The Heterogenous Bank Lending Channel of Monetary Policy

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Does bank heterogeneity matter for monetary policy?

Empirical Evidence of Heterogeneity:

- Liquid assets and size (Kashyap and Stein, 2000)
- Leverage (Jimenez et al., 2012; Dell'Ariccia et al., 2017; Altavilla et al., 2020)
- Rate risk exposure (Gomez et al., 2021). Loan rate pricing (Altunok et al., 2023)

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Limitation. Cross-section alone can't tell us:

- **aggregate transmission** different?
- **counterfactual** policies

This Paper: quantitative model w/ two forms of heterogeneity:

- ex-ante: variable vs. fixed rate (interest-rate exposure)
- ex-post: leverage (capital ratios)

Our contribution

Investigate which forms of bank heterogeneity matter, how much, and why?

- Quantify aggregate and individual responses to monetary surprises

Key Insights

1. IRFs: Stronger contraction in credit of banks with...
   - Fixed-rate loans
   - Lower capital ratios (high leverage)
2. Sources of heterogeneity interact
   - Without heterogeneity in leverage, heterogeneity in loan pricing is less relevant.

     Intuition: loan-pricing matters if close to constraints
     but...constraints activated only with idiosyncratic risk (heterogeneity in leverage)

Outline

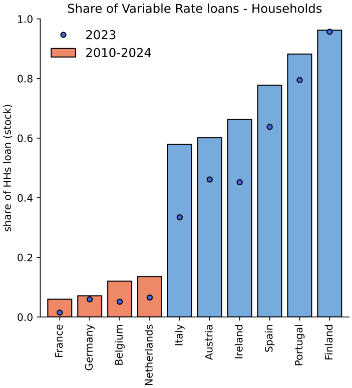
1. Data: Bank heterogeneity in the Euroarea

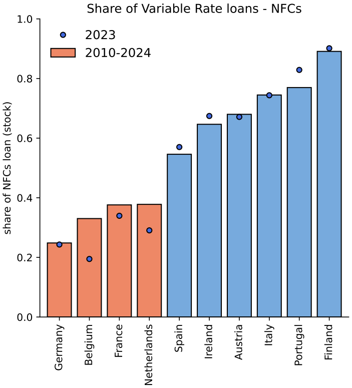
2. Heterogeneous banks model

3. Quantitative Results

Data. Euroarea

Heterogeneity in loan-rates pricing





Data sources: ECB Statistical Data Warehouse. Lending to households includes mortgage loans, consumer loans, and other loans.

- Fixed raters: Germany, France, Belgium, and Netherlands
- Variable raters: Spain, Portugal, Italy, Austria, Finland, Ireland.
- Loan-rate pricing patterns are highly persistent over time

Heterogeneity in bank leverage

Figure 1: CET 1 capital distribution

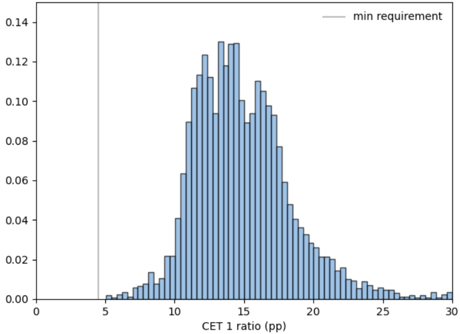
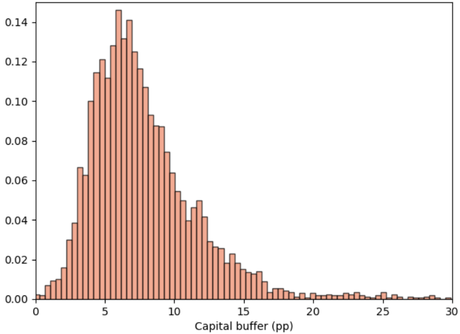


Figure 2: CET 1 buffers distribution



Data sources: S&P Global and ESRB supervisory data on European banks' capital requirements. CET1 capital ratios are defined as CET1 capital over risk-weighted assets. The sample corresponds to 163 large and medium-sized European banks from 2013 to 2020.

- Large heterogeneity in CET 1 capital ratios
- Most European banks hold substantial capital buffers

Data

Model

The model – Banking sector

- Continuum of perfectly competitive banks
- Assets: risk-free short-term reserves and risky long-term loans
  - idiosyncratic credit risk: loan default shocks
  - lending frictions: convex loan origination cost
- Liabilities: short-term, insured deposits, and (accumulated) equity
- Capital Regulation:
  - *minimum capital requirement*: Failure to comply $\rightarrow$ bank's resolution (failure)

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Key Features:

1. ⇒ banks perform maturity transformation

   \+ heterogeneity in loan pricing (FR vs VR) ⇒ Captures NIM dynamics!

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2. $\Rightarrow$ slow moving leverage

   + idiosyncratic credit risk $\Rightarrow$ ex-post heterogeneity in leverage!

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   $+$ heterogeneity in loan pricing (FR vs VR) $\Rightarrow$ Captures NIM dynamics!

2. $\Rightarrow$ slow moving leverage

   $+$ idiosyncratic credit risk $\Rightarrow$ ex-post heterogeneity in leverage

3. $+$ capital regulation $\Rightarrow$ endogenous capital buffers!

Bank - Balance Sheet

- Bank j starts with: legacy loans L_{jt}, accumulated pre-dividend equity E_{jt}
- Chooses: new loans N_{jt}, reserves M_{jt}, and deposits D_{jt}
- Bank's balance sheet

$$L_{jt} + N_{jt} + M_{jt} = D_{jt} + E_{jt} - X_{jt} \tag{1}$$

- Differentiate between short- and long-term assets
  - key distinction from classic banking literature:
    Gertler&Kiyotaki (2010), Gertler&Karadi (2011), Mendicino et. al. (2021), Coimbra&Rey (2023)
  - banks' core function is maturity transformation
    consistent with EA balance-sheet

Assets: Loans

Long-term loan portfolio: continuum of risky loans

- Principal of 1 and avg. effective lending rate r^L_{jt}
- Law of motion:
$$L_{jt+1} = (1-\delta)(1-\omega_{jt+1})(L_{jt}+N_{jt}). \tag{2}$$
  - δ fraction matures with iid prob. (Leland and Toft, 1996)
  - $\omega_{jt+1} \sim F(p,\rho)$ stochastic default rate correlated at the bank level (Vasicek, 2002)
  - loss given default: fraction $\lambda \in (0,1)$ of the principal
- Technology: new loans N_{jt} incur a convex cost $f\left(\frac{N_{jt}}{L_{jt}}\right) L_{jt}$

Loan rate pricing: fixed vs. variable regimes

Fixed-rate regime:

- Loan rate r_t^N is fixed at origination and constant until maturity.
- Average rate on legacy loans:

$$\bar{r}_{jt+1}^L = \frac{r_{jt}^L L_{jt} + r_t^N N_{jt}}{L_{jt} + N_{jt}}$$

Variable-rate regime:

- Loan rate $r_t^N = r_t^M + s_t^N$ adjusts with policy rate.
- Average rate on legacy loans:

$$r_{jt+1}^L = r_t^M + s_{jt+1}^L, \text{ with } \quad s_{jt+1}^L = \frac{s_{jt}^L L_{jt} + s_t^N N_{jt}}{L_{jt} + N_{jt}}$$

Key distinction: ⇒ in VR, repricing is quick as rates track monetary policy directly;
⇒ in FR, repricing is gradual as new loans replace old ones.

