The Heterogenous Bank Lending Channel of Monetary Policy

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The Bank lending channel of monetary transmission

Transmission of monetary policy to lending depends on bank-level characteristics:

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

We ask:

How does these heterogeneity matters for individual and **aggregate** responses?

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Our contribution

1. We document EA banks' heterogeneity in capital ratios and loan pricing

2. We build a quantitative heterogeneous-banks model with:

   → Ex-ante heterogeneity in loan-rate fixation: fixed vs variable rates

   → Ex-post heterogeneity in capital ratios

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Preview of the results

A calibrated heterogeneous-bank model for the EA:

- Long-run distributional features:
  Cross-sectional dist. of assets, capital ratios and capital buffers

- We study aggregate and individual response to monetary policy shocks:
  → Stronger contraction in credit of banks with...
    - Fixed-rate loans
    - Lower capital ratios

  → Also: implications for financial stability

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Outline

1. Data results: stylized facts about bank heterogeneity in the EA
2. A heterogeneous bank model
3. Quantitative results

Dataset for Capital Ratios

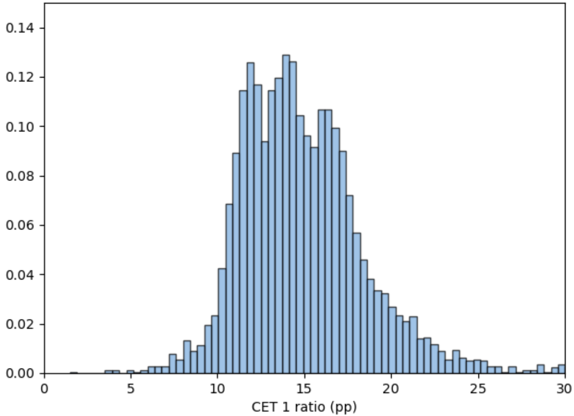
Bank-level panel w/ 163 European banks. 2008.Q1-2020.Q4.

- SP-Capital (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.

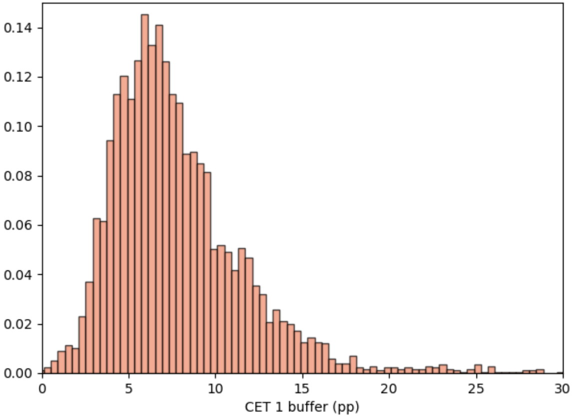
Heterogeneity in Bank Leverage: Capital ratios



	CET1 ratio (pp)
mean	15.2
std	4.5
25p	12.4
50p	14.5
75p	17.0

- Large heterogeneity in banks' CET 1 capital ratios.
- After 2013: Distribution shifted towards higher capital ratios. ⇒

Heterogeneity in Bank Leverage. Capital Buffers



	CET1 Buffer (pp)
mean	6.4
std	4.6
25p	3.6
50p	5.5
75p	8.0

- Most European banks hold capital buffers around 6pp.
- 1/7 banks hold capital buffers greater than 10pp.

Dataset for Loan Pricing

Country-level panel w/ 11 euro area countries. 2000.M1-2023.M12.

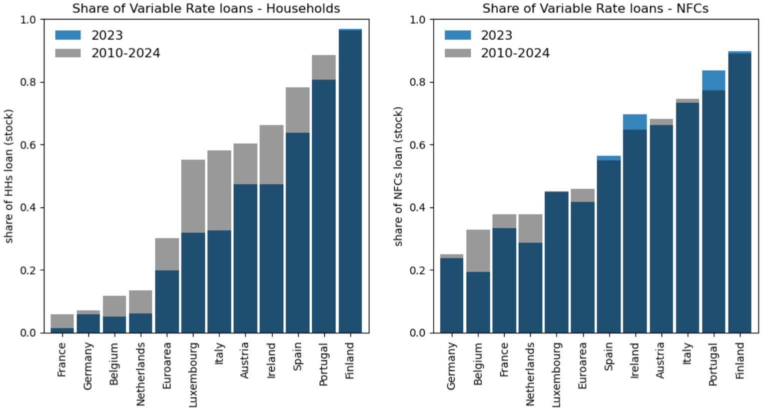
- lending volumes, lending rates, deposits, reserves.
- macro and financial variables.

