Banks Maturity Choices and the Transmission of Interest-Rate Risk

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- Interest-rate risk build-up partly reflects a shift towards long-maturity assets
- **Research questions:**
  - **What are the determinant of banks' maturity choices?**
  - **How banks portfolio choices across maturities affect transmission of interest-rate shocks?**

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  - Combine regulatory bank data with monetary policy shocks

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2. Are responses heterogeneous across banks?
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3. Is there an association between maturity and leverage?
   - **Higher deposit-to-asset** ratios associated to **shorter-maturity** portfolios

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- **Model:** HB framework with **endogenous leverage and maturity choice**
  - Banks invest in short- and long-maturity assets subject to financial frictions
  - **Risk premium** key driver of banks' portfolio choices
  - $\uparrow$ Interest rates $\Rightarrow \downarrow$ networth $\Rightarrow \uparrow$ risk premia $\Rightarrow \uparrow$ short-term assets

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  - $\uparrow$ Interest rates $\Rightarrow \downarrow$ networth $\Rightarrow \uparrow$ risk premia $\Rightarrow \uparrow$ short-term assets
- Exploit cross-sectional patterns as validation for the quantitative model
- Application to the 2022-2023 monetary tightening
  - $\uparrow$ maturity prior to 2022 **amplified** effects of **initial tightening**
  - Effects of **subsequent** hikes **mitigated** as banks $\downarrow$ maturity

Data

- **Consolidated Reports of Condition and Income (Call Reports)**
  - Quarterly balance-sheet data for US commercial banks and BHCs
  - Information on maturity of assets and liabilities starting in 1997
  - Maturity gap = average maturity of assets - average maturity of liabilities
    - Maturity gap is a good measure of bank's interest-rate-risk exposure English et al. 18

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- **FR-Y-9C (BHC quarterly filings) merged to CRSP**

- **Monetary policy shocks from Bu, Rogers, and Wu (2021) and Nakamura and Steinsson (2018)**

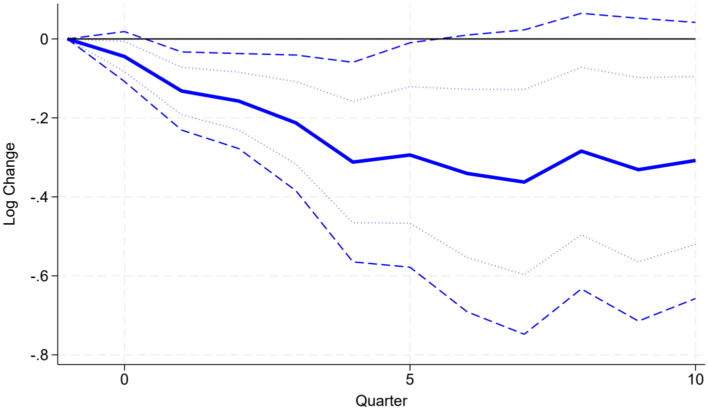
Maturity Gap and Interest Rates - Average Response

- How do banks adjust maturity in response to interest-rate shocks?
- **Empirical Specification** (restrict to 1997-2007)

$$\Delta log \text{ Maturity Gap}_{i,t+h} = \beta_0^h \Delta R_t + \mathbf{\Gamma}_1^h \mathbf{X}_{i,t-1} + \sum_{\tau=1}^{4} \mathbf{\Gamma}_{2,\tau}^h \mathbf{Y}_{t-\tau} + \alpha_i^h + \epsilon_{i,t}$$

  - ΔR_t: change in 1-year treasury rate instrumented with monetary shocks
  - $\mathbf{X}_{i,t-1}$: vector of bank-level controls (deposit-to-asset ratio, log assets, wholesale funding ratio, ROA, nonperforming loans rate)
  - $\mathbf{Y}_{t-\tau}$: vector of aggregate controls (GDP growth, inflation, u-rate, VIX)

Maturity Gap and Interest Rates - Average Response



- **Negative coefficient**: $\uparrow$ interest rate $\Rightarrow$ $\downarrow$ maturity gap

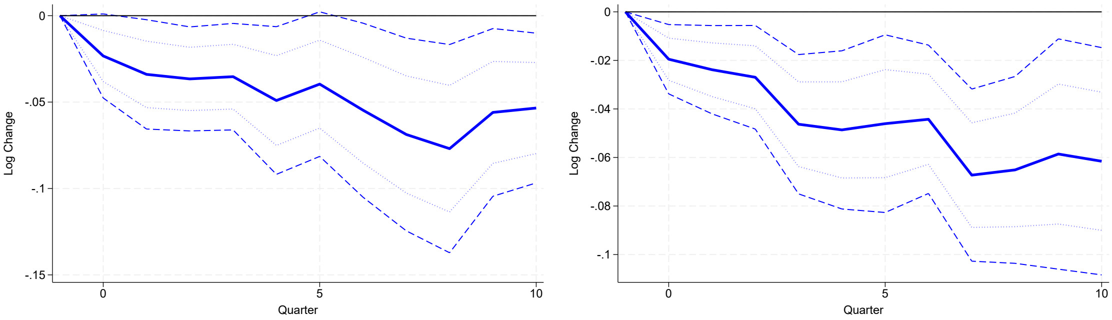
Maturity Gap and Interest Rates - Heterogenous Responses

