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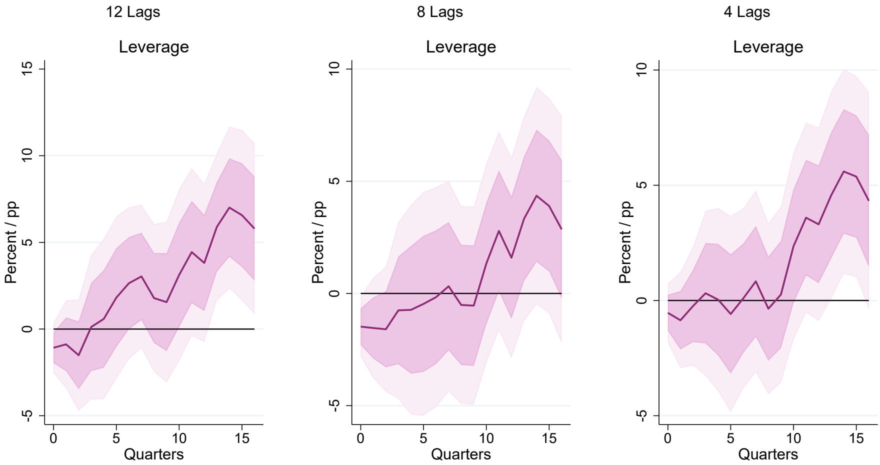
Different Lag Lengths



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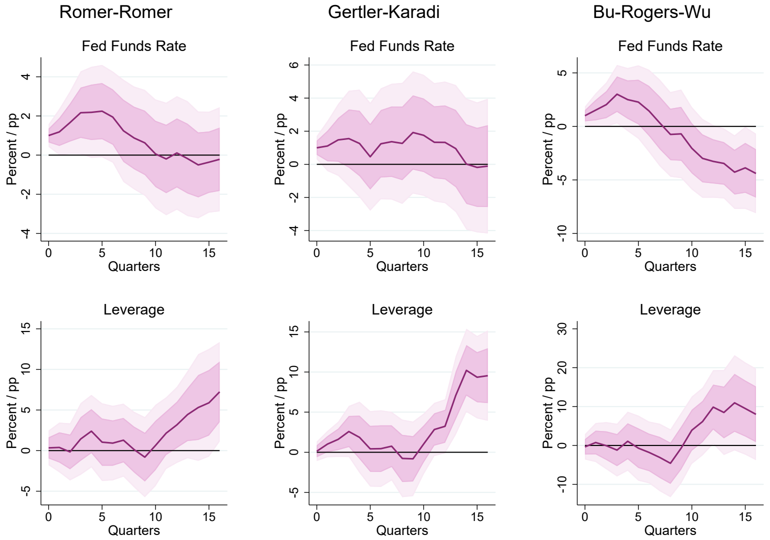
Different Shock Series (1994-2006)



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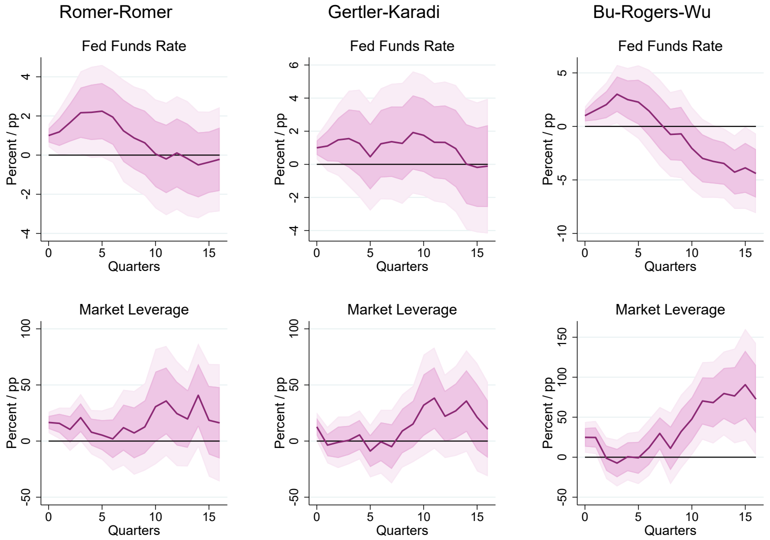
Market Leverage with Different Shock Series (1994-2006)