Documenting:

- loan pricing composition: fixed vs variable rate.
- (Preliminary) responses to monetary policy shocks.

  Panel Local Projections (Jorda (2005), Jorda, Schularick, Taylor (2015))

Heterogeneity in Loan Pricing



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

Heterogeneity in responses to monetary policy shocks

- Estimate the impulse response functions (IRFs) of lending rates and volumes to monetary policy shocks
- Panel Local Projections with country fixed effects (Jorda et al., 2015)

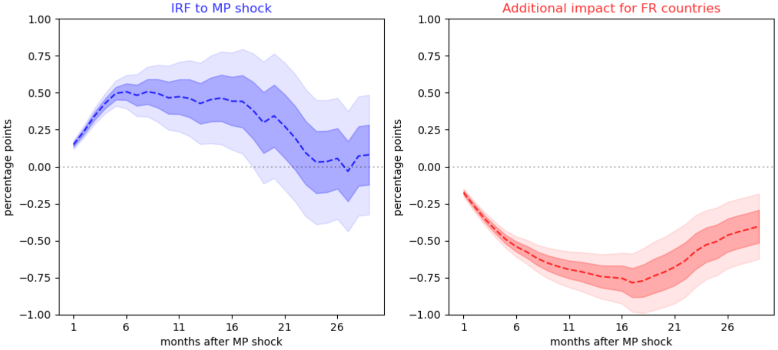
$$\Delta_h y^{\ell}_{c,t+h} = \alpha_{c,h} + \beta^0_h \varepsilon^{MP}_t + \beta^1_h \left[\varepsilon^{MP}_t \times I^{FR}_c\right] + X_{c,t-p}\Gamma_h + e_{c,t+h}$$

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

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

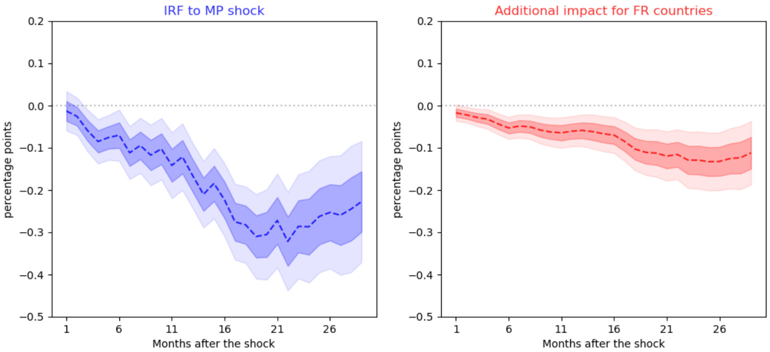
$X_{c,t-p}$: GDP growth, inflation, BBB corporate yield, 1y DE bond yield

Heterogeneity in rate pass through



- A tightening MP shock (Δ^{+}1pp) increases average lending rates to all banks.
- Countries with fixed-rate loan pricing adjust their rates much less.

Heterogeneity in lending growth



- Growth of new credit decreases more strongly in countries with fixed-rate pricing.

The Model

The Model

Banking sector

- Atomistic, perfectly competitive banks.
- Assets: central bank reserves and risky long-term loans.
- Liabilities: short-term (insured) deposit and equity.
- Regulation: (i) Minimum capital requirement, (ii) Buffer requirement, (iii) Liquidity requirement.

Non-financial sector

- Entrepreneurs: Rely on bank loans for funding investment projects.
- Households: Save in deposits and gov. bonds, consume, own the banks.
- Government: monetary policy, deposit insurance scheme, and tax receipts and transfers.

