Reaching for Duration

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5th CEMLA/Dallas Fed Workshop
November 12, 2026

*The views expressed herein are solely those of the authors and do not necessarily reflect the views of the FRB San Francisco, the Board of Governors, or the Federal Reserve System.

Motivation

- Bank maturity mismatch creates inherent financial instability
  $r \uparrow \rightarrow$ value of long-term assets $\downarrow \rightarrow$ withdrawal of deposits ("SVB")

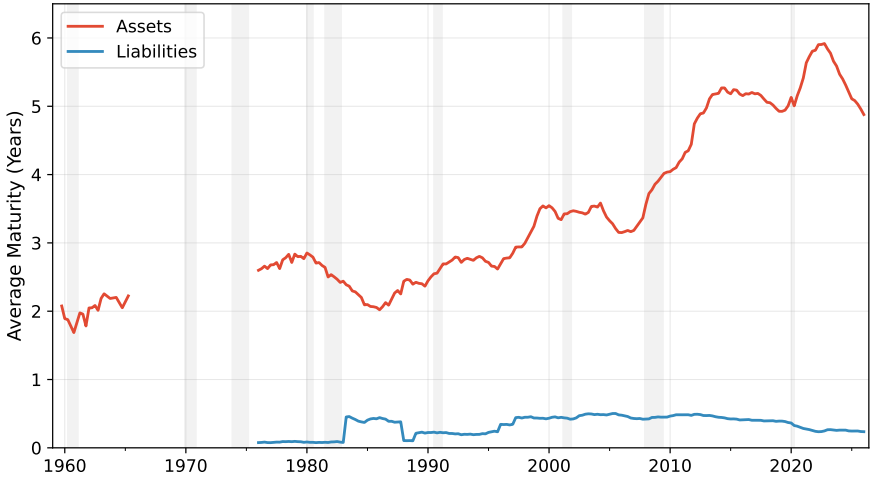
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- **New empirical evidence on maturity structure for U.S. banks:**
  - Collect data from historical Call Report vintages starting in 1959
  - Information on remaining maturity or next repricing date
  - Construct series of average dollar-weighted maturity of assets & liabilities
  - Compute *maturity gap* = maturity assets — maturity liabilities

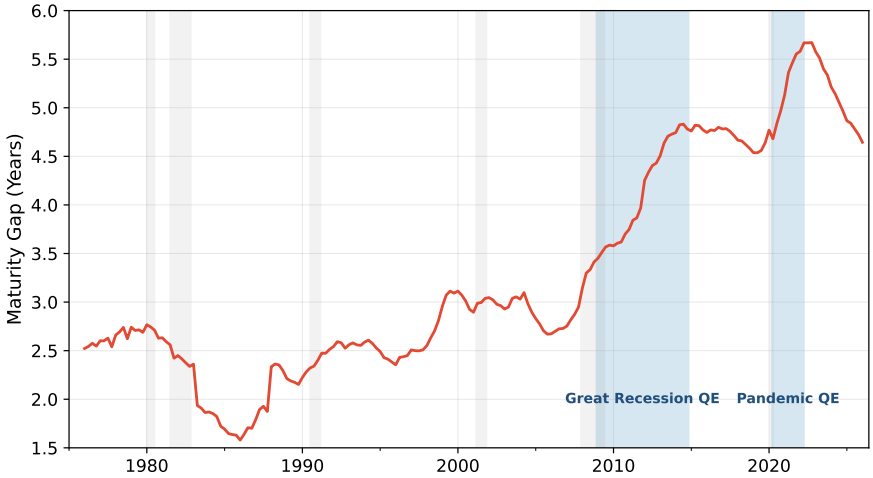
Average Maturity of Assets & Liabilities

Loans & Securities



The Maturity Gap

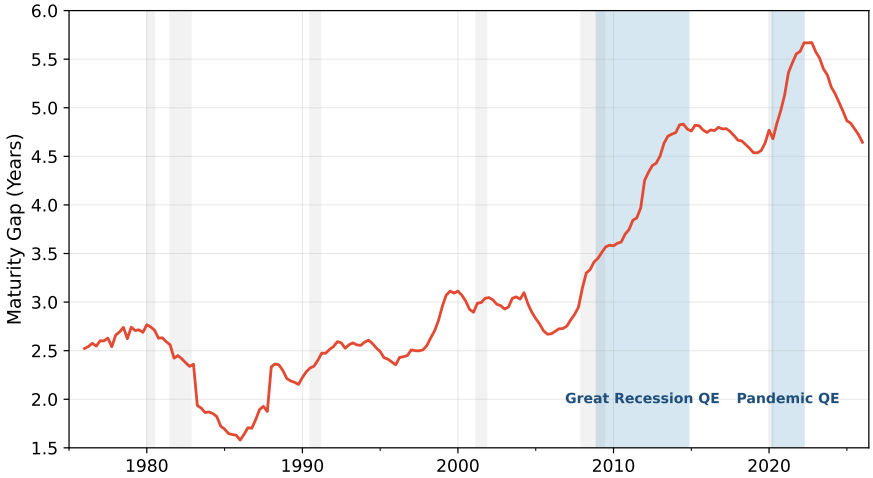
▸ Duration & Prepayment ▸ Bank Size



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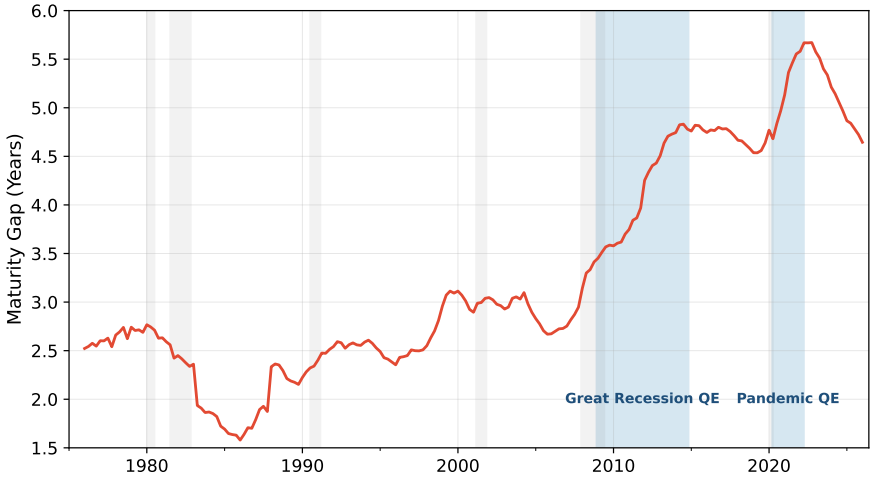
→ Maturity gap more than tripled, from trough 1.6 (in 1986) to peak 5.7 (in 2022)