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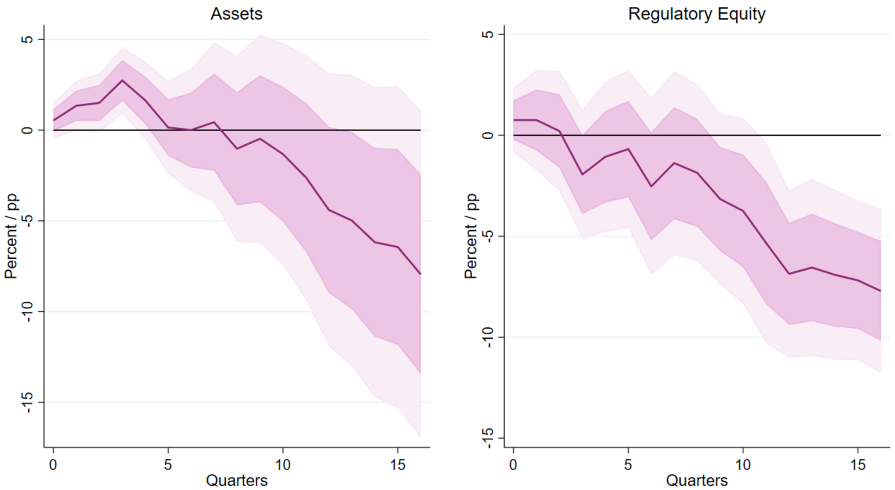
Decomposition of leverage response



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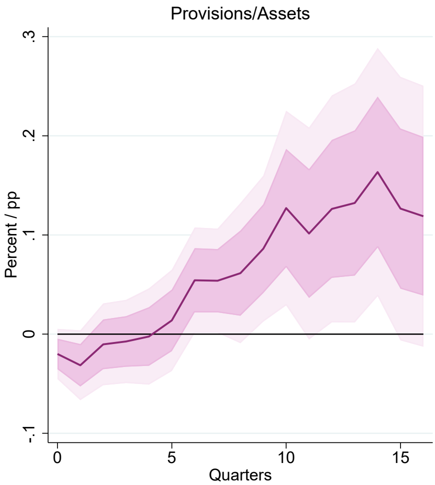
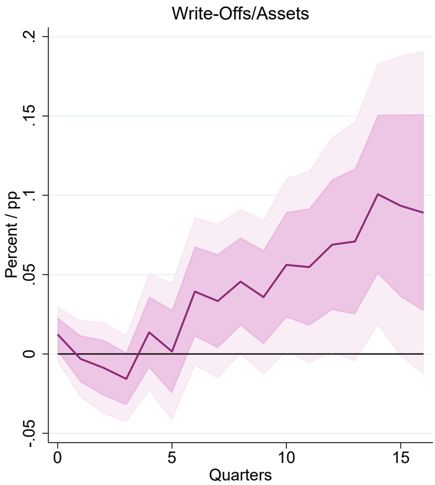
Provisions and Write-Offs





68% and 90% confidence bands displayed

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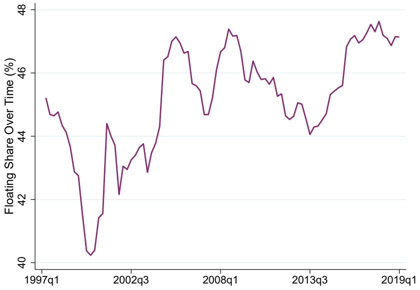
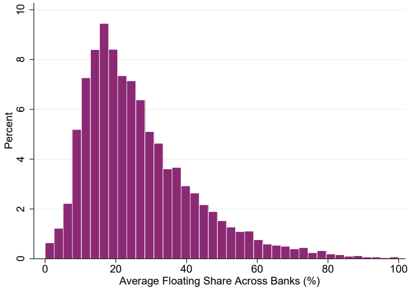
Share of Floating-Rate Loans in the Time Series & Cross Section