Equity Dynamics

$$\underbrace{E_{jt+1} = E_{jt} + \Pi_{jt+1}}_{Equity\ \ accumulation} \qquad \underbrace{E_{jt+1} \geq \gamma L_{jt+1}}_{Min\ \ capital\ \ req}$$

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Net Profits:

Variable rate: $\Pi_{jt+1} = \underbrace{(r_t^N N_{jt} + r_{jt}^L L_{jt})(1 - \omega_{jt+1}) - r_t^D D_{jt}}_{Net\ \ Interest\ \ Margin\ \ (NIM)} + r_t^M M_t - \underbrace{f\left(N_{jt}/E_{jt}\right) L_{jt}}_{Convex\ \ origination\ \ cost}$

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Main mechanism:

- Policy tightening:

$$\Uparrow^+ r_t^M \to \Uparrow r_t^D \to \begin{cases} \Uparrow r_{jt}^L L_{jt} + \Uparrow r_t^N N_{jt} - r_t^D D_{jt}, & \Uparrow\Downarrow \text{ NIM variable rate} \\ \\ \cancel{\Uparrow} \bar{r}_{jt}^L L_{jt} + \Uparrow r_t^N N_{jt} - r_t^D D_{jt}, & \Downarrow \text{ NIM fixed-rate} \end{cases}$$

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Key differences between FR and VR economies

Fixed-rate regime:

- Fixed interest rate on new loans.
- Gradual repricing of legacy portfolio when policy changes.
- Monetary tightening initially compresses net interest margins (NIM)

  $\Rightarrow$ loan income lags and funding costs rise.

Variable-rate regime:

- Interest rate on new loans: fixed spread over r_t^M.
- Quick repricing of legacy portfolio when policy changes.
- Monetary tightening can improve NIM initially

  $\Rightarrow$ loan income rises with policy rate.

Implication: The speed of loan rate adjustment drives differences in profitability, capital ratios, and ultimately the lending response to monetary policy.

The model – Bank problem and environment

- Recursive Bank's Problem

$$V_t^B(L_{jt}, E_{jt}, r_{jt}^L) = \mathbf{1}_{\{E_{jt} \geq \gamma L_{jt}\}} \left[\max_{\{N_{jt}, M_{jt}\}} X_{jt} + \beta \mathbb{E}_t [(1-\chi) V_{t+1}^B(L_{jt+1}, E_{jt+1}, r_{jt+1}^L) + \chi E_{jt+1}] \right]$$

$$\begin{aligned}
\text{s.t.} \quad L_{jt} + N_{jt} + M_{jt} &= D_{jt} + E_{jt} - X_{jt} \,, && \text{(Balance sheet identity)} \\
E_{jt+1} &= E_{jt} - X_{jt} + (1-\tau)\Pi_{jt+1} \,, && \text{(Equity LOM)} \\
&\text{Liquidity Constraint} \\
&\text{Leverage Constraint} \\
r_{jt}^L &= \begin{cases} \text{updates spread} & \text{in a variable-rate economy,} \\ \text{updates rate} & \text{in a fixed-rate economy.} \end{cases} && \text{(Effective Loan Rate)}
\end{aligned}$$

* State space can be reduced from $(L_{jt}, E_{jt}, r_{jt}^L)$ to $\left(\frac{L}{E}, r_{jt}^L\right)$.

value-function Entrepreneurs Timeline

Non-financial sector

- **Entrepreneurs (production)** $\Rightarrow$ Aggregate credit demand:

$$N_t = \begin{cases} g(r_t^L), & \text{for fixed-rate loans} \\ \\ g\left(r_t^L, r_{t+1}^L, \ldots\right), & \text{for variable-rate loans} \end{cases}$$

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- **Households** $\Rightarrow$ Aggregate deposit demand: $D_t = h(r_t^D)$
- **Central Government**
  - Central bank supplies reserves M_t and sets policy rate r_t^M
  - collects taxes and runs a deposit insurance scheme

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Quantitative Results

Calibration highlights

- Quarterly frequency
- Matches euro area bank balance sheets (capital ratios, liquid assets, loan maturities)

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Default rate distribution:

- *Vasicek* credit risk model (Basel IRB foundation):

$$F_j(\omega) = \Phi\left(\frac{\sqrt{1-\rho}\,\Phi^{-1}(\omega) - \Phi^{-1}(p)}{\sqrt{\rho}}\right)$$

- Default rate: $p = 2.65\%$;
- loan correlation $\rho = 0.46$: targets dispersion in bank failure risk.

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Other Pre-set parameters:

- Loan maturity $\delta = 0.05 \Rightarrow$ average duration of 5 years.
- Replicates Basel III. Capital requirement $\gamma = 7\%$; liquidity ratio $\theta = 11.8\%$
- Policy rate $r^M = 1\%$; tax rate $\tau = 20\%$

Key estimated parameters: adjustment frictions and demand elasticities

Loan origination cost:

- Quadratic in new lending intensity:

$$f\left(\frac{N_{jt}}{L_{jt}}\right) = \eta \left(\frac{N_{jt}}{L_{jt}}\right)^2 \quad \text{with } \eta > 0$$

- η targets average voluntary capital buffer (target: 5.1%).

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Entrepreneur entry cost:

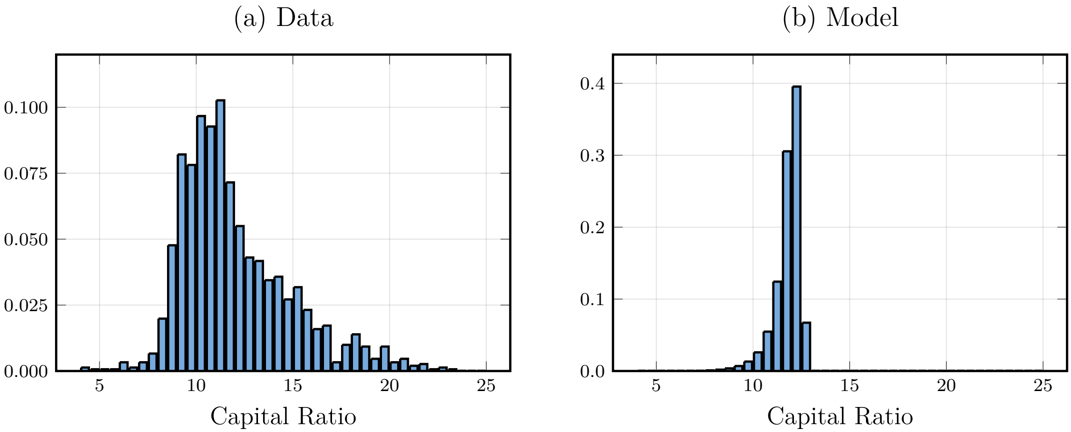
- Rising and convex in credit volume:

$$a(N_t) = \zeta_1 N_t^{\zeta_2} \quad \text{with } \zeta_1, \zeta_2 > 0$$

- Level (ζ_1) targets average lending rates (3%).
- Curvature ($\zeta_2 = 0.50$) governs responsiveness of lending to policy.
- Matches semi-elasticity of new lending: -0.38 for 100bp shock.

