The Heterogenous Bank Lending Channel of Monetary Policy

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Fifth Conference on Financial Stability – Banco de España & CEMFI
Madrid, June 12, 2025

Bank heterogeneity and monetary policy 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)
- Structural models can complement this empirical work by allowing to
  - Recover the effect of heterogeneity on aggregate responses, and
  - Implement counterfactual exercises

Our contribution

1. We document EA banks' heterogeneity in capital ratios and loan-rate fixation

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

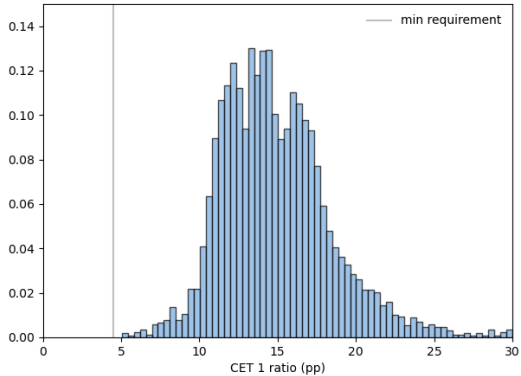
   - Ex-post heterogeneity in capital ratios
   - Ex-ante heterogeneity in loan-rate fixation: fixed vs. variable rates

Preview of the results

- Model can replicate long-run distributional features of EA banks
  - → Cross-sectional distribution of assets and capital ratios
- Aggregate and individual IRFs to monetary policy shocks depend on bank characteristics
  - Stronger contraction in credit of banks with...
    - Fixed-rate loans
    - Lower capital ratios
  - Also: implications for financial stability

Heterogeneity in bank leverage

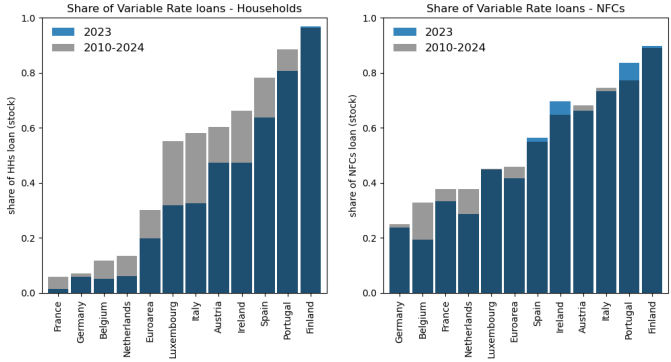
CET1 capital ratios distribution across European banks



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.

Data Buffers

Heterogeneity in loan-rate fixation



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, Finland
- Loan-rate fixation patterns are highly persistent over time

The model – Banking sector

- Continuum of perfectly competitive banks
- **Assets:** Hold both short- and long-term assets
  - Reserves are safe and short-term, earning the policy rate
  - Risky long-term loans, with fixed or variable rates, incur origination costs, mature stochast.
- **Liabilities:** Funded through short-term, insured deposits and (accumulated) equity
- **Regulation:**
  - *Minimum capital requirement*: Failure to comply results in resolution of the bank
  - *Buffer requirement*: Failure to comply restricts dividend payouts
  - *Liquidity requirement*: Requires reserves proportional to deposits

The model – Bank problem and environment

- **Problem of a bank:** Maximize expected discounted dividend payments
  - Banks choose new loan origination, deposits, reserves, and dividends subject to constr.

  $\rightarrow$ Ex-post heterogeneity in equity and leverage due to idiosyncratic loan default shocks

  $\rightarrow$ Ex-ante heterogeneity due to fixed-rate and variable-rate loans ($\rightarrow$ two sep. economies)
- **Environment:** Banking sector is embedded in an environment where
  - Entrepreneurs demand loans to fund long-term investment projects, sensitive to loan rates
  - Households supply deposits and own banks
  - Central bank sets policy rate; government runs deposit insurance

Banks Entrepreneurs Government / Household Timeline

The model – Main frictions

- Deposit insurance + limited liability $\Rightarrow$ Incentives to increase leverage
- Loan adjustment costs + slow moving equity $\Rightarrow$ Slow moving leverage
- Credit risk + capital regulation + slow moving leverage $\Rightarrow$ Endogenous capital buffers
- Main amplification channel:

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

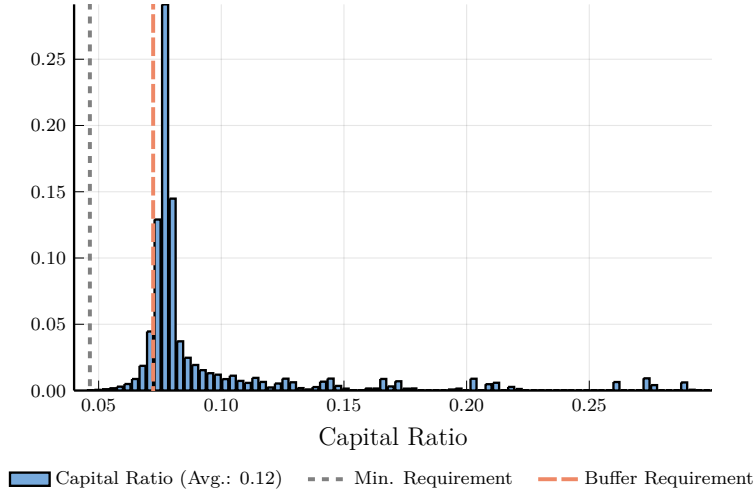
Calibration

- Quarterly frequency
- Matches euro area bank balance sheets (capital ratios, liquid assets, loan maturities)
- Replicates Basel III requirements
- Targets empirical responses of loan rates to monetary policy shocks

→ Today: full pass-through of monetary policy shocks to bank liabilities

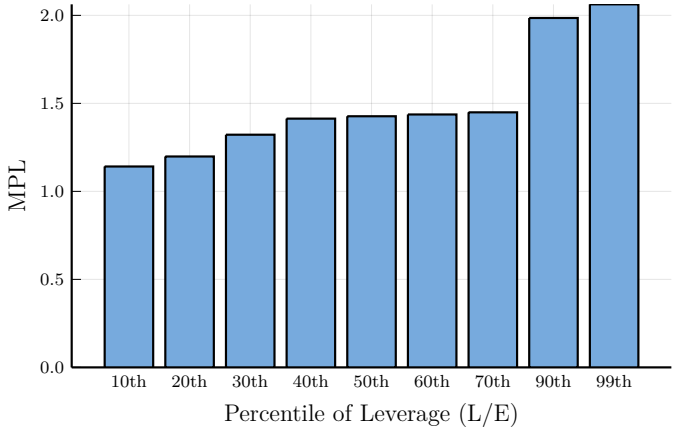
→ WIP: imperfect pass-through

Long-run results: Capital ratios

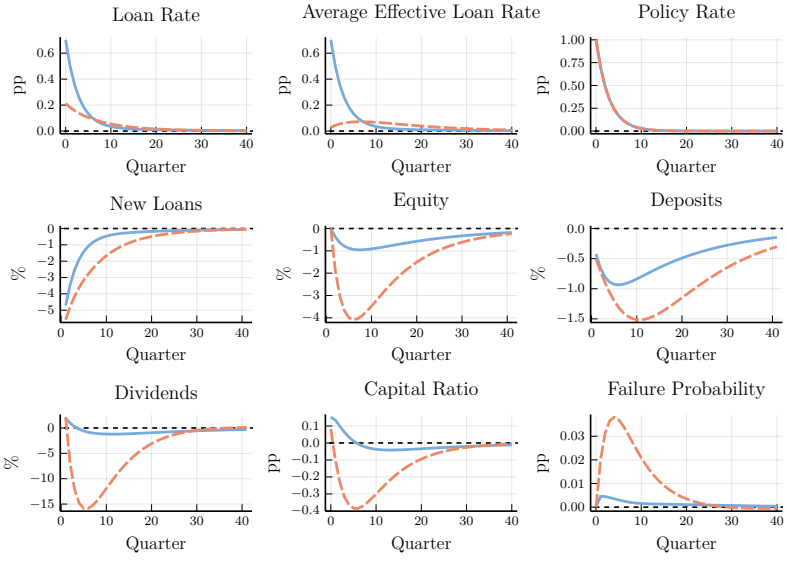


Assets

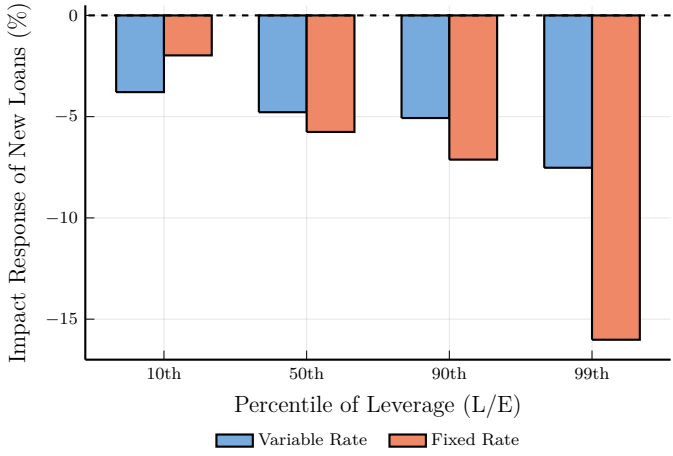
Long-run results: Leverage and marginal propensities to lend



