Interest Rate Risk and Cross-Sectional Effects of Micro-Prudential Regulation

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ECB Annual Research Conference – September 17, 2025

Motivation

- Banks hold fixed-income positions (loans + securities) that decline in value when interest rates (IR) rise ($\Rightarrow V \approx C/R$)
- Banks are funded with insured and uninsured (runnable) deposits
- Recent rate hikes revealed banks' *differential* exposure to IR & run risk
- This paper
  - model to rationalize banks' funding- and portfolio choices *jointly*
  - studies microprudential regulation to improve financial stability

This Paper

- Two period model to analyze funding & portfolio choice in cross-section
  - heterogeneity in banks' lending and deposit productivity
  - product differentation in insured and uninsured deposits
  - portfolio choice between loans and bonds
  - endogenous runs
  - default option

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- Calibrate model to US bank call report data
- Rationalizes the cross-section of bank portfolio and funding choices
- Heterogeneous causes of default across bank size distribution
- Study cross-sectional effects of microprudential policy

  Size-dependent capital requirements reduce run risk with fewer side effects than equal capital requirements or liquidity regulation

Related Literature

- **Interest rate risk exposure in banking**
  Landier, Sraer, and Thesmar (2013); English, Van den Heuvel, and Zakrajšek (2018); Haddad and Sraer (2020); Begenau, Piazzesi, and Schneider (2025); Paul (2023); Greenwald, Krainer, and Paul (2024); DeMarzo, Krishnamurthy, and Nagel (2024); Jiang, Matvos, Piskorski, and Seru (2024)

- **Deposit-centric view of banking**
  Hanson, Shleifer, Stein, and Vishny (2015); Drechsler, Savov, and Schnabl (2017); Stulz, Taboada, and Van Dijk (2022); Haddad, Hartman-Glaser, and Muir (2023)

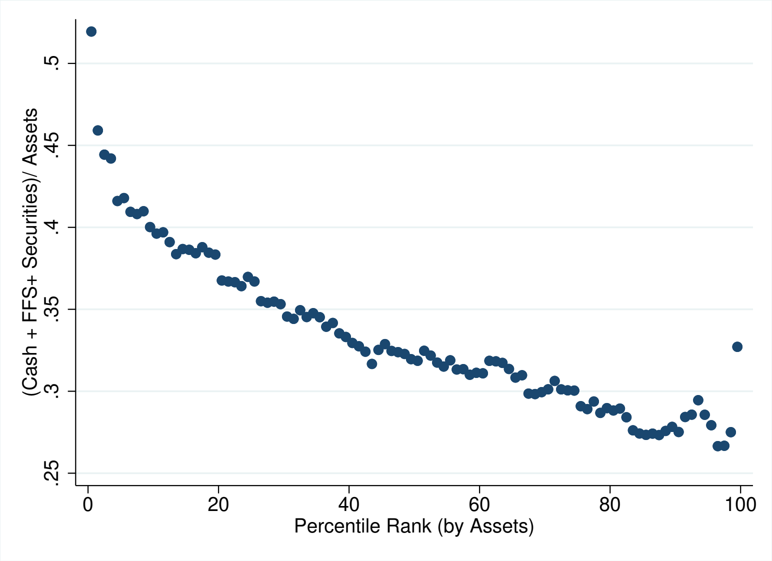
- **Heterogeneous banking-industry models**
  Egan, Hortaçsu, and Matvos (2017); Egan, Lewellen, and Sunderam (2022); Jiang (2023); d'Avernas, Eisfeldt, Huang, Stanton, and Wallace (2024); Jiang, Matvos, Piskorski, and Seru (2023); Buchak, Matvos, Piskorski, and Seru (2024a,b); Jiang, Matvos, Piskorski, and Seru (2024)

- **Quantitative macro-banking models**
  Brunnermeier and Sannikov (2014); He and Krishnamurthy (2013); Elenev, Landvoigt, and Van Nieuwerburgh (2021); Corbae and D'Erasmo (2021); Jamilov (2021); Begenau and Landvoigt (2022); Begenau, Bigio, Majerovitz, and Vieyra (ming); Coimbra and Rey (2024)

- **Fragility through deposit funding structure**
  Diamond and Rajan (2001); Egan, Hortaçsu, and Matvos (2017); Robatto (2019); Dávila and Goldstein (2023); Gertler and Kiyotaki (2015); Pancost and Robatto (2023); Granja, Jiang, Matvos, Piskorski, and Seru (2024); Chang, Cheng, and Hong (2023); Haddad, Hartman-Glaser, and Muir (2023)

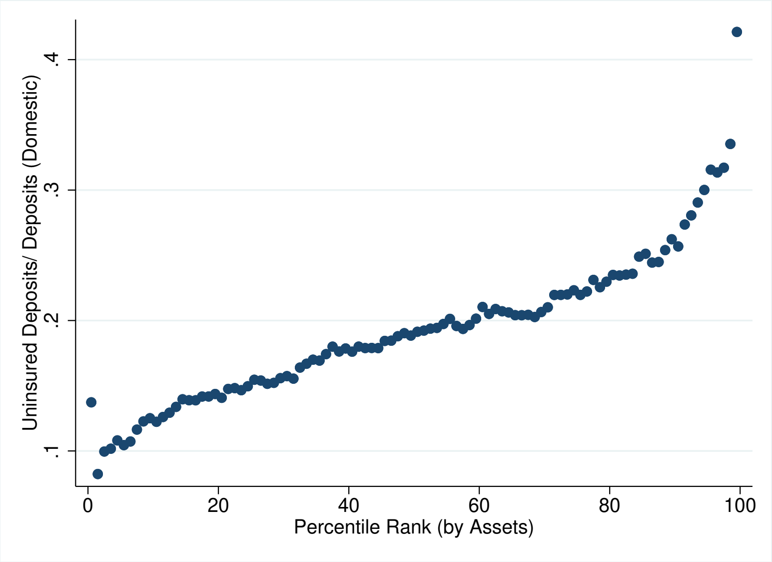
- This paper synthesizes & quantifies forces that rationalize banks' funding, risk, and run exposure choices across the size distribution