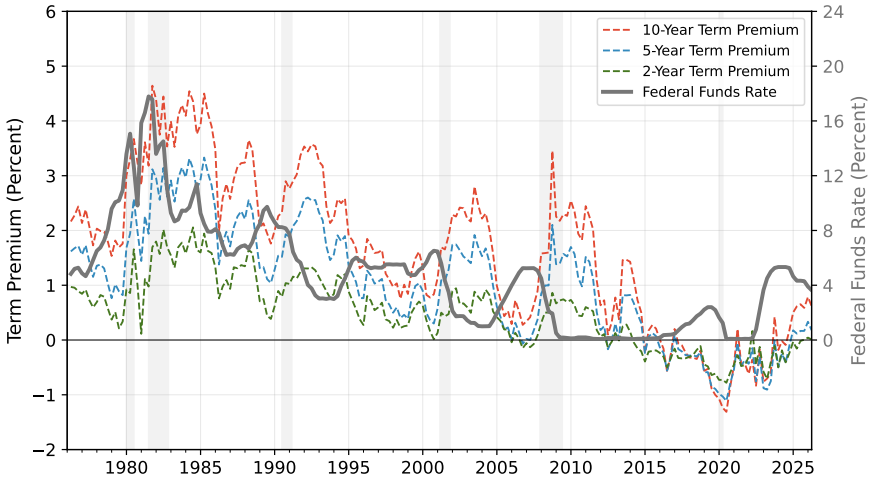
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→ Maturity gap sharply increases during QE periods, against first-order view



Term Premia & Federal Funds Rate



Note: Term premia estimates based on Adrian, Crump, and Moench (2013).

Research Questions

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2. Why do banks increase duration of assets when interest rates & term premia decline? → *low compensation for duration risk*

3. Do banks optimally engage in such behavior, knowing that it increases their exposure to a rise in rates? → *deposit outflows & bank runs*

This Paper

Related Literature

- **Develop a model of bank portfolio choice:**
  - Investments: short-term bond paying r_s & long-term bond paying $r_s + \tau$
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- **Reaching-for-duration effect:**
  - When r_s or τ low: NIM squeezed, banks increase maturity to satisfy κ
  - Earnings calls & 10Ks: support profitability concerns & reaching for duration
  - QE paradox: $\tau \downarrow \;\; \longrightarrow$ concentrates duration risk in banking sector

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- **Financial stability implications:**
  - $r_s \uparrow$: run equilibrium can arise, larger mismatch implies greater exposure
  - QE: $\tau \downarrow \;\rightarrow$ reach-for-duration $\rightarrow$ greater run risk to rate reversal

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- **Bank-level evidence**, **dynamic continuous-time model**, **extensions** (loans, endog. τ)

Baseline Model

- Three dates ($t = 0, 1, 2$), two periods, continuum of identical banks
- **Bank balance sheet**: $\underbrace{\alpha}_{\text{long bond}} + \underbrace{(1-\alpha)}_{\text{short bond}} = \underbrace{(1-e)}_{\text{deposits}} + \underbrace{e}_{\text{equity}}$

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- **Interest rate shock** at $t = 1$: $r_{s,1} = r_{s,0} + \varepsilon$ with $\mathbb{E}[\varepsilon] = 0$ and variance σ^2
- **Operating costs**: $c > 0$ per period, data: ~2.5% of assets
  → practice: branches, personnel, technology, etc.

Baseline Model

▸ Historical Bank Income ▸ NIM & Term Premium

- **Deposit market power**: $r_{d,t} = \beta r_{s,t} \rightarrow \beta \in [0, 1]$ is deposit beta
  $\Rightarrow e + (1-e)(1-\beta) \equiv \lambda$: non-repricing funding

- **Net income at** $t = 1$: $NI_1 = \underbrace{(1-\alpha) r_{s,0} + \alpha r_\ell}_{\text{asset income}} - \underbrace{(1-e)\beta\, r_{s,0}}_{\text{deposit cost}} - \underbrace{c}_{\text{oper. costs}} = \lambda r_{s,0} + \alpha\tau - c$

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- **Profitability constraint**: $NI_1 = \lambda r_{s,0} + \alpha\tau - c \geq \kappa$ $\approx$ ROE-floor
  $\rightarrow$ low earnings costly: capital, ratings, funding, etc.
  $\rightarrow$ banks stabilize dividends, ROA & target ROE

Evidence from Earnings Calls and 10Ks

- **Banks frequently state their earnings targets & lower bounds:** 55% of U.S. banks

  "what we have talked about and – from the beginning of the announcement of this plan, is said that our minimum targets were in – excuse me – an ROE of about 13% as a minimum, with a target range of 15 to 18%"

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- **Banks explain why earnings matter**: (i) "build capital", (ii) "dividends and buybacks", (iii) "share price & valuation", (iv) "compensation", ...