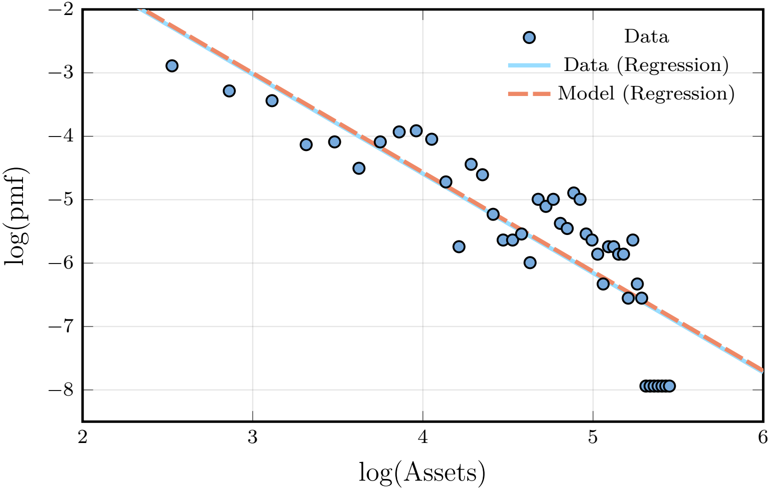
Steady State - Long Run results

Distribution of Capital Ratios



Note: Capital ratios are defined as CET1 capital over risk-weighted assets.

Size Distribution — Tail distribution given χ



- replicates the Power law in the asset-size distribution.

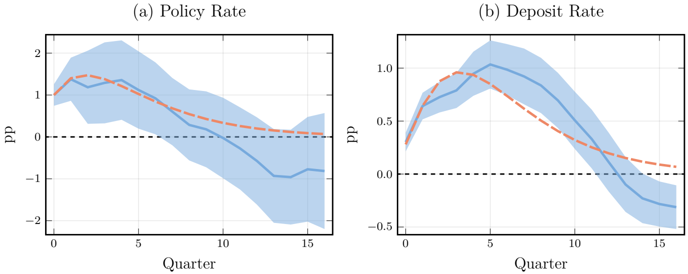
Transitional Dynamics.
Responses to a Monetary Tightening

Simulation: Model responses to a monetary tightening

Simulate MIT shock matching the path of

(a) policy rate IRFs to a monetary surprise.

(b) deposit rate IRFs to a monetary surprise (imperfect pass-through).



solid blue: empirical IRFs ⇒ dashed red: input to the model

- Simulate same path for both economies (FR & VR).

Estimation: Empirical responses to a monetary tightening

Data: Estimate IRFs to monetary surprises

- Panel Local Projections with country fixed effects (Jorda et al., 2015)

$$y^{\ell}_{c,t+h} = \alpha_{c,h} + \beta_{1,h}\varepsilon_t^{MP} + \beta_{2,h}\left[\varepsilon_t^{MP} \times I_c^{FR}\right] + \Gamma_h X_{c,t}(L) + e_{c,t+h}$$

ε_t^{MP}: ΔECB deposits facility rate instrumented (Jarocinski and Karadi,2020)

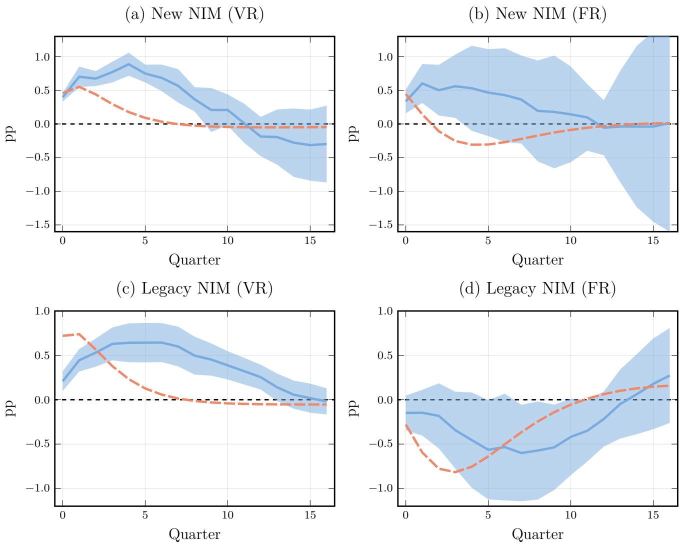
I_c^{FR}: 1 if country c operates with fixed-rate pricing

- Different responses across FR and VR economies

$\{\beta_{1,h}\}_{h=0}^{16Q}$ $\Rightarrow$ avg impact on variable-raters

$\{\beta_{1,h} + \beta_{2,h}\}_{h=0}^{16Q}$ $\Rightarrow$ avg impact on fixed-raters

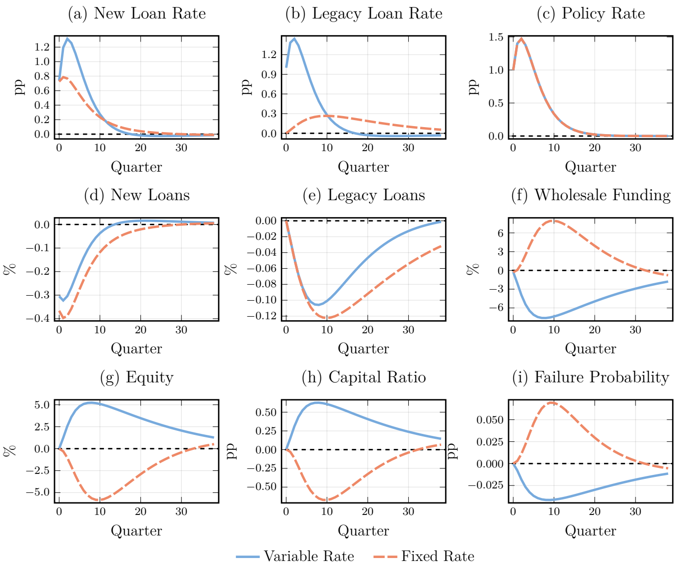
Model vs Data. Untargeted responses to a monetary tightening



- Solid blue: Empirical IRFs, Dashed red: Model simulation

Does Heterogeneity Matter?

Ex-Ante Heterogeneity



Fixed-rate vs. Variable-rate banks: key differences

Variable-rate (VR) banks:

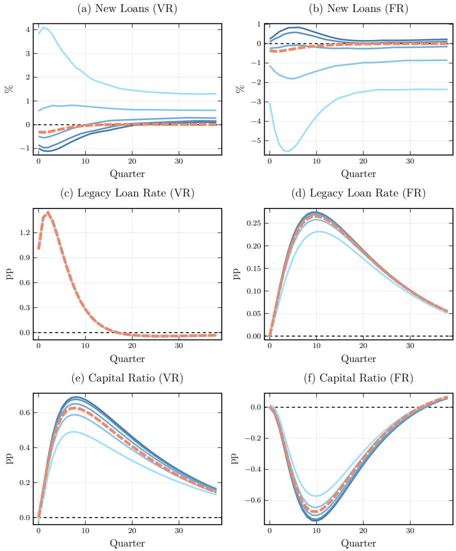
- Loan rates adjust quickly $\rightarrow$ NIM improves after rate hike.
- Higher profitability $\rightarrow$ rising equity & capital ratios.
- Lending expands & bank stability improves.