Aggregate responses to a MP shock



Cross-sectional heterogeneity in the transmission to lending



Concluding remarks

- We document stylized facts about bank heterogeneity in the EA
- We develop a model of banks with heterogeneous leverage and loan-rate fixation
- We study aggregate and individual responses to monetary policy shocks:
  - Stronger contraction in credit of banks with...
    - Fixed-rate loans
    - Lower capital ratios

Appendix

Banks' balance sheet

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

$$L_{jt} + N_{jt} + B_{jt} = D_{jt} + K_{jt},$$

with $K_{jt} \equiv E_{jt} - X_{jt}$ post-dividend equity

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Assets

Loan portfolio: continuum risky long-term loans with atomistic size

- Principal of 1 and per-period avg. effective rate $\bar{r}_{jt}^{L}$
- Mature with iid prob. δ (as in Leland and Toft, 1996)
- Default with prob. p and suffer loss λ
- Loan defaults correlated at the bank level $\rightarrow \omega_{jt+1}$: stochastic default rate
- Law of motion: $L_{jt+1} = (1 - \omega_{jt+1})(1 - \delta)(L_{jt} + N_{jt})$
- Technology: Issuance of new loans N_{jt} incurs an increasing and convex cost $f\left(\frac{N_{jt}}{E_{jt}}\right) E_{jt}$
- Banks can also invest in short-term reserves B_t remunerated at the policy rate r_t^B

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Equity and profits

- Equity is accumulated through retained earnings

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

where τ is the corporate tax rate and profits Π_{jt+1}

- Profits:

$$\begin{aligned}
\Pi_{jt+1} = {} & \bar{r}^{L}_{jt}\left(1-\omega_{jt+1}\right)\left(L_{jt}+N_{jt}\right) - \lambda\omega_{jt+1}\left(L_{jt}+N_{jt}\right) && \text{(return of loans)} \\
& + r^{B}_{t} B_{jt} && \text{(return of reserves)} \\
& - r^{D}_{t} D_{jt} && \text{(remuneration of liabilities)} \\
& - f\left(N_{jt}/E_{jt}\right) E_{t} - \bar{\pi} E_{jt} && \text{(operational costs)}
\end{aligned}$$

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Regulation

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

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

$\rightarrow$ Failure to comply results in resolution of the bank

- New lending and dividends constrained by a *buffer requirement*:

$$K_{jt} \equiv E_{jt} - X_{jt} \geq (1 + \kappa_t)\gamma(L_{jt} + N_{jt})$$

- *Liquidity requirement* proportional to bank deposits:

$$B_t \geq \theta D_t$$

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Non-financial sector

- Aggregate credit demand by entrepreneurs:

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

- 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

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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
- 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

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

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

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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

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

  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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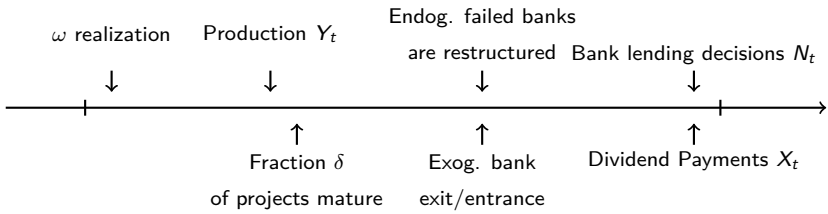
Timeline



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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, Nikolov, Suarez, and Supera, 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^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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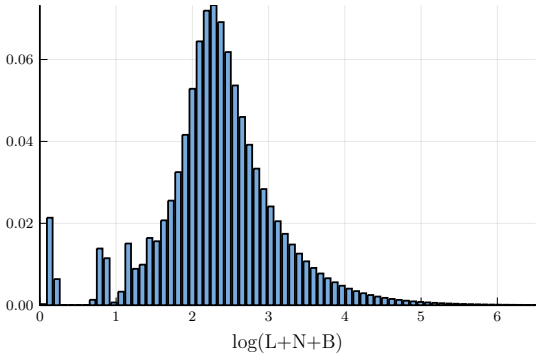
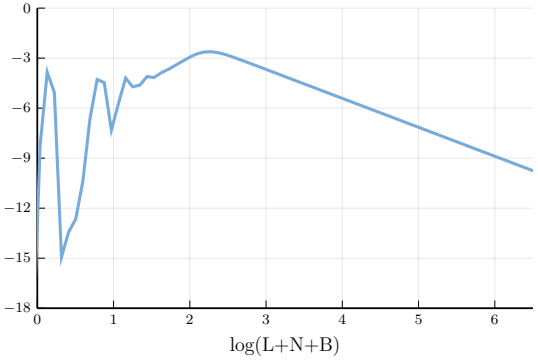
Long-run results: Distribution of bank assets