Two alternative institutional environments: fixed-rate and variable-rate loans

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Bank - Balance Sheet

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

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

- 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
    consistent with EA balance-sheet

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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:

$$L_{jt+1} = (1-\delta)(1-\omega_{jt+1})(L_{jt} + N_{jt}). \tag{2}$$

  → 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: Issuance of new loans N_{jt} incurs a convex cost $f\left(\frac{N_{jt}}{E_{jt}}\right) E_{jt}$

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Equity and Profits

- Equity is accumulated through retained earnings

$$E_{jt+1} = E_{jt} - X_{jt} + (1-\tau)\Pi_{jt+1}, \tag{3}$$

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

- Profits

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

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

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Δr^B_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*:

$$E_{jt} \geq \gamma L_{jt} \quad (5)$$

→ Failure to comply results in resolution of the bank → endogenous failure

→ Assumption: Limited liability +costly asset liquidation (loss $\mu < 1$ of seized assets)

- *Buffer requirement* constraints dividends and new lending:

$$\underbrace{E_{jt} - X_{jt}}_{\text{post-dividend equity}} \geq (1 + \kappa_t)\gamma(L_{jt} + N_{jt}) \quad (6)$$

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Recursive Bank Problem

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subject to (1)-(7) and the effective loan rate $\bar{r}^L_{jt}$:

$$\bar{r}^L_{jt} = \begin{cases} r^L_t & \text{variable-rate economy,} \\ \frac{\bar{r}^L_{jt-1} L_{jt} + r^L_t N_{jt}}{L_{jt} + N_{jt}} & \text{fixed-rate economy.} \end{cases} \tag{8}$$

Bank Problem Non-financial sector Timeline

The Model - Taking stock

Main features:

- deposit insurance + limited liability ⇒ incentives to max leverage
  - → Bernanke & Gertler (1989), Gale & Hellwig (1985), Mendicino et al (2020,2021,2024)
- loan adjustment costs + slow moving equity ⇒ slow moving leverage L/E
- credit risk + capital regulation + slow moving L/E ⇒ endogenous capital buffers
  - → Different from Corbae & D'Erasmo (2021), Coimbra & Rey (2023), Jamilov & Monacelli (2024)
- transmission channel:

MP shocks → equity accumulation → lending

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- transmission channel:

$$\text{MP shocks} \rightarrow \text{equity accumulation} \rightarrow \text{lending}$$

Calibration

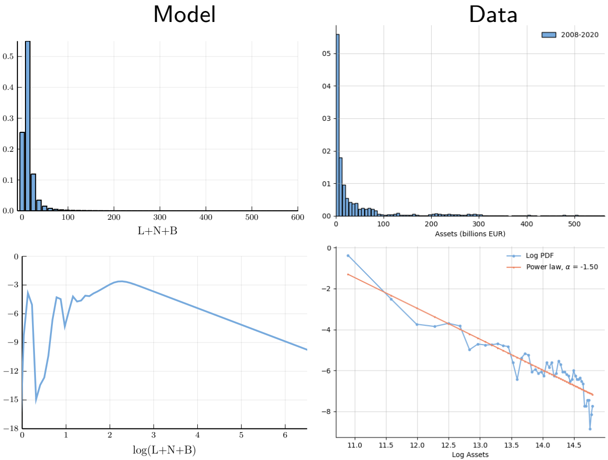
- Quarterly frequency
  - → Preset: Avg. loan maturity, LGDs, interest rates of assets and loan default rates
  - → Policy: Basel III requirements and share of liquid assets
  - → Estimated: banks' ROE, credit risk volatility, and prob. of bank failure

- Model matches the balance sheet and key variables of the EA banking sector.