Fixed-rate (FR) banks:

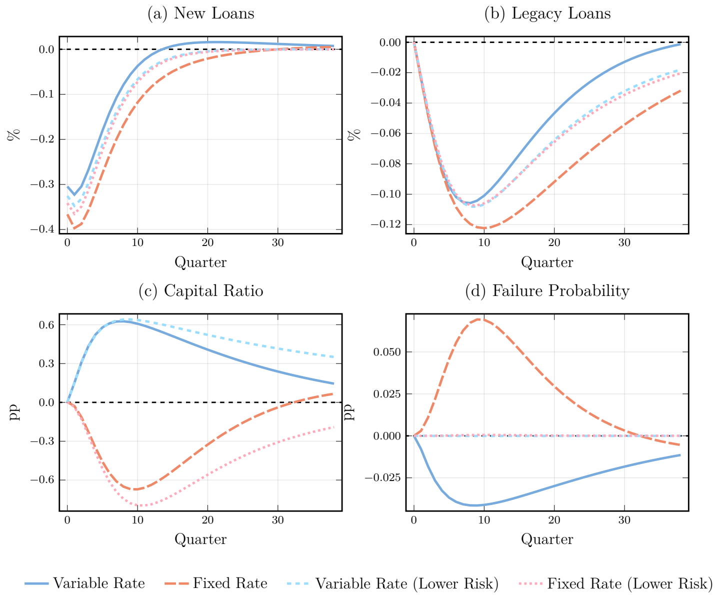
- Income on legacy loans remains fixed $\rightarrow$ NIM compresses.
- Funding costs rise $\rightarrow$ equity erosion & capital deterioration.
- Lending contracts sharply, failure risk increases.

Conclusion: Loan rate fixation patterns shape both the strength of the lending channel and financial stability outcomes.

Ex-post heterogeneity



vs. No Ex-post heterogeneity



Ex-ante vs. ex-post heterogeneity: role of idiosyncratic risk

- Ex-ante heterogeneity (e.g., FR vs. VR) matters **only if** banks face ex-post risk.
- Without idiosyncratic shocks:
  - Capital ratios still diverge (due to NIM dynamics).
  - But no bank fails $\rightarrow$ lending depends only on marginal profitability.
- Loan origination costs prevent banks from leveraging fully **even without risk**.
- Therefore, heterogeneity in capital constraints disappears when risk is muted.

Conclusion: Ex-ante heterogeneity is amplified *only* because ex-post heterogeneity binds for some banks.

Applications

Several Applications/Questions (Very preliminary)

- Monetary policy gradualism ⇒

⇒ Gradual implementation smooths credit responses

- Macroprudential policy: smaller buffer requirements ⇒

⇒ Small gains, benefits more FR banking systems

Conclusion

Concluding remarks

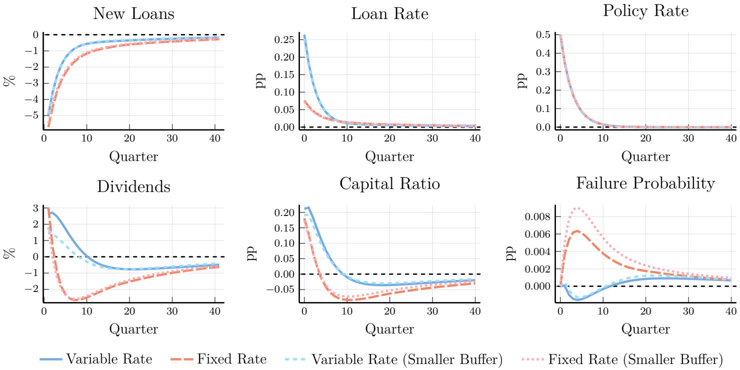
1. Heterogeneous-banks model with ex-ante and ex-post heterogeneity:
   - explains: cross-sectional distributional features
   - explains: estimates MP pass-through to rates, loans and NIM

2. Lessons:
   - stronger contraction in credit of banks with...
     - Fixed-rate loans
   - Both sources of heterogeneity interact:
     - Including only one $\Rightarrow$ almost no differences in responses to MP

Thank You!

Appendix

Stance of Macropru matters for the MP transmission



- Smaller buffer (100 bp) $\rightarrow$ higher prob. of failure for fixed-rate banks

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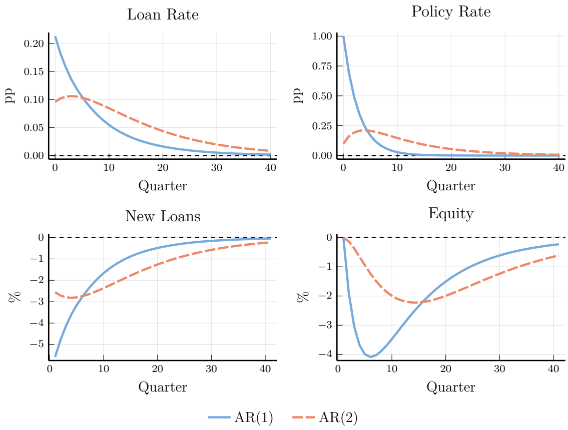
Monetary policy gradualism - Fixed rate banks



- Gradual implementation of monetary policy smooths effects on credit

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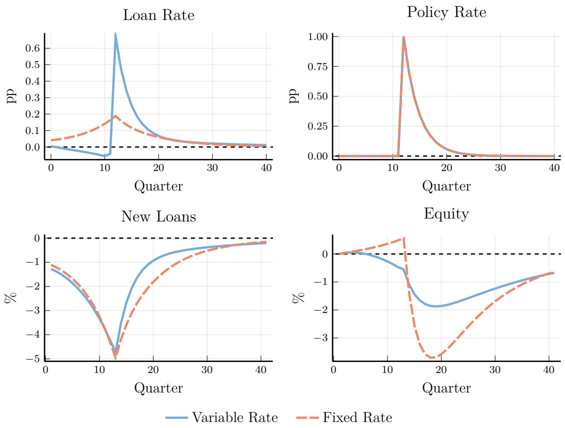
Anticipated monetary policy shock



- Forward guidance reduces the fixed-rate amplification on credit

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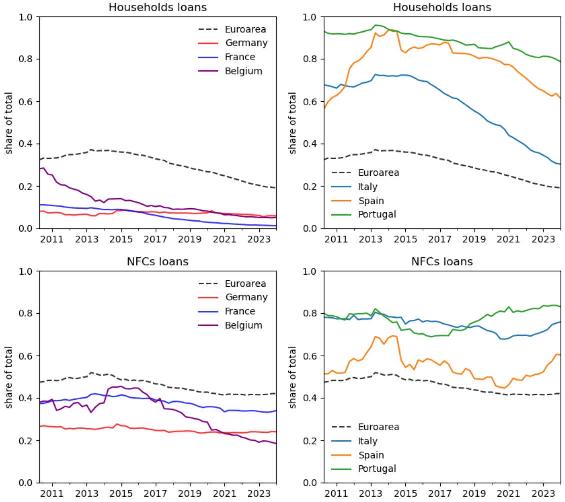
Lending at variable rates



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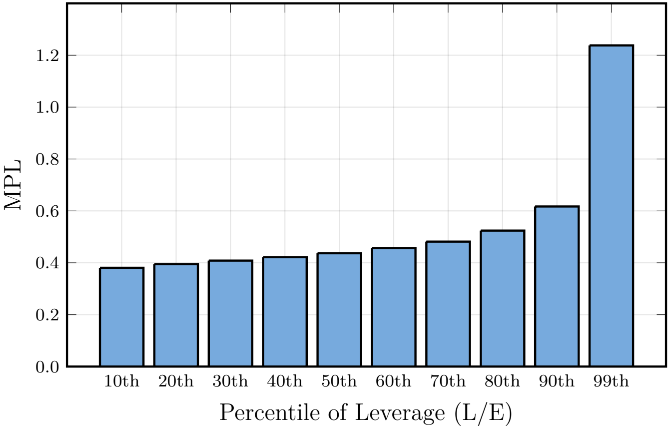
MPL Distribution

Figure 3: Distribution of marginal propensity to lend (MPL)



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Balance Sheet Ratios

Table 1: Consolidated bank balance sheet composition: euro area 2013–2023 vs. model

Assets		**Liabilities**	
Loans	0.88 (0.89)	Deposits	0.78 (0.81)
ST securities and reserves	0.12 (0.11)	Wholesale funding	0.14 (0.09)
		Equity capital	0.08 (0.10)

Note: variables as ratios of total assets. Model counterparts are shown in parentheses.