Securities Share Decreases in Bank Size



Composition of ecurities
Long duration securitity share
Securities share
Cash + FFS share

Uninsured Deposit Share Increases in Bank Size



▸ Uninsured deposit share time series

(Jiang et al., 2023)

Model

Model Overview

- Two periods $t \in \{0, 1\}$
- Representative household with initial endowment W_0, preferences over $t = 0$ consumption, aggregate liquidity, $t = 1$ consumption
- Continuum of banks $i \in [0, 1]$
  - produces liquidity and consumption good
  - owned by households
- Government insures D_i^I but not D_i^U
  - financed w/ lump-sum taxes at $t = 0$ to balance the budget

Household Problem

- Preferences with liquidity term H scaled by ψ

$$U(C_0, C_1, \{D_i^I, D_i^U\}) = U(C) + \psi \log(H)$$

- Liquidity is a nested CES aggregator with ρ_U, ρ_I governing cross-bank differentiation, α substitution between insured and uninsured deposits, A_i quality of bank i's liquidity services

$$H = \left(\int_0^1 (A_i D_i^I)^{\rho_I} \, di \right)^{\frac{\alpha}{\rho_I}} \left(\int_0^1 (A_i D_i^U)^{\rho_U} \, di \right)^{\frac{1-\alpha}{\rho_U}} .$$

- $t = 0$: Allocate endowment to bank equity, insured deposits, uninsured deposits; earn profits and pay taxes

Frac. Unins.

Banks

- Portfolio Choice
  - bonds: price 1, risky payoff R^B (interest rate risk), $\mathrm{E}[R^B] = 1 + r$
  - capital (loans): price 1, time-1 output $\epsilon_i R^K Z_i K_i^{1-\kappa}$
  - components of lending productivity $\epsilon_i R^K Z_i$
    - $Z_i \sim G$ is cross-sectional heterogeneity known at $t = 0$
    - $R^K \in \{R_L^K, R_H^K\}$ is aggregate payoff risk
    - $\epsilon_i \sim F$ is idiosyncratic payoff risk

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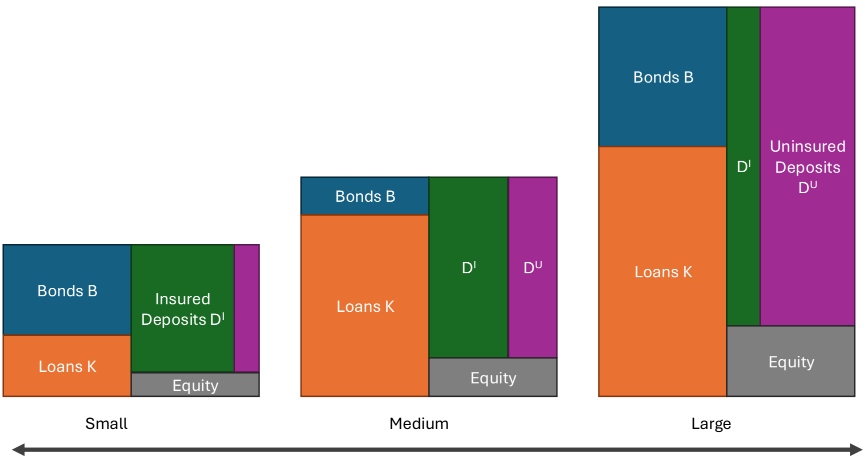
- Funding choice
  - insured deposits D_i^I at price q_i^I to HH
  - uninsured deposits D_i^U at price q_i^U
  - uninsured deposits subject to runs
  - After runs: default option with bankruptcy costs

Bank Balance Sheets



Bank i problem at $t = 1$

Two stages

1. Run stage:
2. Equity payoff & default stage:

Bank i problem at $t = 1$

Two stages

1. Run stage: if bank experiences run, needs to liquidate assets to pay out running uninsured depositors

$$\delta R^K \hat{K}_i + R^B \hat{B}_i \geq (1 - \phi) D_i^U$$

If $\delta < 1$ low enough, it is optimal to liquidate bonds first.

2. Equity payoff & default stage:

Bank i problem at $t = 1$

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2. Equity payoff & default stage: final payoff

$$\begin{aligned} \epsilon_i R^K Z_i K_i^{1-\kappa} + \bar{R}^B B_i - D_i^I - D_i^U & \quad \text{if no run} \\ \epsilon_i R^K Z_i (K_i - \hat{K}_i)^{1-\kappa} + \bar{R}^B (B_i - \hat{B}_i) - D_i^I - \phi D_i^U & \quad \text{if run} \end{aligned}$$

- Final bond payoff
  - partial interest rate risk $\bar{R}^B = \omega R^B + (1-\omega)(1+r)$ for final payoff

Bank i problem at $t = 1$

Two stages

1. Run stage: if bank experiences run, needs to liquidate assets to pay out running uninsured depositors

$$\delta R^K \hat{K}_i + R^B \hat{B}_i \geq (1-\phi) D_i^U$$

   If $\delta < 1$ low enough, it is optimal to liquidate bonds first.

2. Equity payoff & default stage: default iff ϵ_i below threshold:

$$0 = \underline{\epsilon}_i R^K Z_i K_i^{1-\kappa} + \bar{R}^B B_i - D_i^I - D_i^U \quad \text{if no run}$$
$$0 = \overline{\epsilon}_i R^K Z_i (K_i - \hat{K}_i)^{1-\kappa} + \bar{R}^B (B_i - \hat{B}_i) - D_i^I - \phi D_i^U \quad \text{if run}$$

Run coordination game ∼ Davila & Goldstein (2023)

- $\epsilon_i < \underline{\epsilon}_i$: default regardless of runs ("insolvency") $\implies$ receivership