Time-Series Variation



Cross-Sectional Variation



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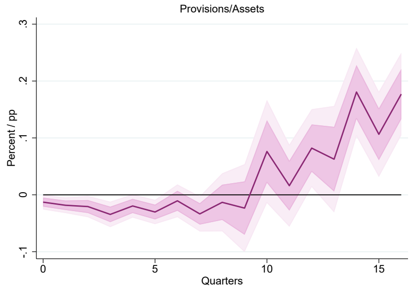
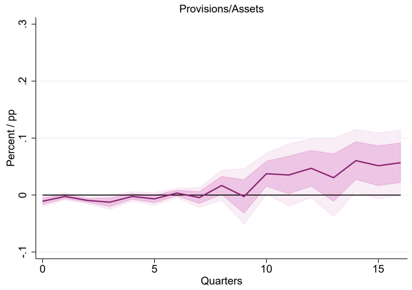
Monetary Policy Shocks versus Changes in the Fed Funds Rate

Contractionary MP Shock



Higher Fed Funds Rate



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Should monetary policy target financial stability?

Woodford (2012)

“the central bank should be willing, at least to some extent, to trade off a greater degree of stability of conventional stabilization objectives — namely, price stability and output-gap stability — for the sake of greater stabilization of the marginal crisis risk.”

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Bernanke (2015)

"addressing those [financial stability] threats, monetary policy is far from ideal...To the extent that it is diverted to the task of reducing risks to financial stability, monetary policy is not available to help the Fed attain its near-term objectives of full employment and price stability."

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$\Rightarrow$ Implicit assumption: higher interest rates reduce bank vulnerability

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A simple model of the core mechanism

Back

- One period model with the following timing:
  1. Beginning: banks make loans funded by deposits and net worth
  2. Middle: shock realisation
  3. End: Settlement takes place
- Banks are exogenously endowed with deposits D, a loan portfolio of size L. Internal net worth $N = L - D$.
- The key choice of the bank is the share of floating-rate loans f_L.
- Deposits are floating-rate liabilities with imperfect pass-through $0 < \beta^{dep} < 1$ which is exogenous.
- The interest rate is a random variable $r = \bar{r} + \varepsilon$ where $\varepsilon \sim \mathcal{N}(0, \sigma^2)$. So, $E[r] = \bar{r}, Var[r] = \sigma^2$. Note that ε is a 'shock' to interest rates.
- $\theta(\varepsilon)$ is the loan-loss rate. $\theta'(\varepsilon) > 0$ and $\theta'(\varepsilon)$ is linear in ε.

Bank problem

Back

- The bank objective is to maximise value by choosing the share of its loans that are floating-rate

$$\max_{f_L} V = E[\pi] - \frac{\gamma}{2} Var[\pi]$$

where π represents bank profits and γ represents risk-aversion.

- Solving the bank problem yields an optimal choice of f_L^*.

Bank Solution Firm Solution Equilibrium

Bank profits

Back

Given a bank's optimal choice f_L^*, profits are

$$\pi = \overbrace{\underbrace{L(1-f_L^*)(\bar{r}+\mu^*(f_L^*))}_{\text{fixed-rate income}} + \underbrace{Lf_L^*(\bar{r}+\varepsilon+\mu^*(f_L^*))}_{\text{floating-rate income}} - \underbrace{D(\bar{r}+\beta^{dep}\varepsilon)}_{\text{cost of deposits}}}^{\text{Net Interest Income}} - \overbrace{Lf_L^*\theta(\varepsilon)}^{\text{Loan Losses}}$$

where μ^* is the equilibrium loan spread.

Assumption: no loan losses on fixed-rate loans as MP shocks do not affect their loan-servicing costs

- Empirical evidence suggests that floating-rate loans are a potential driver of loan losses in response to MP shocks
- Model focuses on loan losses through floating-rate loans to highlight risk transformation

Bank profits

Back

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- Empirical evidence suggests that floating-rate loans are a potential driver of loan losses in response to MP shocks
- Model focuses on loan losses through floating-rate loans to highlight risk transformation

$\Rightarrow$ So what are the implications of issuing floating-rate loans?