Preset Policy Estimated

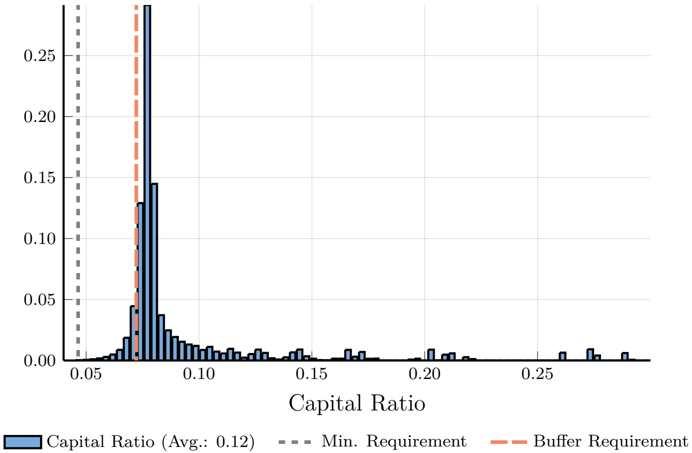
Results

1. Long-Run results: Distribution of bank assets



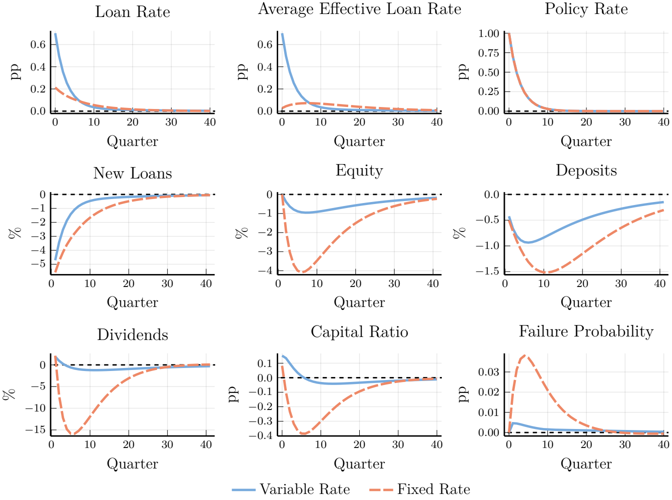
- Power law in the asset distribution $\rightarrow$ Large mass of small & medium sized banks

2. Long-run results: Distribution of capital ratios



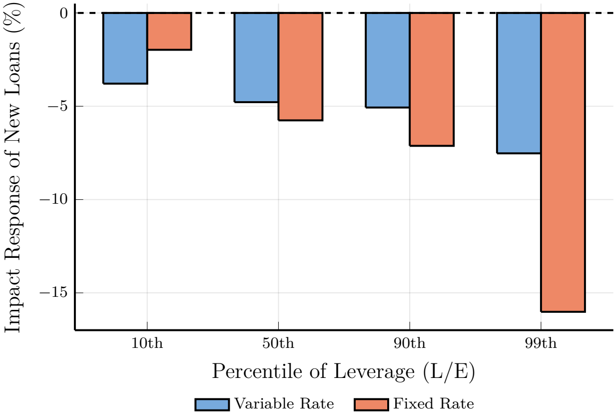
- Most banks are above the buffer capital req. $\rightarrow$ pay dividends

3. Aggregate Responses to a Monetary Policy shock



- Stronger responses in fixed-rate economies

4. Cross-sectional heterogeneity in the transmission to lending



- Stronger responses from highly leveraged banks

Concluding remarks

1. Document bank heterogeneity in leverage and loan-pricing in the EA
   → Estimate LP of rate pass-through and lending responses to MP shocks

2. Develop a heterogeneous-banks model with two dimensions of heterogeneity
   → consistent with long-run distributional features

3. Study aggregate and individual responses to monetary policy shocks:
   → stronger contraction in credit of banks with...

   - Fixed-rate loans
   - Lower capital ratios

Thanks!

Appendix

Research Portfolio

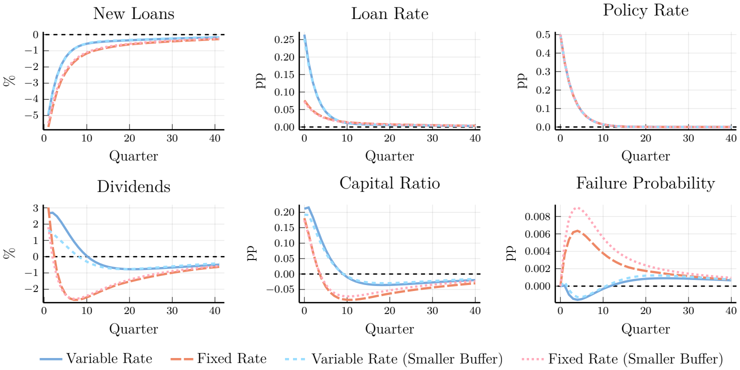
- Banking and Climate Finance
  - → Climate Transition Risk and Bank Capital Requirements. *Economic Modelling, 2024*
  - → The Impact of Energy Price Shocks on Bank Performance via Credit Risk Channels – Evidence from Spanish Loan-Level Data. *Work in Progress*