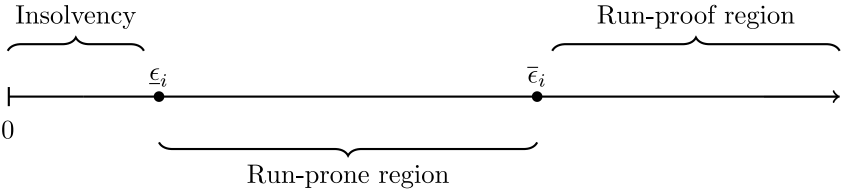
$$0 = \underline{\epsilon}_i R^K Z_i K_i^{1-\kappa} + \bar{R}^B B_i - D_i^I - D_i^U$$

- $\epsilon_i > \overline{\epsilon}_i$: survive potential run ("run-proof") $\implies$ no run

$$0 = \overline{\epsilon}_i R^K Z_i (K_i - \hat{K}_i)^{1-\kappa} + \bar{R}^B (B_i - \hat{B}_i) - D_i^I - \phi D_i^U$$

- $\underline{\epsilon}_i \leq \epsilon_i \leq \overline{\epsilon}_i$: default iff run occurs ("run-prone")

- In run-prone region, draw r.v. (run indicator) run w/ prob π



Bank i problem at $t = 0$

- At $t = 0$, bank i maximizes expected dividends conditional on survival by choosing K_i, B_i, D_i^U, D_i^I s.t. budget and regulatory constraints
- Budget constraint: purchases of capital and bonds are funded with issuance of equity and deposits.
- Banks internalize the effect of their choices on
  - the demand for deposits (monopoly pricing)
  - the pricing of their default risk for uninsured deposits

Equilibrium

- Given
  - elastic supply of bonds and capital at price 1, and
  - distributions for Z_i, A_i, and ϵ_i,
- households and banks optimize,
- government budget constraint holds at equality, and
- markets clear for
  - each bank's insured deposits,
  - each bank's uninsured deposits, and
  - bank stocks.

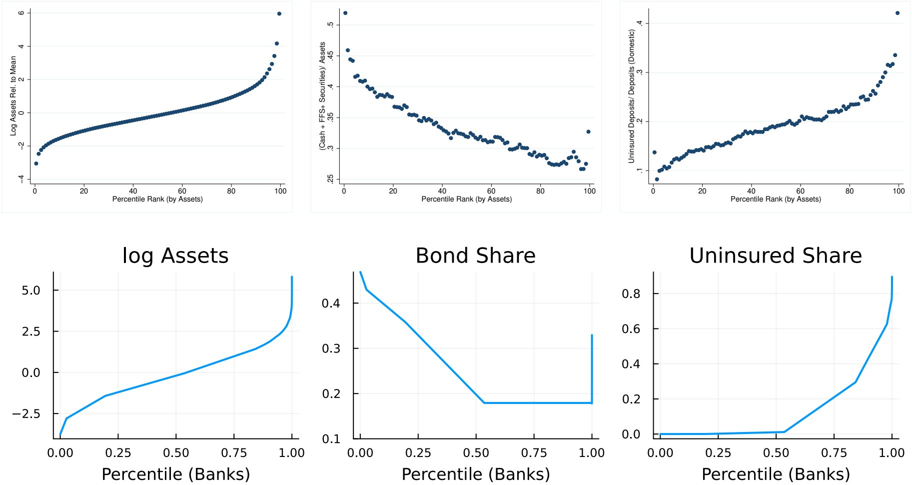
Calibration of key parameters

- Call Reports (bank-level) average over 2010-2022 & market data
- Liquidity preference
  - scale: avg. time deposit rate level (scales liquidity premia)
  - differentiation uninsured ρ^U: gini uninsured
  - differentiation insured ρ^I: transaction deposit rate
  - Find $\rho_I < \rho_U < 1$: insured more product differentiation
- Loan productivity Z:
  - xs sd of assets & Egan et al. (2017)
  - Deposit productivity A perfectly correlated with Z

Unins. recovery

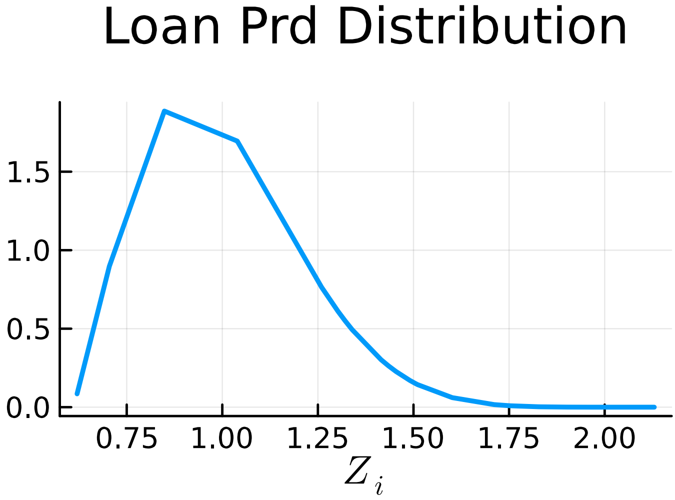
Results

Data (top) vs. Model (bottom)



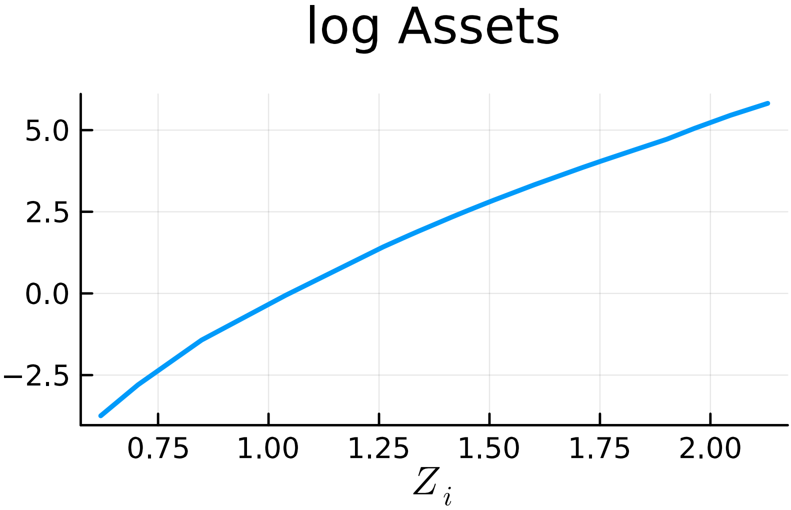
Cross-Section of Funding and Portfolio Choice