  "A lot of banks out there with a weak ROE will simply not be able to build capital and they cannot service their customers. So an earnings capacity is the license to have the right rating, the right funding cost and the right competition"

  — Christian Clausen, Group CEO, Nordea, Q3 2011 earnings presentation

- **10K Evidence**: Pay & covenants frequently tied to returns or earnings

Optimal Portfolio

▸ ROE(r)

- **Risk-averse shareholders**: $\max_{\alpha} U(\alpha) = \frac{1}{2}\mathbb{E}[\Pi_2] - \frac{\rho}{2}\mathrm{Var}[\Pi_2]$
- **Rewrite**: $\max_{\alpha} U(\alpha) = \lambda r_{s,o} + \alpha\tau - c - \frac{\gamma}{2}(\lambda - \alpha)^2, \quad \gamma \equiv \rho\sigma^2$

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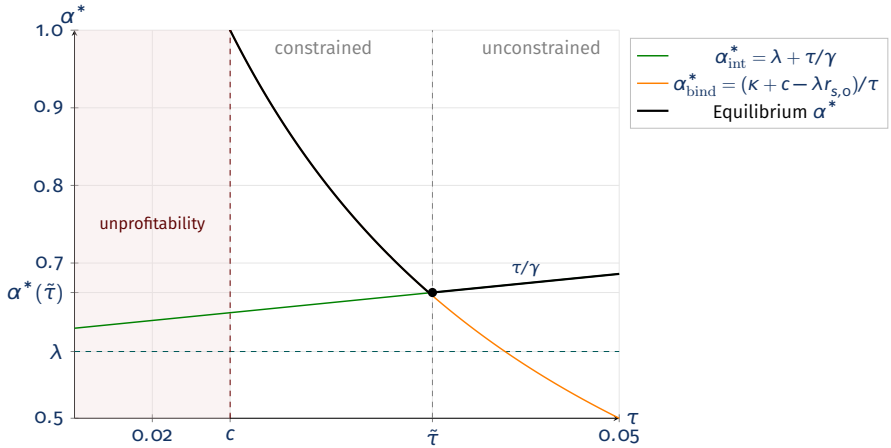
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- **Optimal portfolio:** $\alpha^* = \max\{\alpha^*_{\text{int}}, \alpha^*_{\text{bind}}\}$

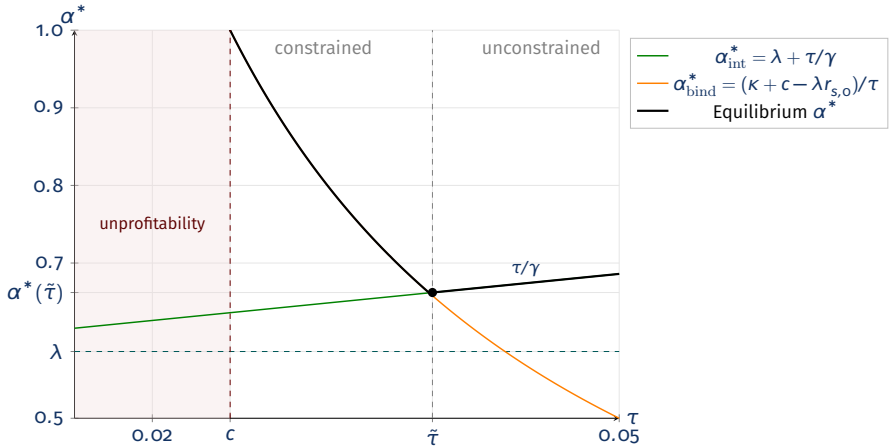
Graphical Illustration in (τ, α)-space



Parameters: $\beta = 0.44$, $\kappa = 0$, $e = 0.06$, $c = 0.025$, $\gamma = 0.5$, $r_{s,0} = 0 \Rightarrow \lambda = 0.586$, $\tilde{\tau} \approx 0.038$.

Graphical Illustration in (τ, α)-space

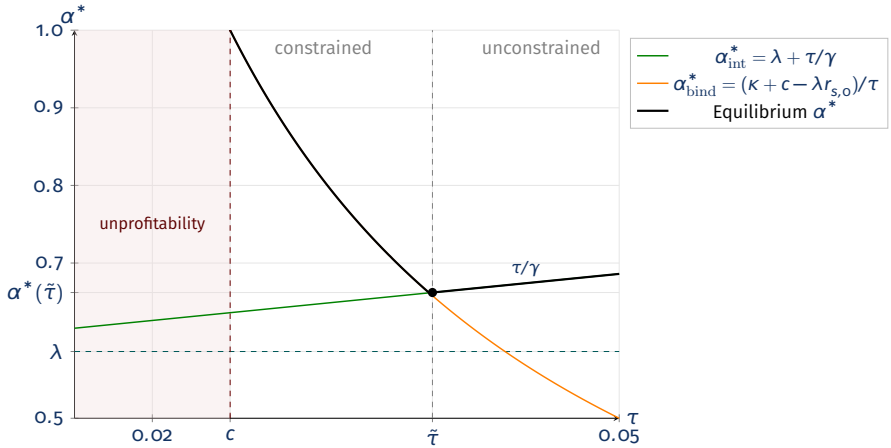
→ $\tau \downarrow$: QE increases asset duration in constrained region; effect convex



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→ Constrained region increases at low $r_{s,0}$, when QE is employed



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Evidence from Earnings Calls

- **Banks frequently state they increase duration when facing earnings pressure**

  "For the first 9 months of the year our return on equity was around 5%. This means that we'll almost have to double it to reach our 2015 target. … We will extend the duration of the Group's bond portfolio in order to increase earnings."

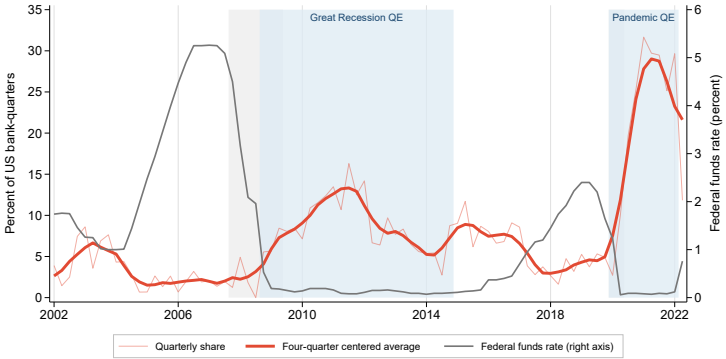
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Evidence from Earnings Calls

→ **Estimate:** $\text{Reaching Statement}_{i,t} = \phi_i + \beta Z_{i,t} + \gamma X_{i,t} + u_{i,t}$

Federal funds rate	-2.54*** (0.44)	-2.84*** (0.51)		
Term premium		-1.92** (0.83)		
NIM, previous quarter			-5.74*** (1.56)	
ROE below target				1.42* (0.77)
Bank FE	✓	✓	✓	✓
Year FE			✓	✓
R^2	0.09	0.10	0.16	0.18
Observations	11,651	11,651	5,836	2,133
Banks	356	356	284	183

Control: log(Executive Words). Standard errors two-way clustered by bank & quarter. 2002:Q1–2022:Q2. Term premium based on Adrian, Crump, and Moench (2013) for 10-year maturity.