Histogram



Log-log plot



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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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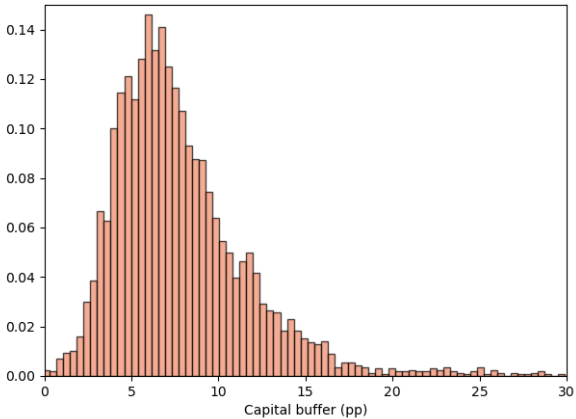
Heterogeneity in bank leverage: capital buffers

CET1 capital buffer distribution across European banks



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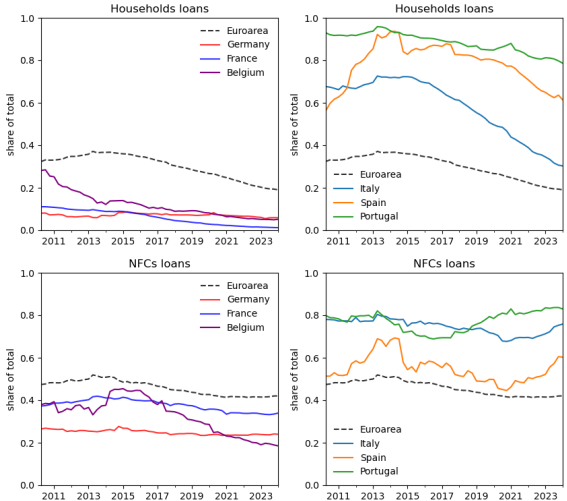
Lending at variable rates



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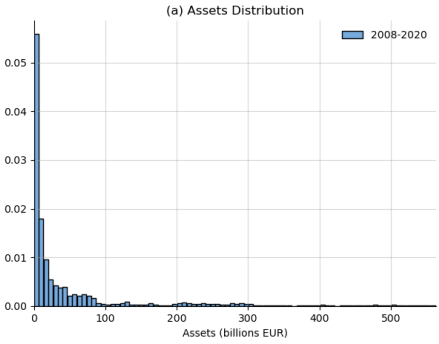
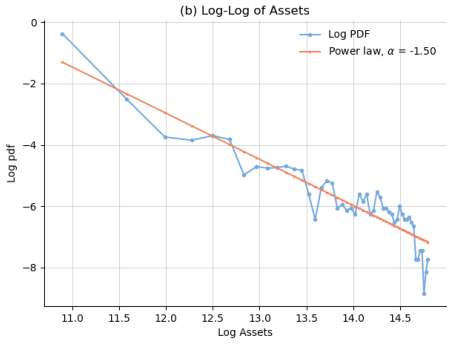
Banks Asset Distribution follows a Power Law





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EA Banks Balance Sheet

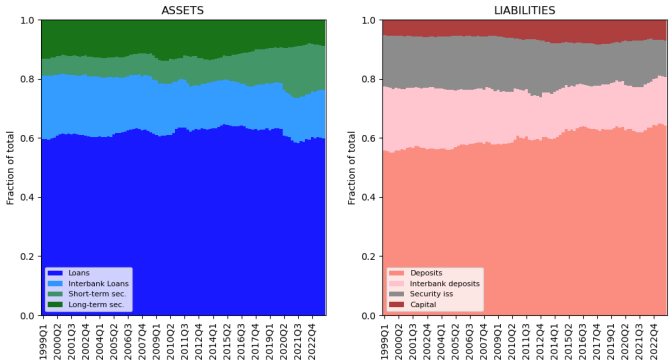

Figure 2: Euro Area MFIs Balance Sheet Composition, 1999-2023

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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 1: 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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