- Cross-section now in terms of loan productivity type Z_i



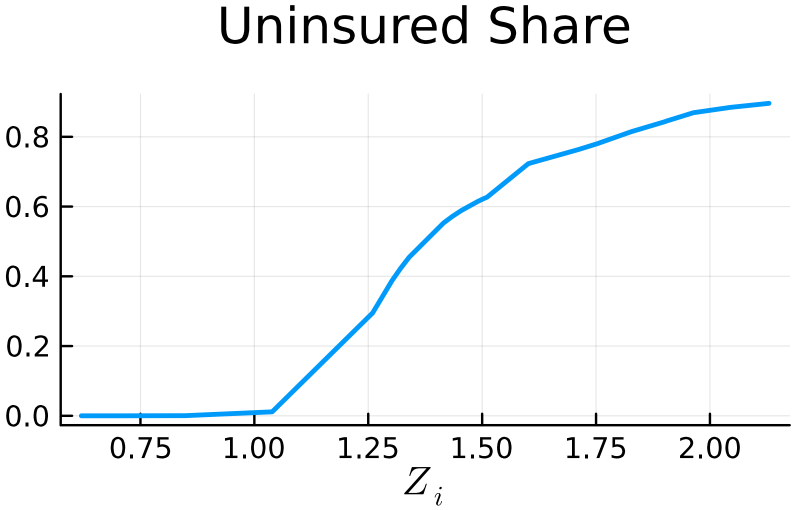
Cross-Section of Funding and Portfolio Choice

- Higher productivity banks are larger



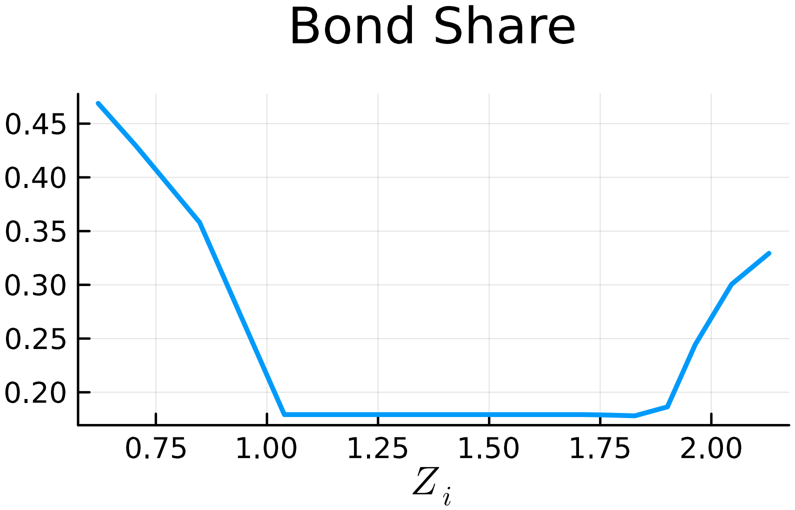
Cross-Section of Funding and Portfolio Choice

- Increasing uninsured share in size (result of $\rho^I < \rho^U$)



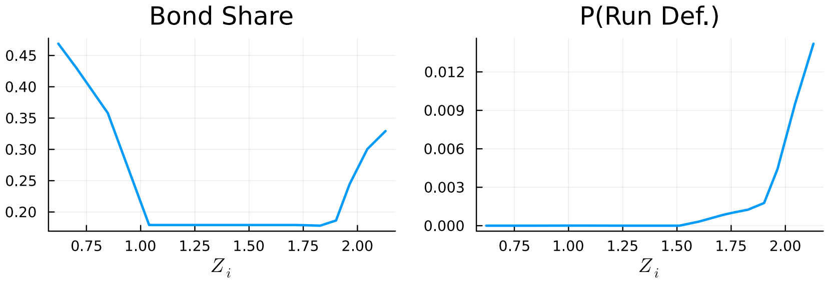
Cross-Section of Funding and Portfolio Choice

- Smaller (unproductive) banks back insured deposits D^I with bonds



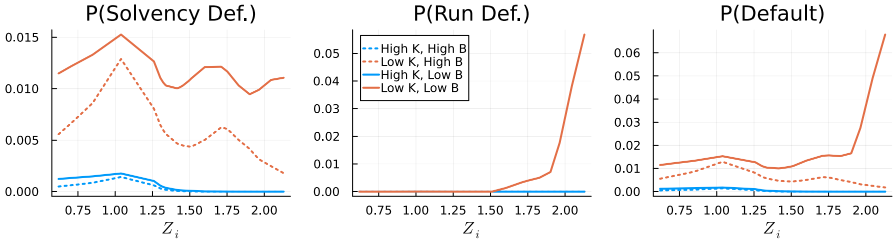
Cross-Section of Funding and Portfolio Choice

- Larger (productive) banks use bonds to hedge run risk from D^U



Interest Rate Risk and Runs & Default Risk

- Rate Increase: low R^B realization
- Small banks default for solvency reasons (esp. when loans do poorly too)
- Large banks face elevated run risk



Interest Rate Risk and Runs & Default Risk

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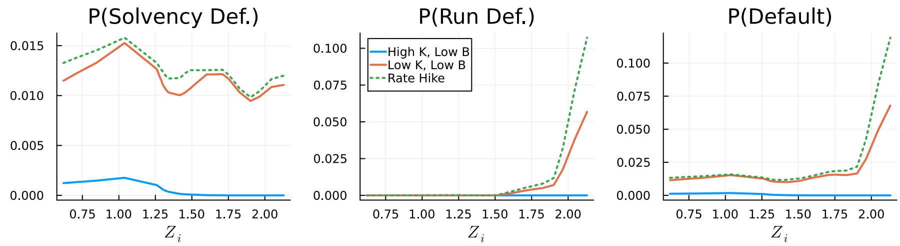
- Small banks default for solvency reasons (esp. when loans do poorly too)
- Large banks face elevated run risk
- "Rate hike": unanticipated (MIT shock) extra low R^B realization
- Unexpected rate hike doubles run defaults for large banks