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→ Reaching statement more likely with low FFR, TP, NIM, or ROE

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- Model prediction: $\beta < 0$. Reverse causality: $\beta > 0$.

Maturity Gap & Bank Profitability

→ Less profitable banks extend maturity gap, 5-6 months per 1% ROA

NI/Assets	-0.54*** (0.06)	-0.45*** (0.05)	-0.42*** (0.05)	-0.43*** (0.05)	-0.40*** (0.05)
Time FE		✓	✓	✓	✓
Bank FE			✓		✓
Controls				✓	✓
Partial R^2	0.01	0.04	0.08	0.04	0.08
Observations	530,026	530,026	529,735	516,792	516,540
Number of Banks	11,201	11,201	10,910	10,989	10,737

Controls: log(assets), scaled liabilities, deposits, securities, lagged profitability & maturity gap. NI/Assets in percent. Rescaled maturity gap. Two-way clustered standard errors by bank & time. Sample: 1997:Q2–2026:Q1.

Maturity Gap & Bank Profitability

→ Reaction due to asset response, raises NIM, and stronger with low term premium

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Deposit Franchise Runs

- **Additional assumptions**:
  - Fraction $u \in (0, 1)$ of depositors is uninsured
  - Interest rate shock uniformly distributed $\varepsilon \sim U[-\bar{\varepsilon}, \bar{\varepsilon}]$

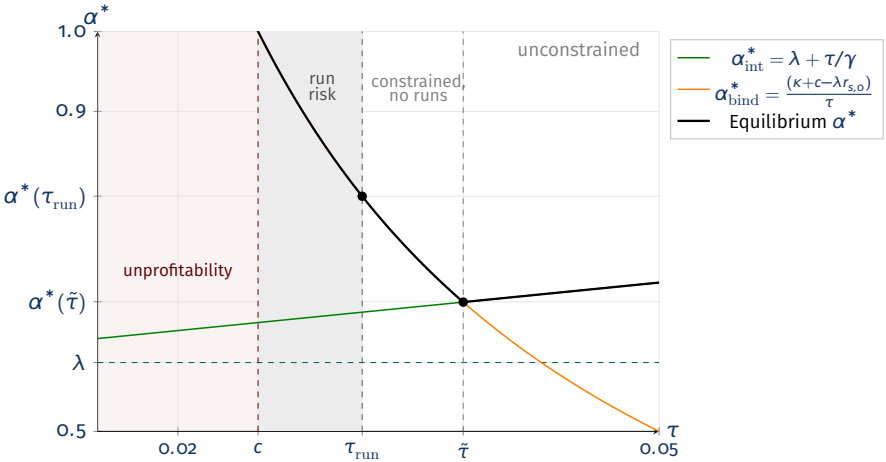
Deposit Franchise Runs

- **Additional assumptions**:
  - Fraction $u \in (0, 1)$ of depositors is uninsured
  - Interest rate shock uniformly distributed $\varepsilon \sim U[-\bar{\varepsilon}, \bar{\varepsilon}]$
- **Deposit franchise runs as in Drechsler et al. (2026) and Jiang et al. (2024)**:
  - At $t = 1$, uninsured depositors can run $\rightarrow$ bank loses franchise value

$$\Delta_V(\varepsilon) = \frac{u(1-e)(1-\beta)(r_{s,0} + \varepsilon)}{1 + r_{s,0} + \varepsilon}$$

  - Run is self-fulfilling if the franchise loss renders bank insolvent:
    bank market value at $t = 1$: $V_1 = (e + \Pi_2)/(1 + r_{s,0} + \varepsilon) < \Delta_V(\varepsilon)$
  - Runs are possible for thresholds $\varepsilon > \varepsilon^*$ and $\alpha > \alpha^*$

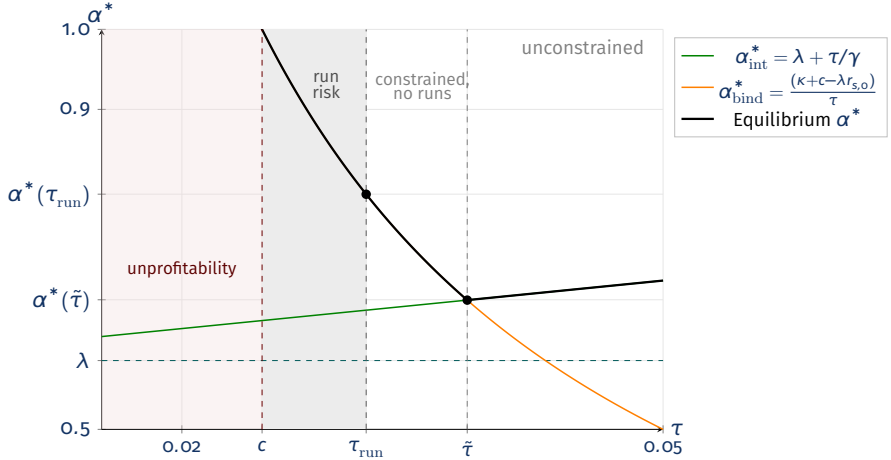
Equilibrium with Bank Runs



New parameters: $u = 0.42$, $\bar{\varepsilon} = 0.14$ ($\tau_{run} = 0.032 < \tilde{\tau}$ and $e + \Pi_2 > 0$ absent a run).