- Are responses heterogeneous across banks?
- **Empirical Specification** (restrict to 1997-2007)

$$\Delta log \text{ Maturity Gap}_{i,t+h} = \beta^h \left(l_{i,t-1} - E_i \left[l_{i,t}\right]\right) \Delta R_t + \mathbf{\Gamma}_1^h \mathbf{X}_{i,t-1} + \alpha_i^h + \alpha_t^h + \epsilon_{i,t}$$

  - ΔR_t: change in 1-year treasury rate instrumented with monetary shocks
  - $l_{i,t-1} - E_i \left[l_{i,t}\right]$: bank i's demeaned deposit-to-asset ratio
  - $\mathbf{X}_{i,t-1}$: vector of bank-level controls (deposit-to-asset ratio, log assets, wholesale funding ratio, ROA, nonperforming loans rate)

Maturity Gap and Interest Rates - Heterogenous Responses



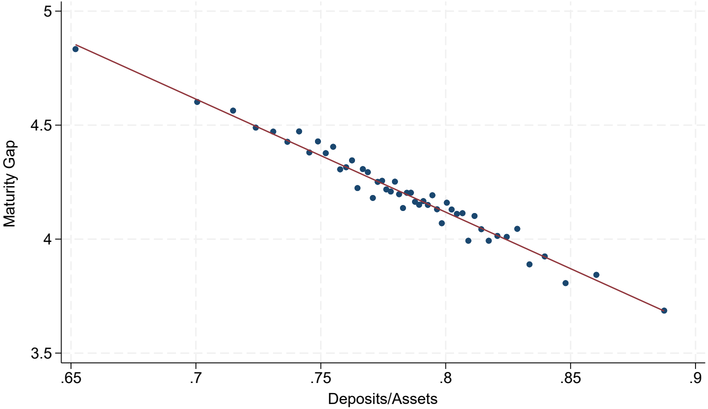
(a) BRW shocks

(b) Nakamura-Steinsson Shocks

- Banks with higher deposit-to-asset ratios reduce their maturity gap relatively more

Maturity Gap and Bank Leverage

- What is the relationship between maturity and leverage decisions?



- Banks with **higher deposit-to-asset** ratios have **lower maturity gaps**

Model Overview

- Build a quantitative model consistent with key empirical findings
  1. $\uparrow$ interest rate $\Rightarrow \downarrow$ maturity
  2. steeper $\downarrow$ maturity for banks with high deposit-to-asset ratios
  3. negative association between deposit leverage and maturity

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  - Heterogeneous banks maximize discounted sum of dividends
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- Key agents:
  - Heterogeneous banks maximize discounted sum of dividends
    - Invest in short- and long-maturity assets subject to financial frictions
  - Risk-neutral household with discount rate $\beta_t = \beta e^{Z_t}$, where Z_t follows a Markov process
    - The risk-free rate is $R_t^f = \frac{1}{\beta_t}$, so interpret Z_t as interest-rate shock

Bank Investment Technology

- Banks have access to **assets of different maturities**
    1. ST, risk-free bonds, a^s, fully mature after one period
    2. LT, risky securities, a^l, that mature at rate $\delta \in (0, 1)$

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- LT assets are equity-type claims to physical capital issued by non-financial firms Gertler Kiyotaki 15 He Krishnamurthy 13
  - Price of LT assets $=$ price of capital $\equiv Q(\mathbf{S})$
  - Return on LT assets subject to idiosyncratic and aggregate risk

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- LT assets are equity-type claims to physical capital issued by non-financial firms Gertler Kiyotaki 15 He Krishnamurthy 13
  - Price of LT assets = price of capital $\equiv Q(\mathbf{S})$
  - Return on LT assets subject to idiosyncratic and aggregate risk
- Key friction: **no-equity issuance constraint**, $div_i \geq 0$
- Finance investment using **defaultable debt** and own net worth Begenau Landvoigt 22

Bank Payoff

- Payoff from investing in portfolio (a_i^s, a_i^l)

$$\Pi(a_i^s, a_i^l) = \underbrace{a_i^s}_{\text{short-term asset}} + \underbrace{\omega_i \left[R^K(\mathbf{S}) + (1-\delta)Q(\mathbf{S})\right] a_i^l}_{\text{long-term asset}}$$