Policy Counterfactuals

Policy I: Capital requirements

- Tightening means lowering θ_K in $D_i^I + D_i^U \leq \theta_K K_i + \theta_B B_i$
- Baseline: TBTF and $\theta_K = 88\%$
- Highly effective at curbing run defaults of largest banks
- Trade-off between consumption and liquidity provision reduction

Outcome	θ_K				
	85%	86%	87%	**88%**	89%
Loans	-0.529	-0.268	-0.022	1.571	-0.007
C0	-0.015	-0.005	0.004	2.073	-0.010
E(C1)	0.095	0.063	0.030	2.201	-0.032
E(DWL)	-68.510	-53.966	-30.007	0.002	42.668
SD(MPK)	-24.002	-17.147	-9.760	0.003	12.571
Liquidity	-2.527	-1.712	-0.876	0.927	0.861
HH Utility	-0.114	-0.074	-0.035	1.509	0.028
Run Def. top 0.1%	-99.983	-60.192	-44.006	0.020	52.801

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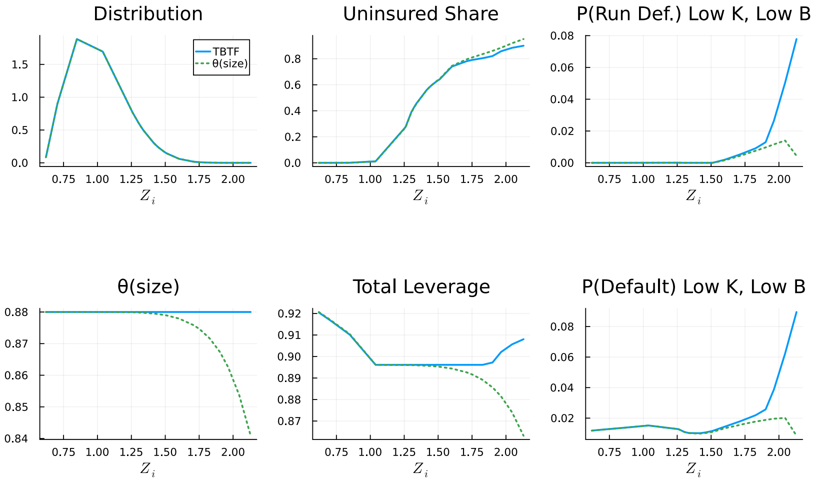
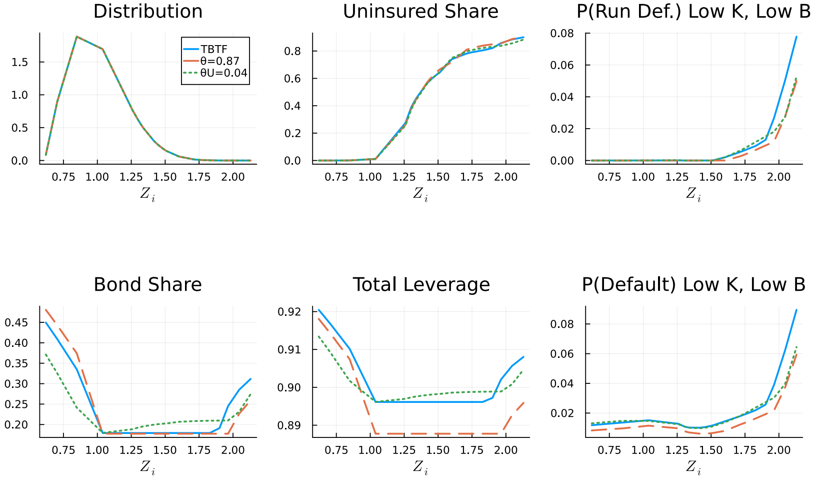
Policy I-s: Size dependent capital requirements

- Size dependent capital requirement (green line)
- Effective at curbing run-risk at large banks
- More targeted at reducing risk without much decline in liquidity



Policy II: Liquidity requirements

- Varying θ^U: $\theta^D D_i^I + (\theta^D + \theta^U) D_i^U \leq B_i$
- Tighter liquidity requirement reduces large bank run-risk
- Asset portfolio distorted away from loans towards bonds



Policy Comparison

- Liquidity requirements have more pronounced side effects

Outcome				
	TBTF	$\theta = 85\%$	θ(size)	$\theta^U = 4\%$
Loans	1.571	-0.529	0.005	-0.536
C_0	2.073	-0.015	0.000	-0.028
E(C_1)	2.201	0.095	0.001	0.025
E(DWL)	0.002	-68.510	-1.137	2.883
SD(MPK)	0.003	-24.002	-0.007	6.175
Liquidity	0.927	-2.527	-0.038	0.043
HH Utility	1.509	-0.114	-0.001	0.022
Run Def. top 0.1%	0.020	-99.983	-41.414	-20.395

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Policy Comparison

- Liquidity requirements have more pronounced side effects
- Higher cap.req. eliminates defaults, but less lending & deposits
- Size dependent cap.req. eliminates many run defaults at low cost

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Conclusion

- Show model ingredients needed to match cross-sectional heterogeneity in bank asset and liability portfolios

  $\Longrightarrow$ heterogeneous asset productivity & deposit product differentiation