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- Bank j starts with: legacy loans L_{jt}, accumulated pre-dividend equity E_{jt}
- Chooses: new loans N_{jt}, reserves M_{jt}, and deposits D_{jt}
- Dividends X_{jt} follow an exogenous rule
- The bank's balance sheet

$$L_{jt} + N_{jt} + M_{jt} = D_{jt} + E_{jt} - X_{jt} \tag{3}$$

- We differentiate between short- and long-term assets
  - key distinction from classic banking literature:
    Gertler&Kiyotaki (2010), Gertler&Karadi (2011), Mendicino et. al. (2021), Coimbra&Rey (2023)
  - banks' core function is maturity transformation
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Assets: Loans

Long-term loan portfolio: continuum of risky loans with atomistic size

- Principal of 1 and avg. effective lending rate $\bar{r}_t^L$
- Law of motion:

$$L_{jt+1} = (1-\delta)(1-\omega_{jt+1})(L_{jt} + N_{jt}). \tag{4}$$

  - δ fraction matures with iid prob. (Leland and Toft, 1996)
  - $\omega_{jt+1} \sim F(p, \rho)$ stochastic default rate correlated at the bank level (Vasicek, 2002)
  - loss given default: fraction $\lambda \in (0, 1)$ of the principal
- Technology: Issuance of new loans N_{jt} incurs a convex cost $f\left(\frac{N_{jt}}{E_{jt}}\right) E_{jt}$

Equity and Profits

- Equity is accumulated through retained earnings

$$E_{jt+1} = E_{jt} - X_{jt} + (1-\tau)\Pi_{jt+1}, \tag{5}$$

$\Rightarrow$ slow moving leverage L_{jt}/E_{jt}

- Profits

$$\begin{aligned} \Pi_{jt+1} = {} & \bar{r}^L_{jt}\left(1-\omega_{jt+1}-\lambda\omega_{jt+1}\right)\left(L_{jt}+N_{jt}\right) - r^D_t D_{jt} && \big(\text{net interest income}\big) \\ & + r^M_t M_{jt} && \big(\text{return of reserves}\big) \\ & - f\left(N_{jt}/E_{jt}\right)E_{jt} - \bar{\pi}E_{jt} && \big(\text{operational costs}\big) \end{aligned}$$

Δr^M_t monetary policy $\rightarrow$ profits depends on leverage L_{jt}/E_{jt}

$\rightarrow$ net interest income effect: pass-through to $\{r^L_t, r^D_t\}$

$\rightarrow$ assets composition effect

Equity and Profits

- Equity is accumulated through retained earnings

$$E_{jt+1} = E_{jt} - X_{jt} + (1-\tau)\Pi_{jt+1}, \tag{6}$$

$\Rightarrow$ slow moving leverage L_{jt}/E_{jt}

- Profits

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\Pi_{jt+1} = {} & \bar{r}^L_{jt}\left(1-\omega_{jt+1}-\lambda\omega_{jt+1}\right)\left(L_{jt}+N_{jt}\right) - r^D_t D_{jt} && \text{(net interest income)} \\
& + r^M_t M_{jt} && \text{(return of reserves)} \\
& - f\left(N_{jt}/E_{jt}\right)E_{jt} - \bar{\pi}E_{jt} && \text{(operational costs)}
\end{aligned}$$

Δr^M_t monetary policy $\rightarrow$ profits depends on leverage L_{jt}/E_{jt}

$\rightarrow$ equity accumulation $\rightarrow$ lending

Regulation

- Pre-dividend equity needs to satisfy a *minimum capital requirement*:

$$E_{jt} \geq \gamma L_{jt} \tag{7}$$

  - Failure to comply results in resolution of the bank $\rightarrow$ endogenous failure
  - Assumption: Limited liability $+$costly asset liquidation (loss $\mu < 1$ of seized assets)

- *Buffer requirement* constraints dividends and new lending:

$$\underbrace{E_{jt} - X_{jt}}_{\text{post-dividend equity}} \geq (1 + \kappa_t)\gamma(L_{jt} + N_{jt}) \tag{8}$$

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- *Liquidity requirement* proportional to bank deposits:

$$B_t \geq \theta D_t \tag{9}$$

Recursive Bank Problem

$$
\begin{aligned}
V_t^B(L_{jt}, E_{jt}, r_{jt}^L) &= \mathbf{1}_{\{E_{jt} \geq \gamma L_{jt}\}} \left[\max_{\{N_{jt}, M_{jt}\}} X_{jt} + \beta \mathbb{E}_t[(1-\chi) V_{t+1}^B(L_{jt+1}, E_{jt+1}, r_{jt+1}^L) + \chi E_{jt+1}] \right] \\
\text{s.t.} \quad X_{jt} &= \psi \max\{0, E_{jt} - \gamma(1+\kappa_t)(L_{jt} + N_{jt})\}\,, && \text{(Dividend payout rule)} \\
L_{jt} + N_{jt} + M_{jt} &= D_{jt} + E_{jt} - X_{jt}\,, && \text{(Balance sheet identity)} \\
L_{jt+1} &= (1-\delta)\,(1-\omega_{jt+1})\,(L_{jt} + N_{jt})\;, && \text{(Loan LOM)} \\
E_{jt+1} &= E_{jt} - X_{jt} + (1-\tau)\Pi_{jt+1}\,, && \text{(Equity LOM)} \\
E_{jt} - X_{jt} &\geq \gamma\,(L_{jt} + N_{jt})\;, && \text{(Capital requirement)} \\
M_{jt} &\geq \theta D_{jt}\,, && \text{(Reserve requirement)} \\
\Pi_{jt+1} &= r_{jt}^L\,(L_{jt} + N_{jt})\,(1 - \omega_{jt+1}) - \lambda\omega_{jt+1}\,(L_{jt} + N_{jt}) + r_t^M M_{jt} - r_t^D D_{jt} \\
&\quad - f\,(N_{jt}/E_{jt})\,E_{jt}, && \text{(Profits)} \\
r_{jt}^L &= \begin{cases} r_t^N & \text{in a variable-rate economy,} \\ \frac{\bar{r}_{jt-1}^L L_{jt-1} + r_{t-1}^N N_{jt-1}}{L_{t-1} + N_{t-1}} & \text{in a fixed-rate economy.} \end{cases} && \text{(Effective Loan Rate)}
\end{aligned}
$$

◂ back

Non-financial sector

- Aggregate credit demand by entrepreneurs:

$$N_t = \begin{cases} g(r_t^L), & \text{for fixed-rate loans} \\ \\ g\left(r_t^L, r_{t+1}^L, \ldots\right), & \text{for variable-rate loans} \end{cases}$$