- Real Estate and Mortgage Markets
  - → The amplification effects of adverse selection in the mortgage market. *Journal of Housing Economics, 2023.*
  - → Mortgage securitization and information frictions in general equilibrium. R&R *Review of Economic Dynamics*
  - → The Consequences of Macroprudential Policy for Consumption, Housing Tenure, and Mortgage Pricing in General Equilibrium. *Work in Progress*

Other Exercises

- Forward guidance ⇒
- Monetary policy gradualism ⇒
- Macroprudential policy: smaller buffer requirements ⇒

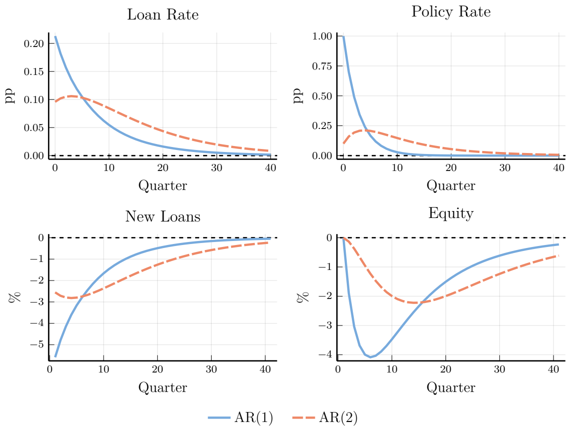
Stance of Macropru matters for the MP transmission



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

back

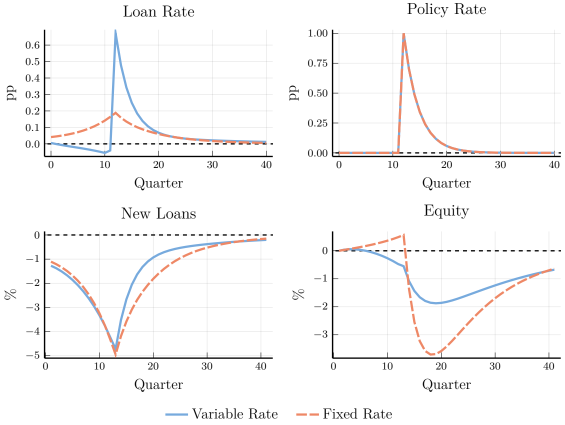
Monetary policy gradualism - Fixed rate banks



- Gradual implementation of monetary policy smooths effects on credit

back

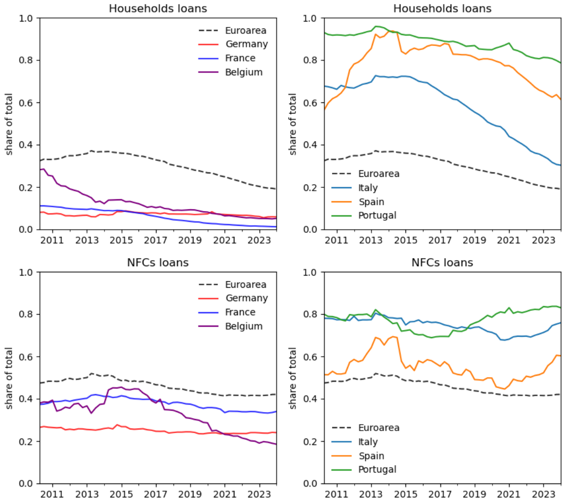
Anticipated monetary policy shock



- Forward guidance reduces the fixed-rate amplification on credit

back

Lending at variable rates



back

Recursive Bank Problem

$$V_t^B(L_t, E_t, \bar{r}_{t-1}^L) = \mathbf{1}_{\{E_t \geq \gamma L_t\}} \left[\max_{\{D_t, N_t, B_t\}} X_t + \beta \mathbb{E}_t[(1-\chi) V_{t+1}^B(L_{t+1}, E_{t+1}, \bar{r}_t^L) + \chi E_{t+1}] \right]$$