Equilibrium with Bank Runs

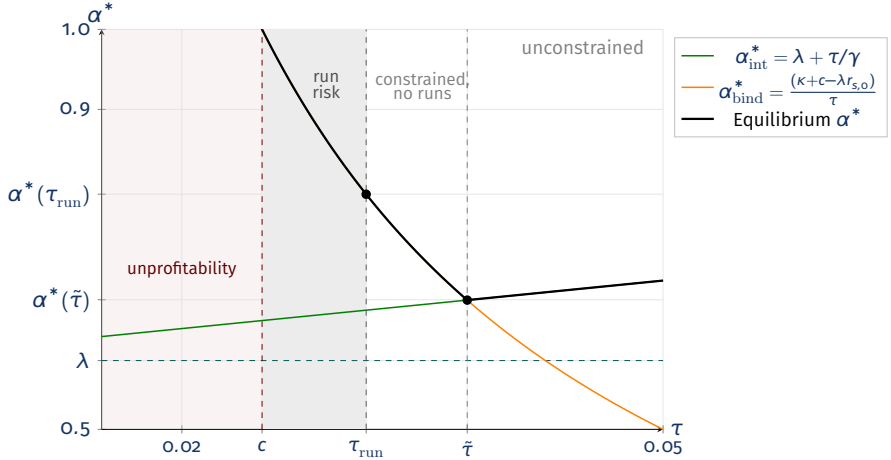
→ Banks expose themselves to runs in constrained region below τ_{run}



New parameters: $u = 0.42$, $\bar{\varepsilon} = 0.14$ ($\tau_{\text{run}} = 0.032 < \tilde{\tau}$ and $e + \Pi_2 > 0$ absent a run).

Equilibrium with Bank Runs

→ $\tau \downarrow$: QE leads banks to reach for duration → greater run risk to rate reversal



New parameters: $u = 0.42$, $\bar{\varepsilon} = 0.14$ ($\tau_{run} = 0.032 < \tilde{\tau}$ and $e + \Pi_2 > 0$ absent a run).

Dynamic Continuous-Time Model

Details

- **Setup**: continuous time $t \in [0, T]$, balance sheet in levels: $L_t + B_t = N_t + D_t$
- **Asset returns**: $\mathrm{d}r_{s,t} = \kappa_r(\bar{r} - r_{s,t})\,\mathrm{d}t + \sigma_r\,\mathrm{d}W_{r,t}$, $\mathrm{d}r_{\ell,t} = (r_{s,t} + \tau)\,\mathrm{d}t - \sigma_\ell\,\mathrm{d}W_{r,t}$

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- **Net worth evolution**: $\mathrm{d}N_t/N_t = \big[r_{s,t} + \alpha_t\tau + \big((1-\beta)r_{s,t} - c\big)\delta\big]\mathrm{d}t - \alpha_t\sigma_\ell\,\mathrm{d}W_{r,t}$ (NWE)
  with $\alpha_t \equiv L_t/N_t$, deposits: $D_t = \delta N_t$, cost $\beta r_{s,t} + c$
- **Objective**: $\max_{\{\alpha_s\}_{s\in[t,T]}} \mathbb{E}_t\big[e^{-\omega(T-t)}N_T^{1-\rho}/(1-\rho)\big]$
  s.t. (1) $\mathbb{E}_t\big[\mathrm{d}N_t/N_t\big] \geq \kappa\,\mathrm{d}t \approx$ ROE-floor; (2) (NWE)

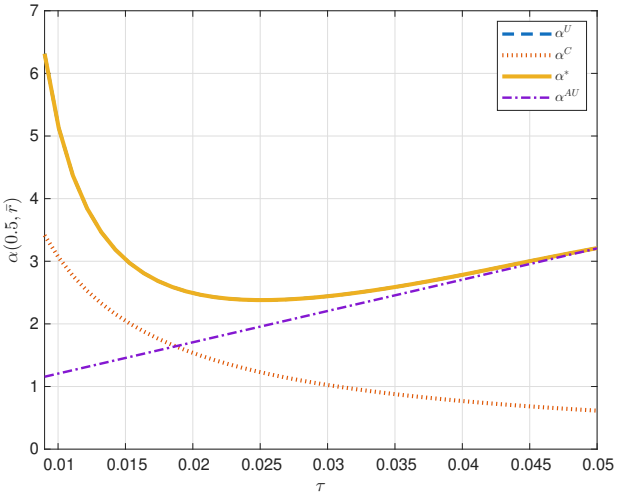
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  s.t. (1) $\mathbb{E}_t\big[\mathrm{d}N_t/N_t\big] \geq \kappa\,\mathrm{d}t \approx$ ROE-floor; (2) (NWE)
- **Solution**: $\alpha^* = \max\{\alpha^U, \alpha^C\}$: $\alpha^U = \underbrace{\frac{\tau}{\rho\sigma_\ell^2}}_{\text{myopic}} - \underbrace{\frac{\xi_r^*\,\sigma_r}{\xi^*\rho\sigma_\ell}}_{\text{hedging}} \qquad \alpha^C = \frac{\kappa + c\delta - [1+\delta(1-\beta)]r_{s,t}}{\tau}$

→ *risk of future binding constraint*: hedging demand ↑ ⇒ "ex-ante reach for duration"

Global Duration Policy

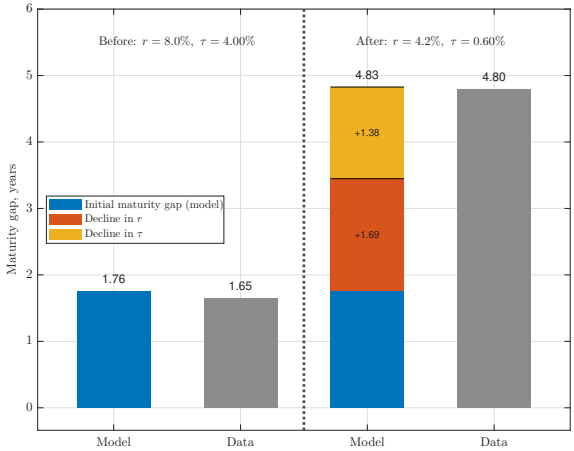


α^C: constrained. α^{AU}: always-unconstrained benchmark. α^U lies behind α^* (yellow).

Model vs. Data: Maturity Gap

▸ Mapping ▸ Role of Constraint ▸ Deposit Beta

→ Model matches rise in maturity gap, r_s & τ each ∼50%, constraint never binds



1985: $r_s = 8\%$, $\tau = 4\%$. **2025**: $r_s = 4.2\%$, $\tau = 0.6\%$. Aumann–Shapley attribution.