- Different manifestation of rate risk in cross-section

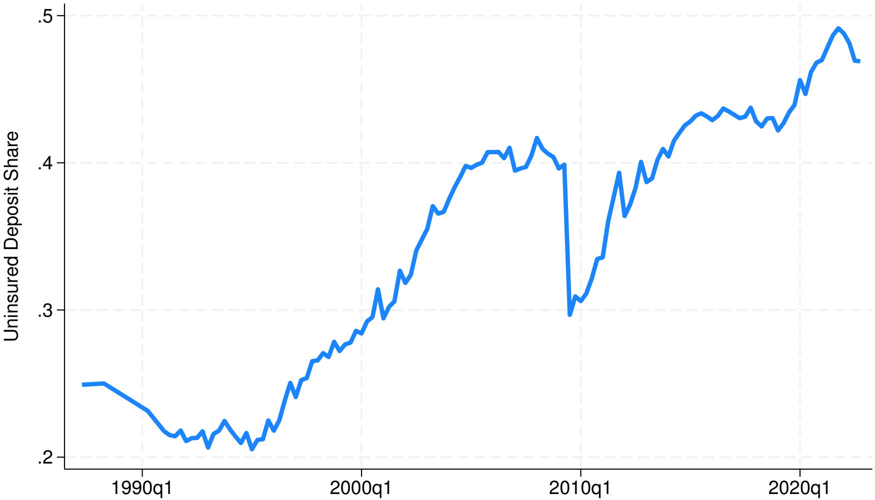
  $\Longrightarrow$ solvency risk for small banks, run risk for large

- Study financial stability consequences of micro-prudential regulation in cross-section of banks

  $\Longrightarrow$ size-dep cap reqs reduce runs with fewest side effects

Appendix

Aggregate Uninsured Deposit Share Has Doubled



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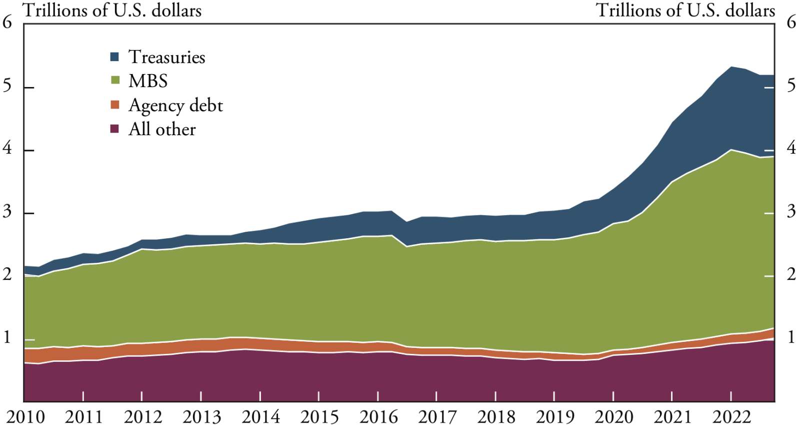
Aggregate Security Share Spiked During Pandemic & Recovery

Back

Aggregate Composition of Bank Securities

Chart 2

Most Securities Held by Banks Are Treasury or Agency MBS



Note: Chart shows total investment securities held by commercial banks measured at amortized cost.
Source: FFIEC Call Reports.

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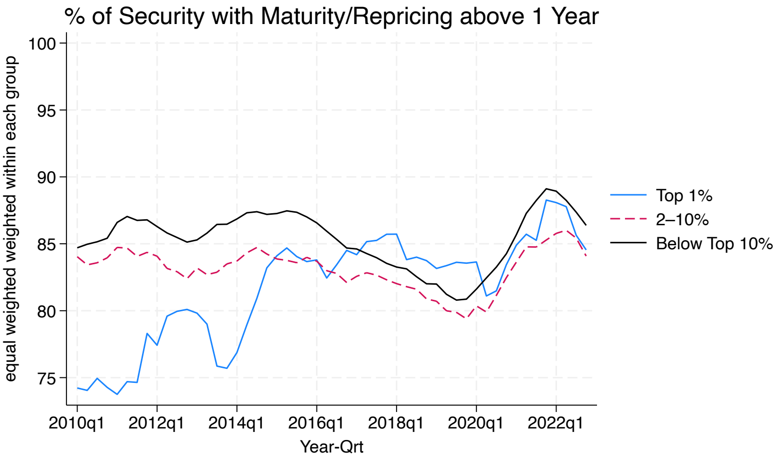
Share of Long-Duration Securities



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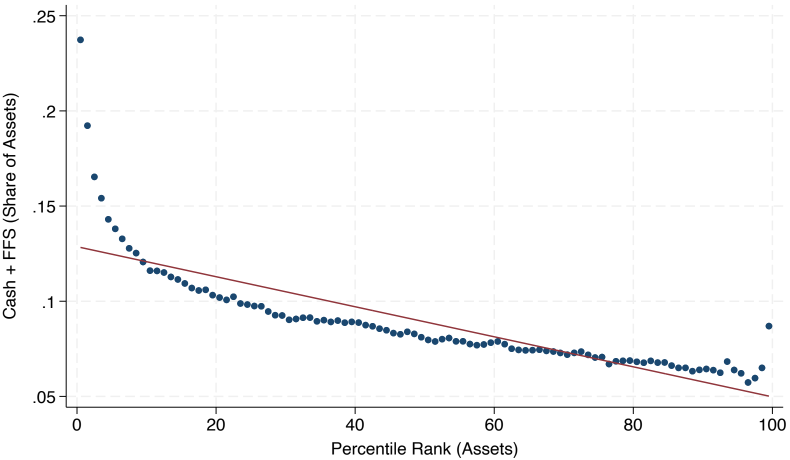
Cash and Federal Funds Sold over Bank Size



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LCR Eligible Assets

$$\text{LCR} = \frac{\text{HQLA}}{\text{30 day net outflow rate}} \geq 1$$

Table 1: Categories of High-Quality Liquid Assets under the Liquidity Coverage Ratio Standard

Category	Cap	Discount	Included Assets
Level 1	None	0%	◆ Unrestricted Federal Reserve balances ◆ U.S. Treasury securities ◆ Liquid and marketable securities issued by other U.S. government agencies whose obligations are explicitly guaranteed by the U.S. government ◆ Unrestricted reserves held at foreign central banks ◆ Low-risk securities issued or guaranteed by a foreign sovereign entity, the Bank for International Settlements, the International Monetary Fund, the European Central Bank, European Community, or a multilateral development bank and that meet certain criteria
Level 2A	40%	15%	◆ Certain securities issued by a U.S. government-sponsored enterprise such as Fannie Mae or Freddie Mac ◆ Higher-risk securities issued or guaranteed by a foreign sovereign entity or a multilateral development bank and that meet certain criteria
Level 2B	15%	50%	◆ Liquid and marketable corporate debt securities that meet certain criteria ◆ Liquid and marketable publicly traded common stocks that meet certain criteria

Source: Based on Davis Polk & Wardwell LLP, "U.S. Basel III Liquidity Coverage Ratio Final Rule: Visual Memorandum," September 23, 2014

Notes: The "cap" is the maximum percentage of a bank's high-quality liquid assets that can come from each category. The values of Level 2A and Level 2B assets are discounted to reflect assumptions about their lower liquidity and higher risk.