$$\begin{aligned}
\text{s.t.} \quad K_t &= E_t - X_t, && \text{(After-dividend equity)} \\
X_t &= \psi \max\left(0, E_t - \gamma\left(1+\kappa_t\right)\left(L_t + N_t\right)\right), && \text{(Dividend payout rule)} \\
D_t &= L_t + N_t + B_t - K_t, && \text{(Balance sheet identity)} \\
L_{t+1} &= (1-\delta)\left(1-\omega_{t+1}\right)\left(L_t + N_t\right), && \text{(Loan LOM)} \\
E_{t+1} &= E_t - X_t + (1-\tau)\Pi_{t+1}, && \text{(Equity LOM)} \\
K_t &\geq \gamma\left(L_t + N_t\right), && \text{(Capital requirement)} \\
B_t &\geq \bar{\theta} D_t, && \text{(Reserve requirement)} \\
\Pi_{t+1} &= \bar{r}_t^L\left(1-\omega_{t+1}\right)\left(L_t + N_t\right) + r_t^B B_t - r_t^D D_t \\
&\quad - \lambda \omega_{t+1}\left(L_t + N_t\right) - f\left(\frac{N_t}{E_t}\right) E_t - \bar{\pi} E_t, && \text{(Profits)} \\
\bar{r}_t^L &= \begin{cases} r_t^L & \text{in a variable-rate economy,} \\ \frac{\bar{r}_{t-1}^L L_t + r_t^L N_t}{L_t + N_t} & \text{in a fixed-rate economy.} \end{cases} && \text{(Effective Loan Rate)}
\end{aligned}$$

back

Non-financial sector

The model closes in General Equilibrium:

- Aggregate credit demand by entrepreneurs $N_t = g(r_t^L)$
- 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

Entrepreneurs Households Government back

Non-financial sector

The model closes in General Equilibrium:

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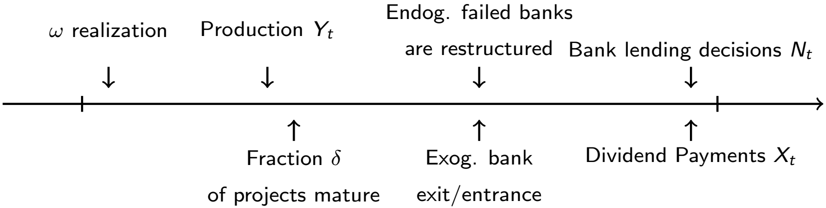
Timeline



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The Model - Entrepreneurs

- Every period there is a mass of new risk-neutral, penniless entrepreneurs
  - $\rightarrow$ Need one unit of initial investment
  - $\rightarrow$ Project produces A_t units of final good in every period it operates
  - $\rightarrow$ Project ends regularly with probability δ
  - $\rightarrow$ Project fails with probability p ($1-\lambda$ of initial investment can be recovered)
  - $\rightarrow$ Starting an investment project incurs a utility cost of $a(N_t)$ to the entrepreneur
- Due to free entry, entrepreneurs enter until the value of entering V_{it} equals $a(N_t)$
- 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

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

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

The Model - 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., $r_t^D = r_t^B$
- The consolidated government has the a budget constraint of the form

$$T_t + \left(B_t + B_t^H\right) + \tau \Pi_t = \left(1 + r_{t-1}^B\right)\left(B_{t-1} + B_{t-1}^H\right) + \Upsilon_t, \tag{9}$$

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.

Summary block

The Model - Entrepreneurs

- The value of entering a loan contract is

$$V_{it}^E = \beta(1-p)(1-\chi)\left[(A_{t+1} - r_{it}^L) + (1-\delta)V_{it+1}^E\right], \qquad \text{(Variable Rate)}$$

$$\begin{aligned} V_{it}^E &= \sum_{s=1}^{\infty}[\beta(1-p)(1-\chi)]^s(1-\delta)^{s-1}(A_{t+s} - r_{it}^L) \\ &= \frac{\beta(1-p)(1-\chi)(A - r_{it}^L)}{1-\beta(1-p)(1-\chi)(1-\delta)} \\ &+ \sum_{s=1}^{\infty}[\beta(1-p)(1-\chi)]^s(1-\delta)^{s-1}(A_{t+s} - A), \qquad \text{(Fixed Rate)} \end{aligned}$$

where $\beta \in (0,1)$ is the subjective discount factor of the household.