Conclusion

- U.S. banks' **maturity mismatch has more than tripled** since mid-1980s
  ... tracking the secular decline in interest rates and term premia

- We develop a model in which banks face profitability constraints
  → when term premia & interest rates fall, banks **reach for duration**

Conclusion

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- Increases banks' vulnerability to runs following interest rate reversals
- **QE paradox**: could concentrate duration risk in banks → raises financial instability

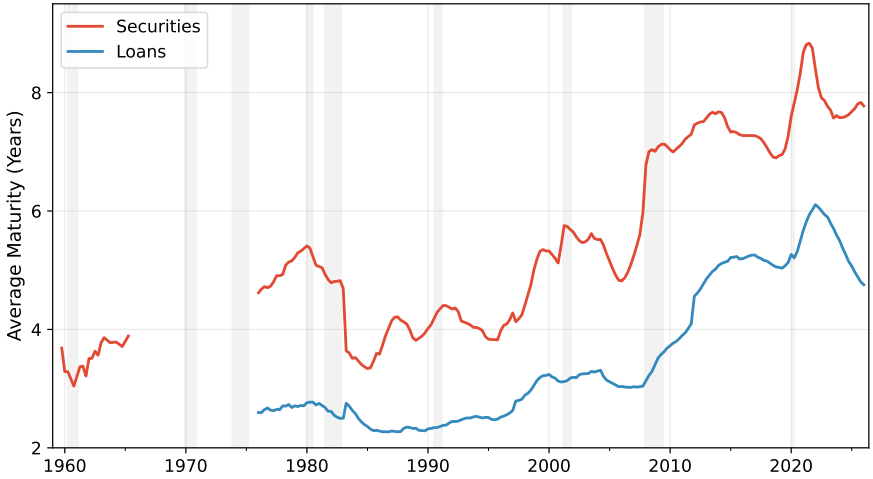
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  → when term premia & interest rates fall, banks **reach for duration**
- Increases banks' vulnerability to runs following interest rate reversals
- **QE paradox**: could concentrate duration risk in banks → raises financial instability
- 2023 banking crisis: optimal decision when rates & term premia were low in 2020/21
- **Future work**: optimal QE design, weighing against intended macro effects

Appendix Slides

Average Maturity of Loans & Securities

Back



Related Literature

Back

- **Banks' interest rate risk & risk-taking at low rates**: Flannery (1981/83), Borio & Zhu (2012), Dell'Ariccia et al. (2014/17), Jiménez et al. (2014), Martinez-Miera & Repullo (2017), Claessens et al. (2018), English et al. (2018), Gomez et al. (2021), Drechsler et al. (2021), Di Tella & Kurlat (2021), Ulate (2021), Abadi et al. (2023), Begenau et al. (2025), Wang (2025)
  → ***Our paper***: *role of the term premium for bank profitability & duration risk-taking*

- **Reaching for yield**: Becker & Ivashina (2015), Di Maggio & Kacperczyk (2017), Domanski et al. (2017), Choi & Kronlund (2018), Lian et al. (2019), Daniel et al. (2021), Barth et al. (2024)
  → ***Our paper***: *banks reach for duration as a rational response to an earnings floor*

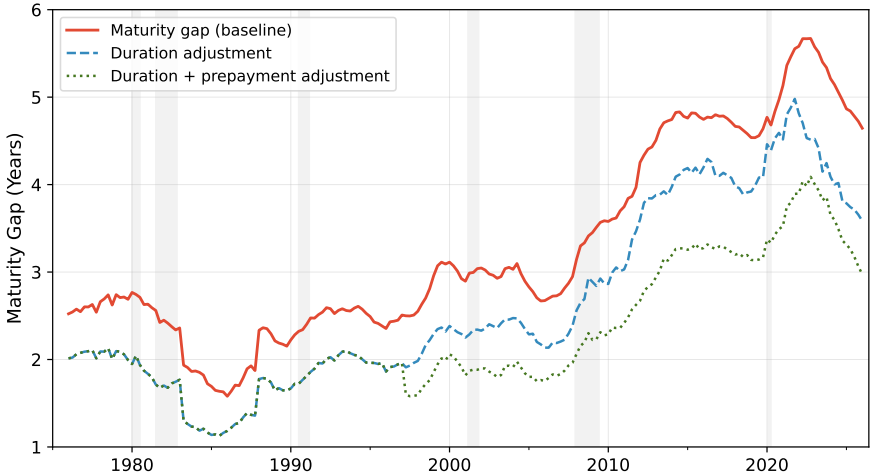
  Hanson & Stein (2015): yield-oriented behavior arises from profitability concerns in response to term premium
  Campbell & Sigalov (2022): margin of adjustment is duration, relevant compensation is term premium

- **Risk-shifting**: Keeley (1990), Hellmann, Murdock & Stiglitz (2000)
  → ***Our paper***: *distinct mechanism, risk-averse banks, no limited-liability put*

- **Bank runs & monetary policy vs. financial stability**: Diamond & Rajan (2012), Stein (2012), Ajello et al. (2022), Boyarchenko et al. (2022), Haddad et al. (2023), Jiang et al. (2024), DeMarzo et al. (2024), Drechsler et al. (2026), Alexandrov & Brunnermeier (2026)
  → ***Our paper***: *QE compresses term premia → reach for duration → run exposure*

Duration & Prepayment Adjustments

Construction Back



Trough-to-peak changes: 260% baseline, 340% duration, 260% duration+prepayment.

Duration & Prepayment Adjustments: Construction

Back

- **Duration adjustment**: replace each bucket midpoint M by the Macaulay duration of a par bond:

$$D(M, y_t) = ((1 + y_t)/y_t)\left(1 - (1 + y_t)^{-M}\right)$$

  - Bucket-matched yields: 3-month T-bill ($<$1 year) & zero-coupon yields from Gürkaynak, Sack & Wright (2007) ($\geq$1 year)

- **Prepayment adjustment**: for mortgage-related positions (MBS & 1–4 family mortgages, separately reported since 1997:Q2), weight $= \kappa_t \cdot M$ instead
  - Effective duration dominated by prepayment, not coupon effects
  - κ_t: through-the-cycle ratio of effective to stated duration $\rightarrow$ base levels 0.40 (MBS) & 0.50 (mortgages)
  - Time variation: κ_t falls when current mortgage rates are below their trailing five-year average (stronger refinancing incentives)