LCR Outflow Assumption

Table A.1: (Continued) The Liquidity Coverage Ratio (LCR): Asset- and Liability-Side Requirements

Abbreviations for secured funding collateral are for levels of High Quality Liquid Assets: L1 = Level 1, L2a = Level 2a and L2b = Level 2b. Abbreviations for funding counter-parties are: SB = small business; NFin = non-financial; Fin = financial.

Panel B: LCR Outflow Categories, Inflow and Outflow Rates			
LCR Outflow Category	Y-9C item	LCR Outflow Rate	LCR Inflow Rate
Secured Funding	ON Repo Sold	L1 & L2A collateral: 0-15%	L1 & L2A collateral: 0-15%
	Securities Lent	L2B & non-HQLA collateral: $25-100\%$[1]	L2B & non-HQLA collateral: $50-100\%$
Unsecured Funding	ON fed funds purchased	Retail & SB: $3-40\%$[2]	
	Deposits	Insured retail deposits: 3%	
	Trading Liabilities	Uninsured retail deposits: 10%	
	Commercial Paper	Wholesale: 5-100%	
	Other Borrowed Money		
	Subordinated Debt		
	Other Liabilities		
	Equity		
Commitments	Unused Commitments	Retail & SB non-mortgage: 5%	
	Standby Letters of Credit	NFin Wholesale: 10-30% Fin Wholesale: 40-100%	
Derivatives	Net Derivatives	100%	

1. Borrowings from exempted central banks have rate=0%.

2. Brokered deposits maturing less than or equal to 30 days have a 100% runoff rate.

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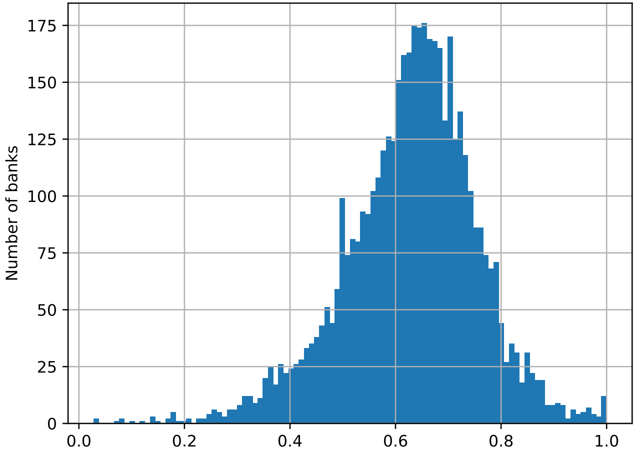
Fraction Uninsured In Large Accounts

- Which fraction of accounts >$250K is uninsured?
- Histogram of bank averages



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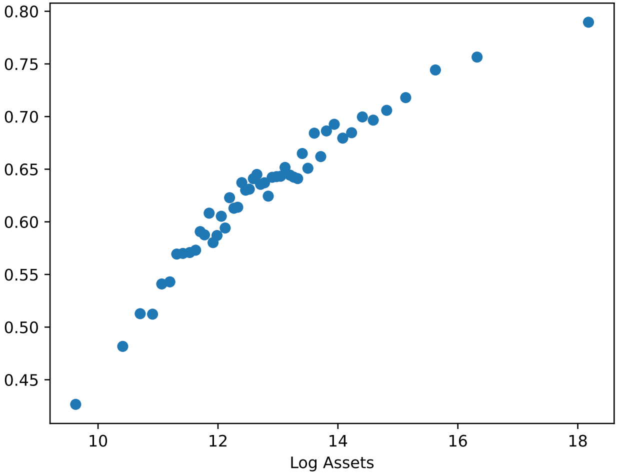
Fraction Uninsured In Large Accounts

- Fraction uninsured in large accounts by bank size
- Largest banks have largest uninsured accounts



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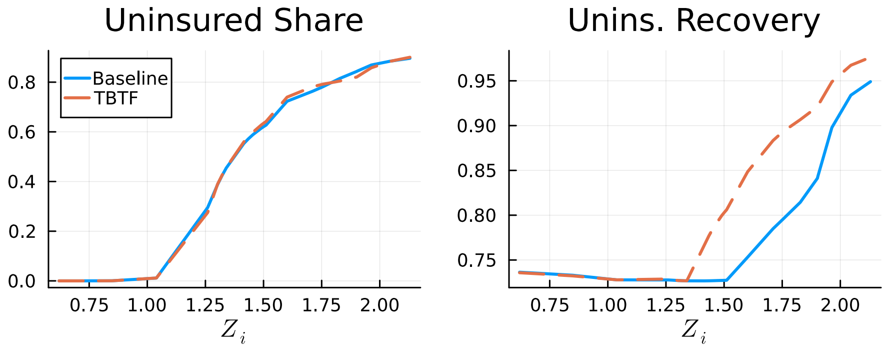
Uninsured Deposits Total Recovery



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Uninsured Deposits Bailouts

- From Pancost & Robatto (2023)
- Uninsured deposits historically very safe

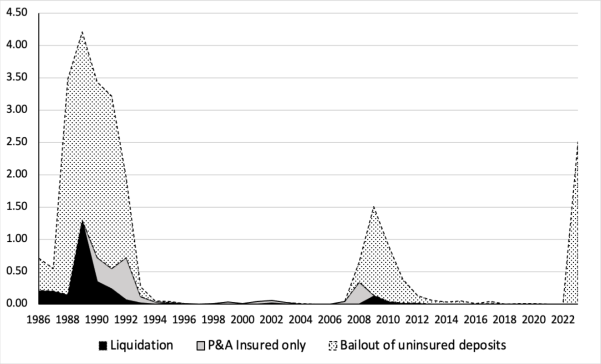

Figure 2. Default rate by resolution
The figure plots the bank default rate between 1986 and 2023 weighted by deposits, distinguishing between liquidation (black area), purchase and assumption of insured deposits only (gray area), and resolutions in which uninsured deposits were bailed out (dotted area).