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- ω_i: i.i.d return shock $\Rightarrow$ generate heterogeneity across banks
- **Interest-rate risk arises through the asset price** $Q(\mathbf{S})$
  - $\uparrow$ interest rate $\Rightarrow \downarrow$ supply of funds $\Rightarrow \downarrow Q(\mathbf{S})$
- Exposure to interest-rate risk depends both on **leverage** and **maturity**

Timing

$$n_i = \Pi(a_i^s, a_i^l) - b_i$$

$$\omega_i a_i^l$$

Shocks — **Continue/default/exit** — **Portfolio/finance**

t

ω_i

$R^f(Z)$

w.p. $1-\sigma$ $\rightarrow V^c$

$\rightarrow V^d = 0$

w.p. σ $\rightarrow V^{\text{exit},r}$

$\rightarrow V^{\text{exit},d} = 0$

$\underbrace{\iota_i}_{\text{rep. indicator}} \longrightarrow t+1$

$a_i^{s\prime}$

$a_i^{l\prime}$

$b_i^{\prime}$

Optimal Portfolio Choice

$$\underbrace{E_{\omega',\mathbf{S}'|\mathbf{S}} R_i^l(\mathbf{S}',\mathbf{S}) - R_i^s(\mathbf{S})}_{\text{exp. excess return}} = \underbrace{-\frac{Cov(m_i(\mathbf{S}'), R_i^l(\mathbf{S}',\mathbf{S}))}{E_{\omega',\mathbf{S}'|\mathbf{S}} m_i(\mathbf{S}')}}_{\text{risk premium}}$$

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- A **unexpected rise** in the risk-free interest rate
  - $\Rightarrow$ expected capital gains, i.e. low $Q(\mathbf{S})$ and high $E_{\mathbf{S}'|\mathbf{S}} Q(\mathbf{S}')$
  - $\uparrow$ expected excess returns $\Rightarrow$ LT assets **more** attractive

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  - $\uparrow$ expected excess returns $\Rightarrow$ LT assets **more** attractive
  - $\Rightarrow$ experience capital losses, i.e. low $Q(\mathbf{S})$ depletes banks' net-worth
  - $\uparrow$ risk premium $\Rightarrow$ LT assets **less** attractive

Optimal Portfolio Choice

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- **Risk premium** more relevant for **financially constrained** (high leverage) banks
- As a result, banks with high deposit leverage
  - choose portfolios with shorter maturity, and
  - following a rise in R^f rebalance more strongly toward short-term assets.

Calibration

- Model calibrated at annual frequency between 1997 and 2021.
- Fixed parameters
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- Interest rate process estimated from the data
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  - Fit an AR(1) to 10-year real interest rate in the data

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  - Fit an AR(1) to 10-year real interest rate in the data
- Calibrate remaining parameters to match bank balance-sheet moments
  - Match **average** maturity gap and **cross-sectional dispersion of maturity gap**

Maturity Gap and Interest Rates: Model vs Data

$$\Delta \log \text{ Maturity Gap}_{i,t+1} = \beta l_{i,t} \Delta R_t^f + \gamma l_{i,t} + \alpha_t + \alpha_0 + \epsilon_{i,t}$$

Maturity Gap and Interest Rates: Model vs Data

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	(1)		(2)		(3)	
	Data	Model	Data	Model	Data	Model
dep/asset	0.06^{***}	0.11	0.05^{***}	0.11	0.05^{***}	0.11
	(0.03,0.08)		(0.02,0.07)		(0.03,0.09)	
dep/asset × mp shock	-0.02^{**}	-0.01	-0.03^{***}	-0.01	-0.04	-0.01
	(-0.05,-0.00)		(-0.05,-0.01)		(-0.10,0.02)	
logassets × mp shock			-0.01	-0.0		
			(-0.06,0.11)			
mp shock					-0.13^{*}	-0.02
					(-0.27,0.00)	
Bank controls	yes	yes	yes	yes	yes	yes
Bank FE	yes	no	yes	no	yes	no
Time FE	yes	yes	yes	yes	no	no
Aggregate controls	no	no	no	no	yes	yes

Maturity Gap and Bank Leverage: Model vs Data

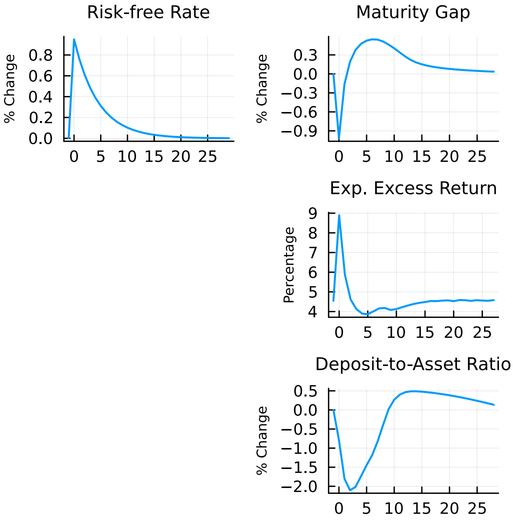
$$\text{Maturity Gap}_{i,t} = \beta l_{i,t} + \gamma \log(a^s_{i,t} + a^l_{i,t}) + \alpha_t + \alpha_0 + \epsilon_{i,t}$$