Interest Rate Risk versus Credit Risk

Back

Define deviations from equilibrium profitability (Return on Assets) as:

$$\Delta \equiv \frac{\pi}{L} - \frac{E[\pi]}{L}$$

$$\implies \Delta = \underbrace{f_L^* \varepsilon - \frac{D}{L} \beta^{dep} \varepsilon}_{\text{interest rate risk}} - \underbrace{f_L^* \left(\theta(\varepsilon) - E[\theta(\varepsilon)]\right)}_{\text{credit risk}}$$

Intuition

1. Banks have floating-rate liabilities which expose them to rate risk
2. To hedge this risk, banks issue floating-rate loans
3. Interest rate risk is passed onto borrowers
4. If borrowers cannot hedge this risk, it becomes a credit risk for banks

Interest Rate Risk versus Credit Risk

Back

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⇒ Banks do risk transformation: interest rate risk becomes credit risk

Model predictions

Back

Differentiating Δ wrt to an interest rate shock allows us to construct the model IRFs as functions of the floating share (f_L):

$$\underbrace{\frac{\partial \Delta}{\partial \varepsilon}}_{\text{Profits IRF}} = \underbrace{f_L^* - \frac{D}{L}\beta^{dep}}_{\text{Net Interest Income IRF}} - \underbrace{f_L^* \theta'(\varepsilon)}_{\text{Provisions IRF}}$$

Model predictions

Back

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In response to MP shock, a bank with a higher floating share (f_L) should:

1. Have higher net interest income
   - $\Rightarrow$ Banks with higher f_L are less exposed to interest rate risk
2. Have higher loan-loss provisions
   - $\Rightarrow$ Banks with higher f_L are more exposed to credit risk

$\Rightarrow$ Net impact on profits depends on which dominates

Bank Solution

The bank has the following objective

$$\max_{f_L} V_b = E[\pi_b] - \frac{\gamma}{2} Var[\pi_b]$$

where profits are given by the following

$$\pi_b = L(1 - f_L)(\bar{r} + \mu(f_L)) + Lf_L(\bar{r} + \varepsilon + \mu(f_L)) - D(\bar{r} + \beta\varepsilon) - Lf_L\theta(\varepsilon)$$

Taking the first-order condition with respect to f_L and simplifying yields the following expression for f_L^*

$$f_L^* = \frac{\frac{\partial \mu(f_L)}{\partial f_L} - \overline{\theta(\varepsilon)}}{\gamma L \left(\sigma_\varepsilon^2 + \sigma_\theta^2 - 2\rho_{\varepsilon\theta}\right)} + \frac{D\beta \left(\sigma_\varepsilon^2 - \rho_{\varepsilon\theta}\right)}{L \left(\sigma_\varepsilon^2 + \sigma_\theta^2 - 2\rho_{\varepsilon\theta}\right)}$$

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Firm Solution

The bank has the following objective

$$\max_{I} V_f = E[\pi_f] - \frac{\gamma}{2} Var[\pi_f]$$

where profits are given by the following

$$\pi_f = AI - I - I(1 - f_L)(\bar{r} + \mu(f_L)) - If_L(\bar{r} + \varepsilon + \mu(f_L)) - If_L\theta(\varepsilon)$$

Taking the first-order condition with respect to I and simplifying yields the following expression for $\mu(f_L)$

$$\mu(f_L) = A - 1 - \bar{r} - f_L\overline{\theta(\varepsilon)} - \gamma I f_L^2 \sigma_\varepsilon^2 - \gamma I f_L^2 \sigma_\theta^2 - \gamma f_L \rho_{\varepsilon\theta}$$

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Model Equilibrium

In equilibrium, we will have a loan spread, μ^* that will equate firm credit demand, I, with bank loan size, L.

Taking the derivative of μ with respect to f_L^* allows us to obtain a solution for f_L^* in terms of exogenous components

$$f_L^* = \frac{D\beta\gamma\left(\sigma_\varepsilon^2 - \rho_{\varepsilon\theta}\right) - \gamma\rho_{\varepsilon\theta} - 2\overline{\theta(\varepsilon)}}{\gamma L\left(3\sigma_\varepsilon^2 + 3\sigma_\theta^2 - 2\rho_{\varepsilon\theta}\right)}$$

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