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- Aggregate deposit demand by households: $D_t = h(r_t^D)$

Non-financial sector

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- Aggregate deposit demand by households: $D_t = h(r_t^D)$
- Central bank supplies reserves B_t and sets policy rate r_t^B

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- Aggregate deposit demand by households: $D_t = h(r_t^D)$
- Central bank supplies reserves B_t and sets policy rate r_t^B
- Government collects taxes and runs a deposit insurance scheme

back

Entrepreneurs

- Every period there is a mass of new risk-neutral, penniless entrepreneurs
  - Need one unit of initial investment
  - Project produces A_t units of final good in every period it operates
  - Project ends regularly with probability δ
  - Project fails with probability p ($1-\lambda$ of initial investment can be recovered)
  - Starting an investment project incurs a utility cost of $a(N_t)$ to the entrepreneur
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- V_{it} depends on the type of loan contract: fixed-rate vs. variable rate loans
- If $A_t = A$, one can show that the loan demand is given by

$$N_t = \left\{ \frac{\beta(1-p)(1-\chi)}{\zeta_1} \left[(A - r_t^L) + (1-\delta)\zeta_1 N_{t+1}^{\zeta_2} \right] \right\}^{1/\zeta_2}, \qquad \text{(Variable Rate)}$$

$$N_t = \left\{ \frac{1}{\zeta_1} \frac{\beta(1-p)(1-\chi)(A - r_{it}^L)}{1 - \beta(1-p)(1-\chi)(1-\delta)} \right\}^{1/\zeta_2}. \qquad \text{(Fixed Rate)}$$

back

Remaining Model Elements

- Households solve a consumption saving problem with an asset-in-advance constraint similar to Bianchi and Bigio (2019), which yields a demand schedule of the form

$$D_t + B_t^H = \epsilon_1 (1 + r_t^D)^{\epsilon_2},$$

which implies that the demand for deposits is fully elastic (for sufficiently large ϵ_1)

- Furthermore, since households hold both deposits and bonds, there is a one-to-one pass-through in rates, i.e., $r_t^D = r_t^M$
- The consolidated government has the a budget constraint of the form

$$T_t + \left(B_t + B_t^H\right) + \tau \Pi_t = \left(1 + r_{t-1}^M\right)\left(M_{t-1} + B_{t-1}^H\right) + \Upsilon_t, \tag{10}$$

where Π_t are aggregate profits from banks, and Υ_t represents the net operating deficit of the deposit insurance scheme, including the bank resolution cost.

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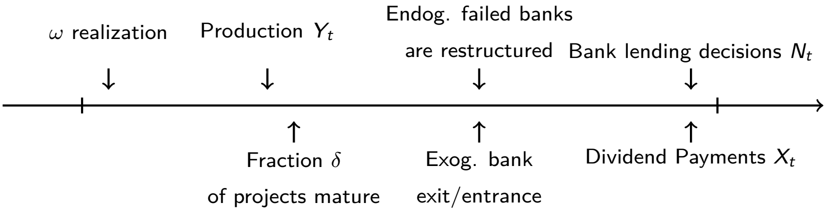
Timeline



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Calibration - Preset Parameters

Bank's Technology

Parameter	Description	Value	Target/Source
p	Loan default rate, mean (pp)	2.65	Mean annual corporate default, EA 1992-2016.
λ	Loan loss-given-default	0.30	Mendicino et al., 2020
μ	Bank resolution cost	0.30	Mendicino et al., 2020
δ	Loans maturity	0.20	Standard.
χ	Bank's exogenous exit rate	0.028	Gertler and Karadi, 2011
ξ	Largest deposit shock	0.11	Average liquidity (reserves) buffer. SDW ECB
η_1	Loan origination cost, level	0.022	Bank's marginal propensity to lend.
η_2	Loan origination cost, power	2.0	Quadratic convex origination cost.
r^D	Deposits rate (annual, pp)	1.0	Mean composite overnight deposits rate, 2003-2022.
r^M	Reserves rate (annual, pp)	1.0	Mean Deposits Facility Rate (DFR), 1999-2022.
ϵ_1	Deposit demand (level)	1.00	Level parameter.
ϵ_2	Deposit demand (power)	2.00	Standard.

back

Calibration - Policy Parameters

Policy parameters

Parameter	Description	Value	Target/Source
θ	Reserve requirement	0.01	Minimum Reserve Requirement. ECB
γ	Capital Requirement	0.0825	Basel III risk-weighted formula. See Appendix.
κ	Capital buffer req.	0.3125	Avg. combined buffer requirements (2.5%).
τ	Corporate tax rate	0.20	Standard

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Calibration - Jointly Estimated Parameters

Parameter	Description	Value	Target	Data	Model
β	Bankers' discount factor	0.994	Banks return on equity (ROE), annual	6.4	5.8
ρ	Loan default correlation	0.46	Bank failure probability, annual	0.66	0.67
ψ	Target bank dividend	0.05	Voluntary buffer (excess capital).	5.1	6.3
ζ_1	Ent. entry cost (level)	14.14	Average lending rates	3.0	3.0
ζ_2	Ent. entry cost (power)	0.0025	Monetary shock pass-through on lending rates	0.4	0.3

Note: All moments are in percentage points.

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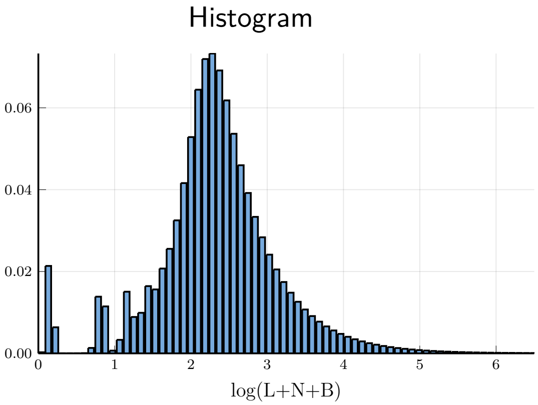
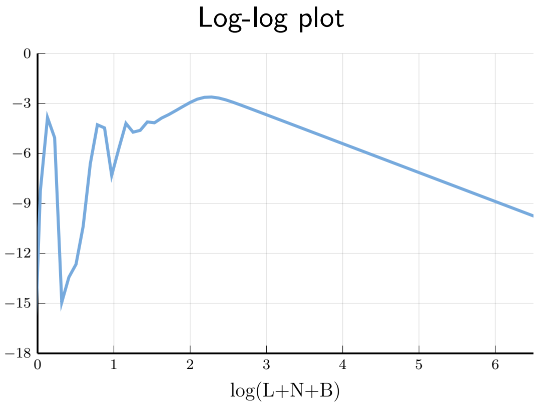
Long-run results: Distribution of bank assets





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Dataset for Capital Ratios

Bank-level panel w/ 163 European banks. 2008.Q1-2020.Q4.

- S&P Global (proprietary): CET 1 ratios, total assets, total risk-weighted assets.
- Supervisory (ECB, ESRB): CCoB, CCyB, bank specific: GSII, OSII, SRB, P2R.

Two measures:

- CET1 ratio = Common Equity Tier 1 / Risk-Weigthed Assets.
- CET1 buffer = CET 1 ratio - min requirement (4.5pp) - CCoB - CCyB
  - max$\{GSSI, OSII, SRB\}$ - P2R.