Maturity Gap by Bank Size

Back

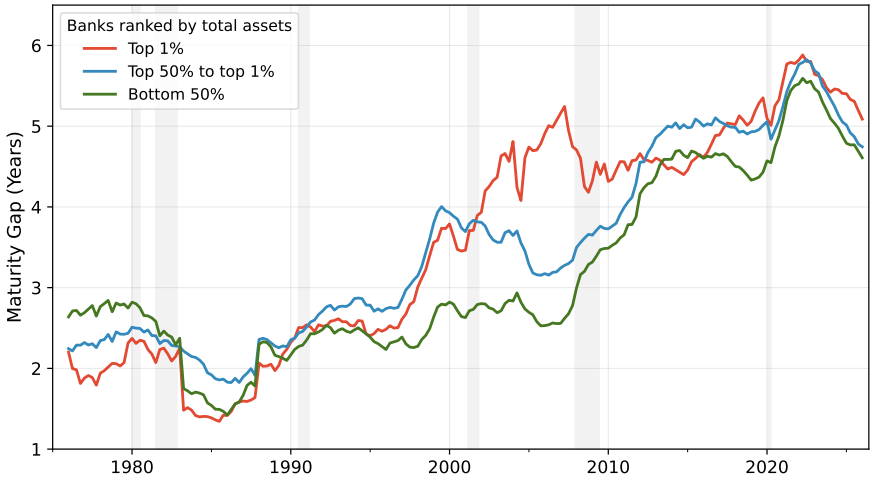
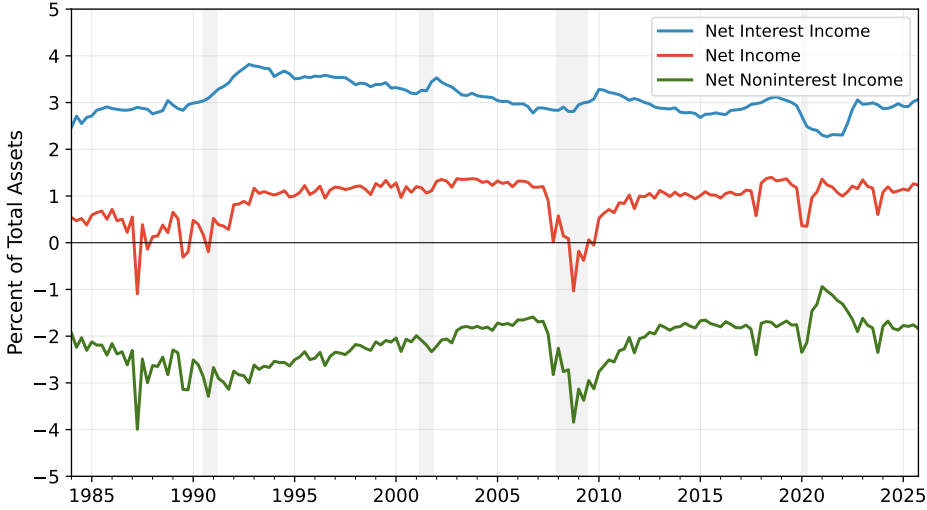


Figure shows value-weighted series for various size buckets.