Maturity Gap and Bank Leverage: Model vs Data

$$\text{Maturity Gap}_{i,t} = \beta l_{i,t} + \gamma \log(a^s_{i,t} + a^l_{i,t}) + \alpha_t + \alpha_0 + \epsilon_{i,t}$$

	Maturity Gap$_{i,t}$	
	Data	Model
dep/asset	-0.0521***	-0.1072
	(-7.06)	
logasset	-0.0912	0.0280
	(-0.72)	
Bank controls	yes	no
Bank FE	yes	no
Time FE	yes	yes

Impulse Response Functions



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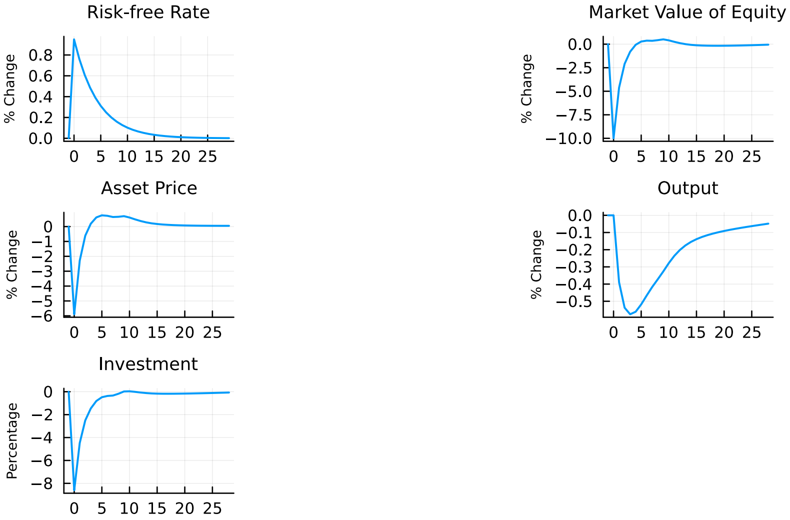

Counterfactual Experiments

- **How does banks' portfolio reallocation across maturities affect macro dynamics?**
- Solve two alternative models
  1. no access to short-term assets, and
  2. fixed long-term-asset share $\frac{a^l}{a^s+a^l}$
- Recover sequence of shocks, $[\epsilon_{1997}, ..., \epsilon_{2023}]$, such that model-implied 10-year real interest rate match empirical data
- Feed these shocks into each model variant and compare macro dynamics around the 2022-2023 tightening episode.

2022-2023 Tightening Episode: Counterfactuals

	Baseline	No Short-term Bonds (relative to baseline)	Fixed Portfolo Share (relative to baseline)
Unconditional Moments			
Avg. Deposit-to-Asset Ratio	0.65	1.011	1.021
Vol. Asset Price	0.03	0.938	0.935
Vol. Market Value of Equity	0.09	1.0	1.007
$\Delta_{2018,2021}$			
Maturity Gap	1.91%		
$\Delta_{2020,2022}$			
Asset Price	-2.77%	1.901	0.895
Market Value of Equity	-5.78%	1.705	0.964
$\Delta_{2020,2023}$			
Asset Price	-4.87%	1.851	1.536
Market Value of Equity	-10.15%	1.75	1.474

Conclusions

- I document that banks respond to interest rate hikes by shortening asset maturity.
  - Response is heterogeneous: more pronounced for banks with high deposit-to-asset ratios.
- I develop a macro-finance model with endogenous leverage and portfolio choices
  - Matches empirical dynamics and cross-sectional patterns.
  - Highlights role of risk premia in shaping banks' maturity choices under interest-rate risk.
- Banks' maturity choices important to understand transmission of interest-rate risk
- In the paper, also discuss implications of liquidity and leverage policies

Policy Counterfactuals

- **Can policy stabilize the banking sector in the face of interest-rate risk?**
- Liquidity requirement
  - Banks must hold at least a share $\hat{\theta}$ of total assets in the form of short-term bonds

$$\frac{a^{l'}}{a^{s'} + a^{l'}} \leq 1 - \hat{\theta}$$

- Capital requirement

$$\frac{b'}{a^{s\prime} + a^{l\prime}} \leq \bar{l}$$

Heterogeneous Effects of Liquidity Requirement