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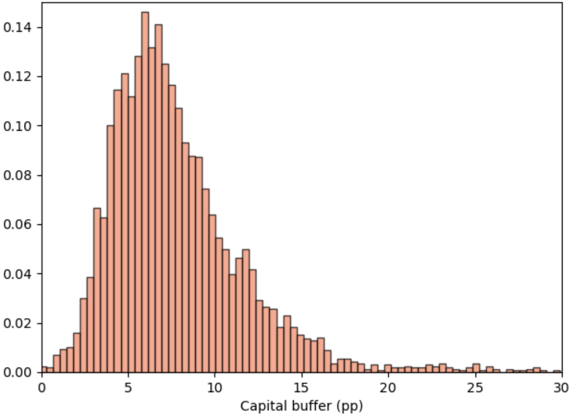
Heterogeneity in bank leverage: capital buffers

CET1 capital buffer distribution across European banks



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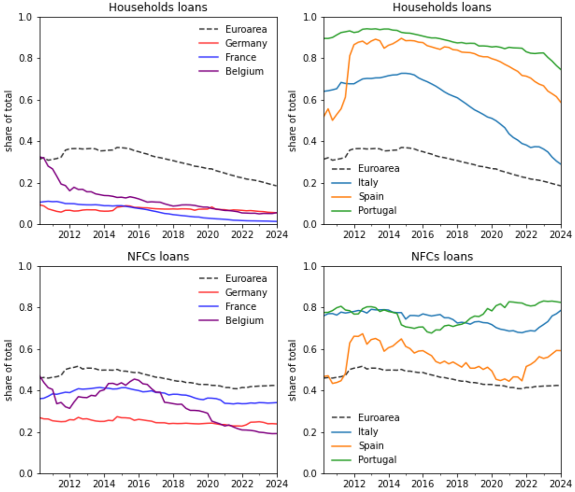
Lending at variable rates



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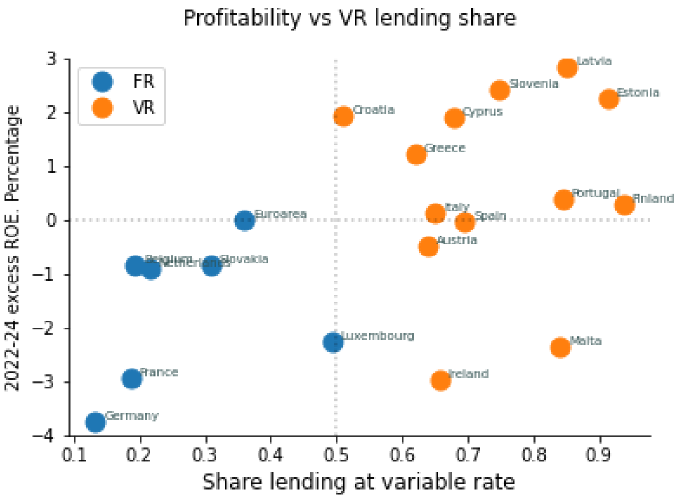
Loan Profitability across EA banks



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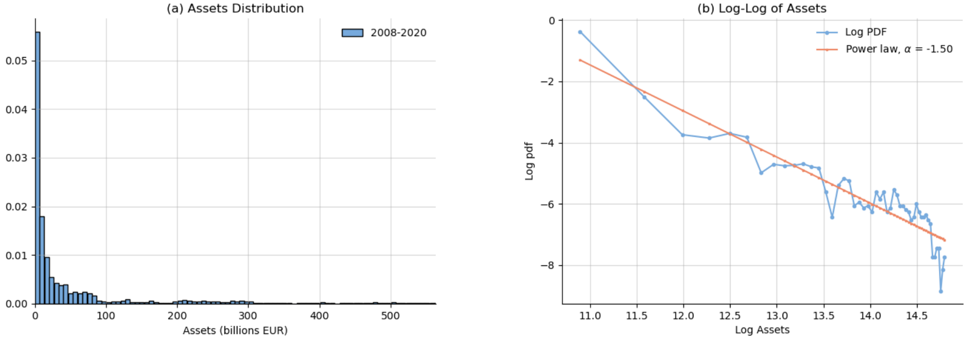
Banks Asset Distribution follows a Power Law



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EA Banks Balance Sheet

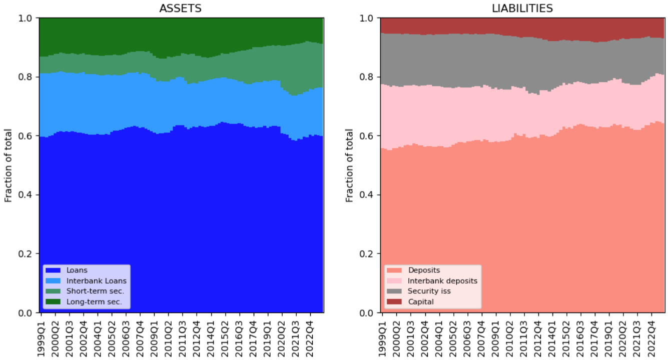

Figure 5: Euro Area MFIs Balance Sheet Composition, 1999-2023

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EA Banks Balance Sheet

Assets		Liabilities	
Loans	0.62	Deposits	0.60
Interbank loans	0.17	Interbank deposits	0.17
Short-term security holdings	0.09	Security issuance	0.16
Long-term security holdings	0.12	Capital	0.07

Table 2: MFIs Balance Sheet Composition, 1999 - 2023

Assets	Liabilities
Legacy Loans L_{jt}	Deposits D_{jt}
New Loans N_{jt}	Capital $K_{jt} \equiv E_{jt} - X_{jt}$
Reserves B_{jt}^R	

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Heterogeneity in NIM responses

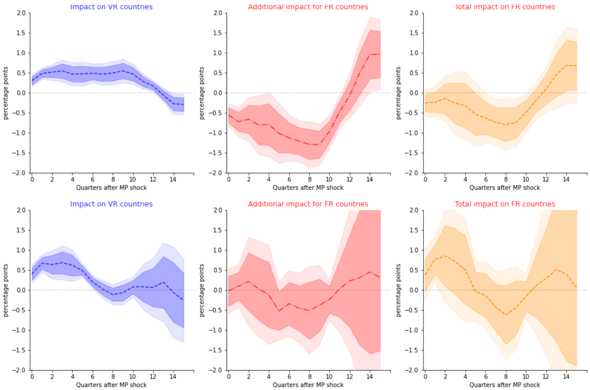

Figure 6: Net interest margin, stocks (top) and flows (bottom)

- The NIM on stocks for FR countries has a zero (or negative) response to a monetary tightening.
- The NIM on flows increases in response to a monetary tightening for FR and VR countries.