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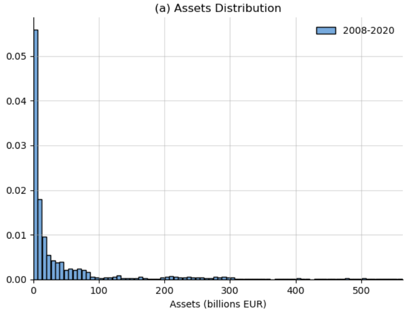
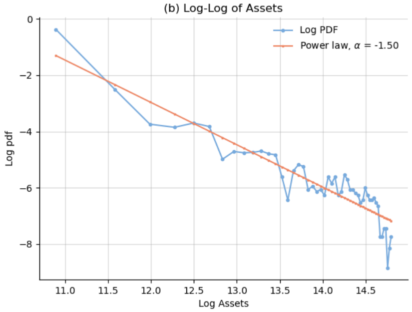
Banks Asset Distribution follows a Power Law





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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., 2024
μ	Bank resolution cost	0.30	Mendicino et al., 2024
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^B	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.

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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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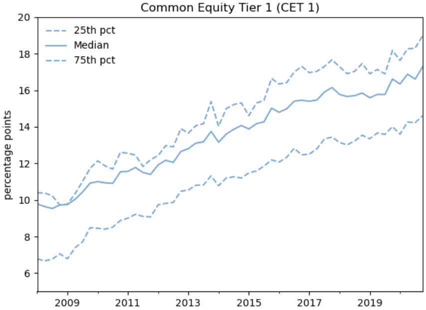
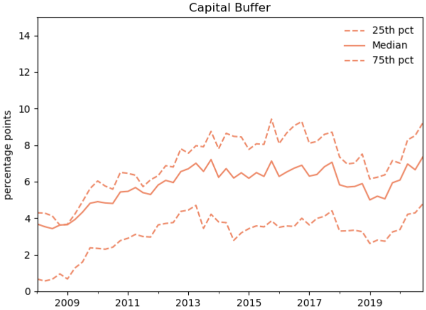
Evolution of Capital Ratios and Capital buffers





- Consistent with the implementation of Basell III after the GFC.

  Gambacorta and Shin (2016) document similar patterns for bank's leverage in a sample of globally international banks.

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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: 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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EA Banks Balance Sheet

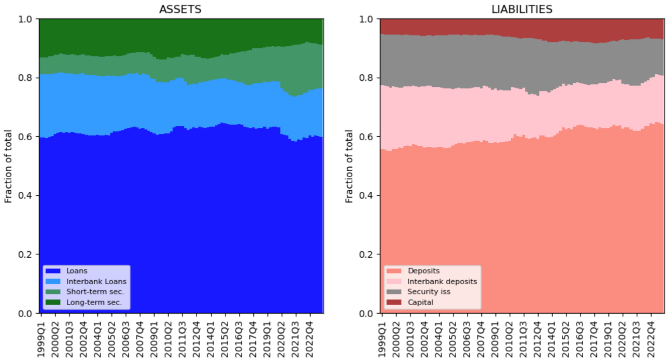

Figure: Euro Area MFIs Balance Sheet Composition, 1999-2023

◂ back

Related Literature

Heterogeneity and the bank lending channel of monetary policy

- Kashyap & Stein (2020), Jimenez et al. (2012), Dell'Ariccia et al.(2017), Altavilla et al.(2020), Gomez et al. (2021), Altunok et al (2023)

  Hoffman et al (2023), Albertazzi, Fringuellotti, Ongena (2024, EER)

Macro models of banking and financial frictions in GE:

- CSV + moral hazard: Townsend (1979), Carlstrom & Fuerst (1997), Kiyotaki & Moore (1997), Bernanke, Gertler, Glichrist (1999), Gertler & Kiyotaki (2010), Gertler & Karadi (2011)
- CSV + limited liability + deposit insurance: Karaken & Wallace (1978), Mendicino et al (2020, 2021, 2024)
- ex-ante heterogeneity: size (Corbae & D'Erasmo (2021)), leverage (Coimbra & Rey (2023)), Returns (Jamilov & Monacelli (2024))

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