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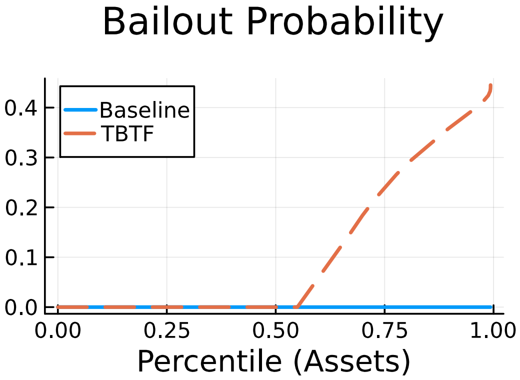
Too-big-to-fail guarantees partially insuring uninsured

- Probabilistic bailout guarantees of D^U increases bailout prob to max 45%



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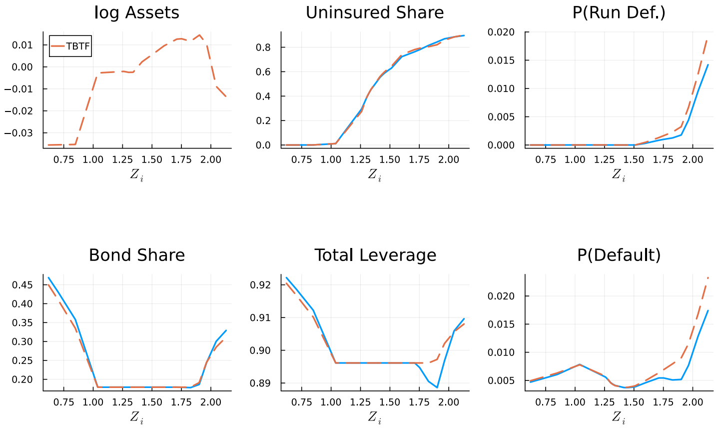
Too-big-to-fail guarantees partially insuring uninsured

- Probabilistic bailout guarantees of D^U increases bailout prob to max 45%
- Raises leverage for mid-large banks & reduces precautionary bonds
- Large banks' run risk increases and uninsured share unchanged



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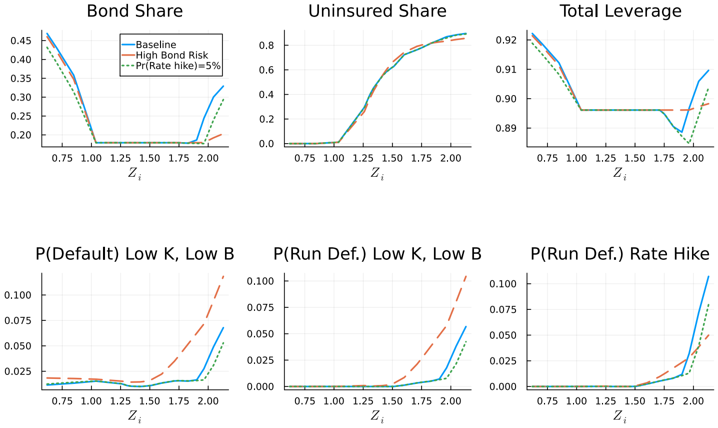
What if banks expect risky bonds?

- Bond returns more volatile at Std = 8.5% instead of Std = 3.5%
- Rational anticipation of high bond risk no safer portfolios
- High risk makes bonds unattractive to hold for large banks



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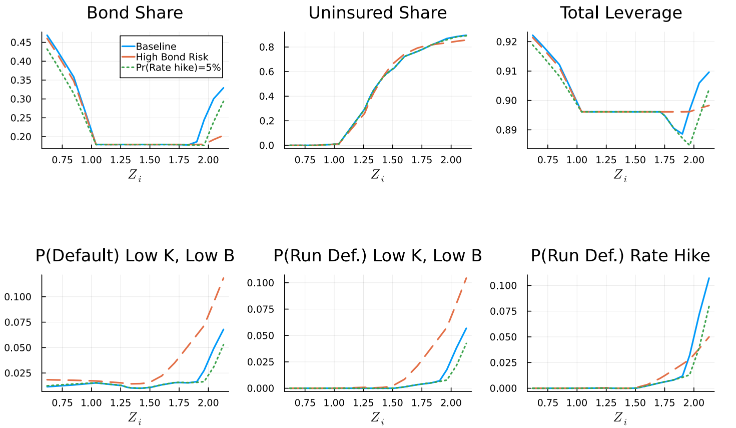
What if banks expect risky bonds?

- When banks expect high downside risk: $\Pr(\text{Rate hike}) = 5\%$
- Bonds become less attractive (mean return declines)
- Reduction in leverage & D_i^U at large banks lowers default risk



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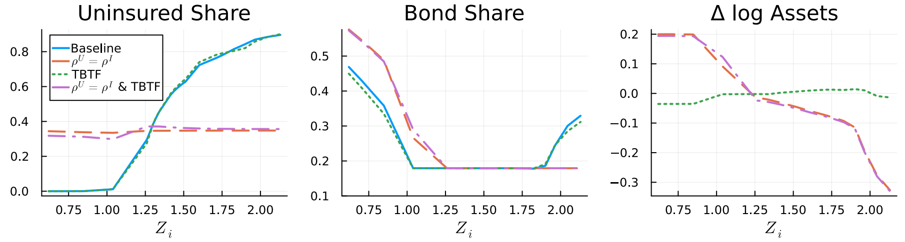
Deposit product differentiation and bank choices

- Profitability of insured > uninsured in benchmark
- Study economy with identical product diff. in both deposit types
- Differentiation enables the model to match uninsured share
- Guaranteeing uninsured deposit does not drive uninsured share



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