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Heterogeneity in Lending rate responses

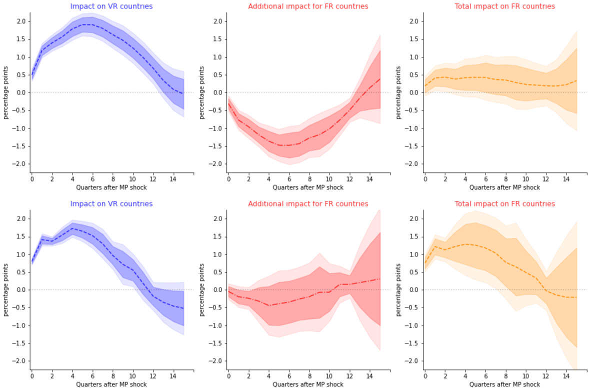

Figure 7: Avg lending rates, stocks (top) and flows (bottom)

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Heterogeneity in deposit rate responses

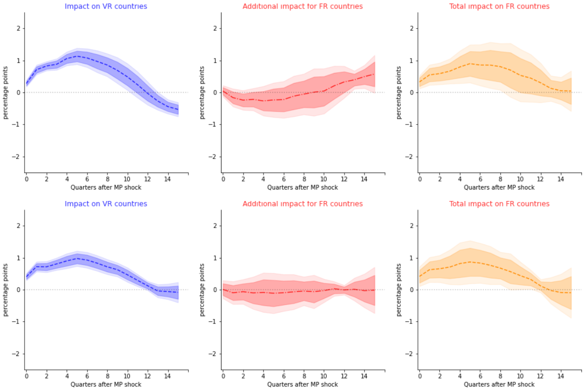

Figure 8: Avg deposit rates, stocks (top) and flows (bottom)

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Heterogeneity in Deposit rate responses: Overnight vs Time Deposits

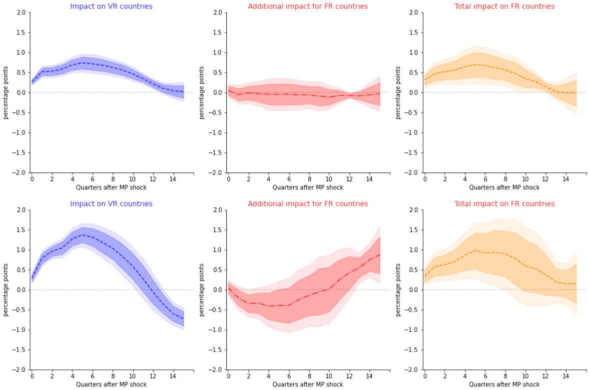

Figure 9: Avg deposit rates, Overnight (top) and Time Deposits (bottom)

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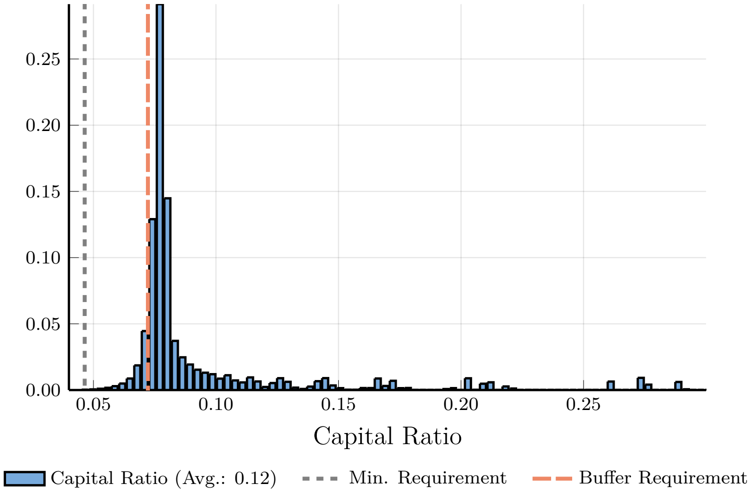
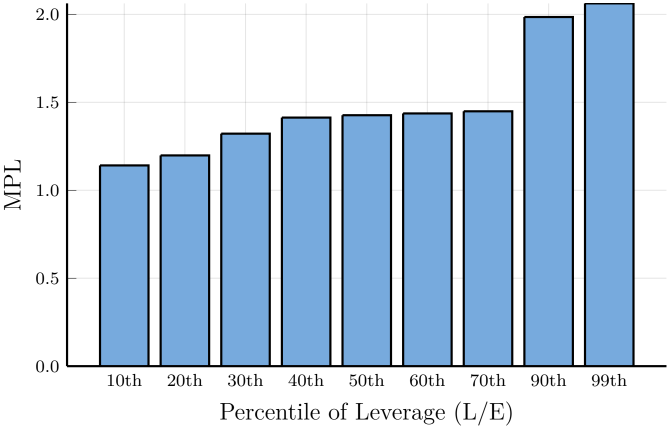
Long-run results: Capital ratios



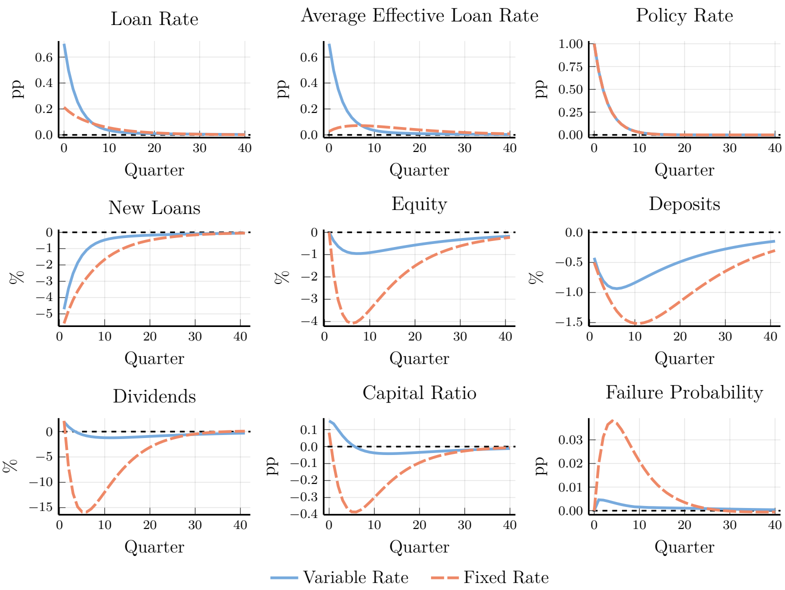
Assets

Long-run results: Leverage and marginal propensities to lend

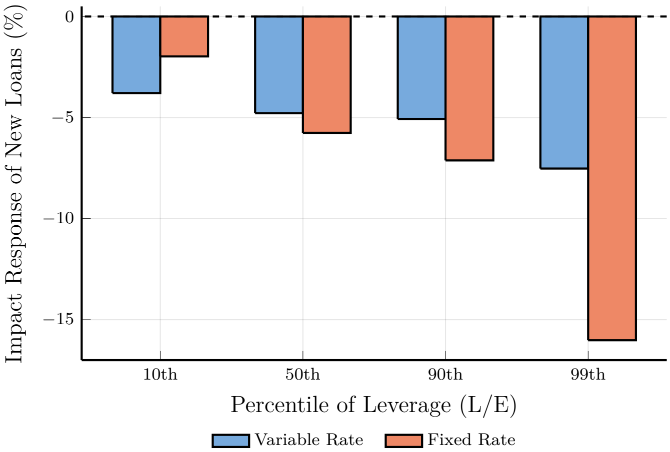
MPL_E: new lending response to a one-unit increase in equity



Aggregate responses to a MP shock



Cross-sectional heterogeneity in the transmission to lending



Entrepreneurs

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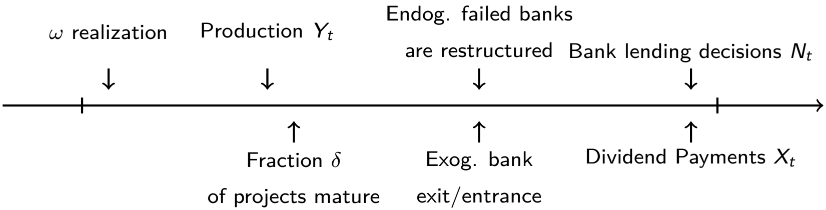

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