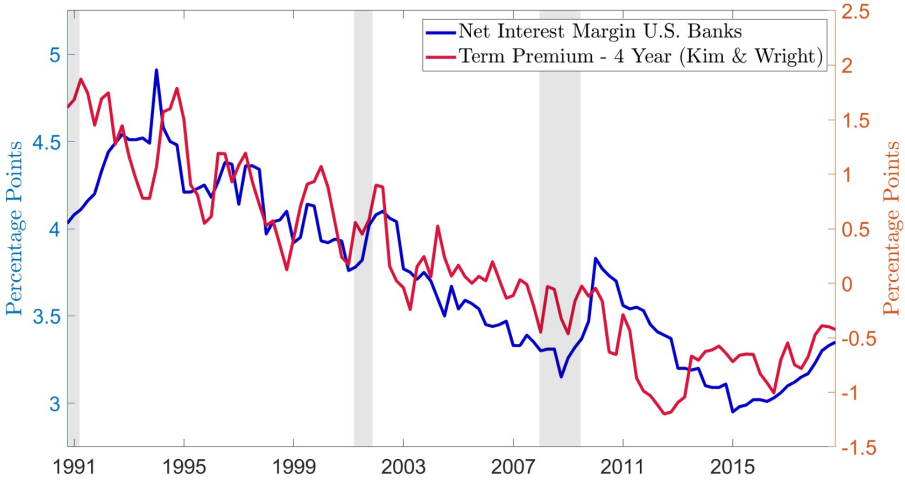
Historical Bank Income Measures

Back



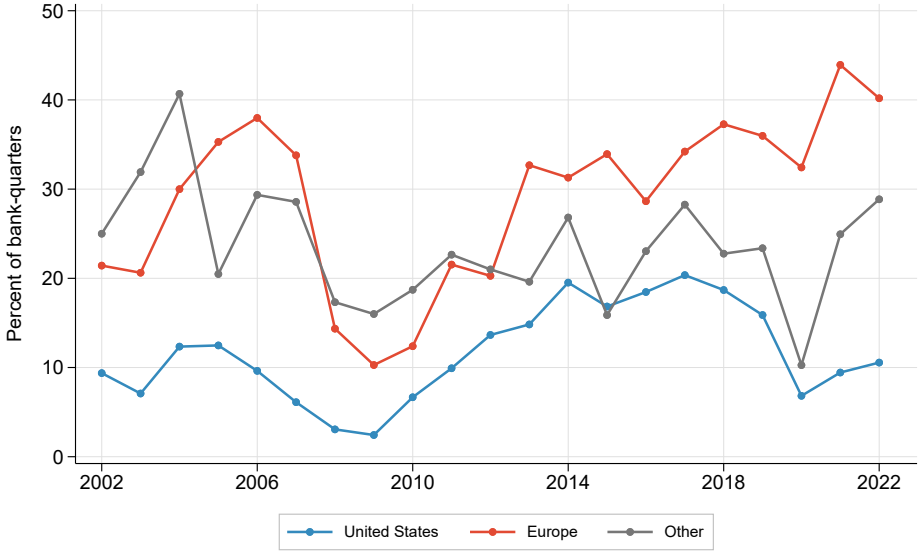
Net Interest Margins & the Term Premium

Back



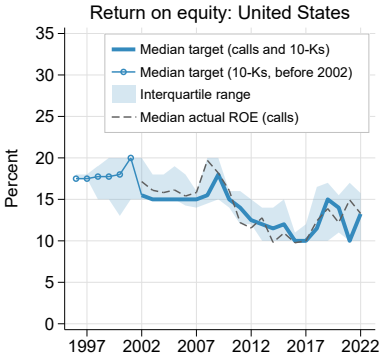
Frequency Return Targets

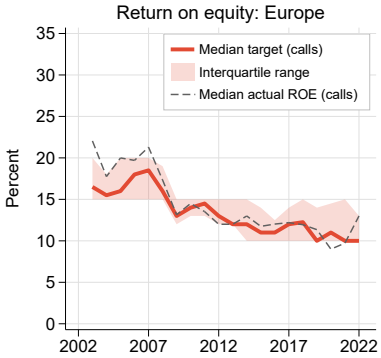
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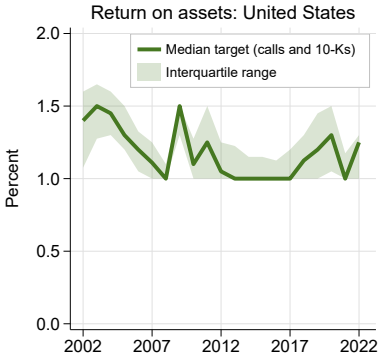


Return Targets

Back

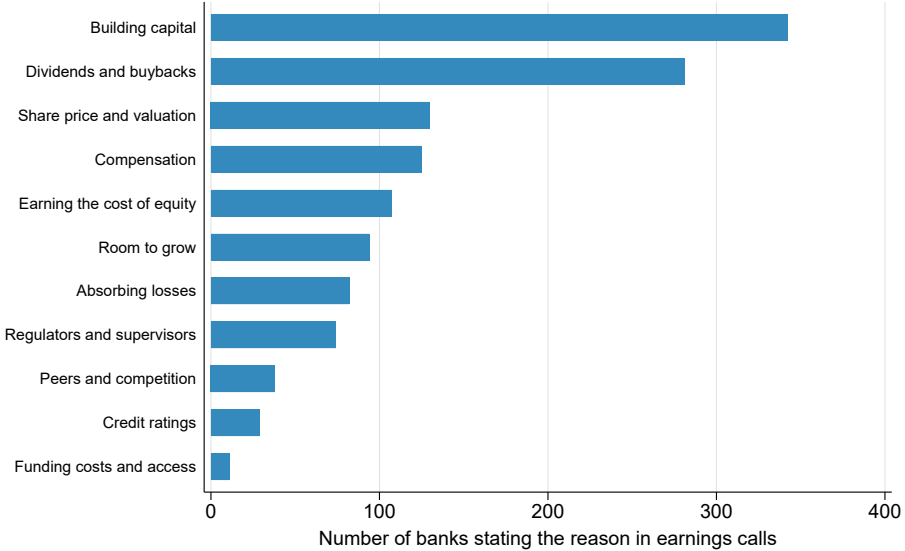






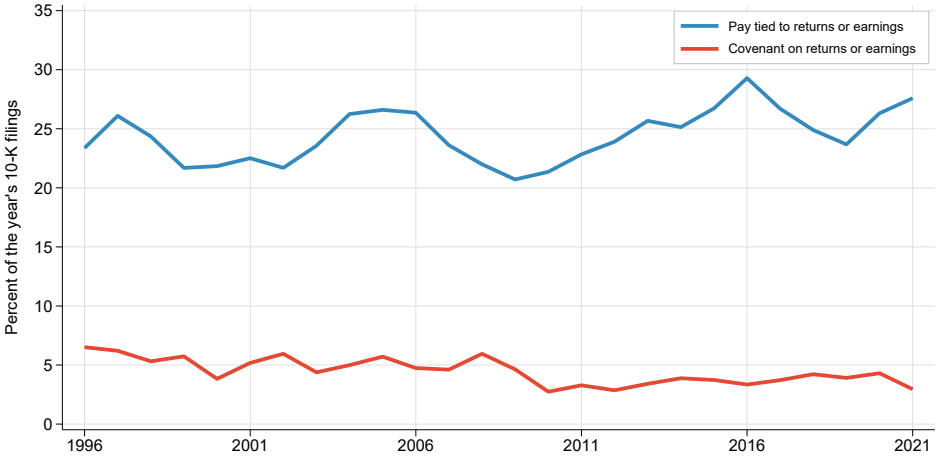
Reasons Why Earnings Matter

Back



Pay & Covenants tied to Returns & Earnings

Back



Rate-dependence of ROE

Back

- **Profitability constraint as ROE-floor that depends on r:**

$$NI_1 \geq \kappa = e \cdot (\kappa_0 + s \cdot r)$$

- **Then optimal portfolio is:**

$$\alpha_{bind} = \frac{e\kappa_0 + c - (\lambda - s \cdot e)}{\tau}$$

- **With the relation to r:**

$$\frac{\partial \alpha_{bind}}{\partial r} < 0 \quad if \quad \frac{\lambda}{e} > s$$

- **Assume $s = 1$; calibration implies $\frac{\lambda}{e} \approx 9.78$. Intuition:** $r \downarrow \rightarrow$ deposit spread $\downarrow$

Comparative Statics

Back

- **Rate level**: $r_{s,o} \downarrow \rightarrow \lambda r_{s,o} \downarrow \rightarrow \tilde{\tau} \uparrow, \alpha^*_{\text{bind}} \uparrow$
- **Deposit market power**: $\beta \downarrow \rightarrow \lambda \uparrow \rightarrow \lambda r_{s,o} \uparrow \rightarrow \tilde{\tau} \downarrow, \alpha^*_{\text{bind}} \downarrow$ (hedge $\uparrow$)
- **Equity**: $e \uparrow \rightarrow \lambda \uparrow \rightarrow \lambda r_{s,o} \uparrow \rightarrow \tilde{\tau} \downarrow, \alpha^*_{\text{bind}} \downarrow$ (hedge $\uparrow$)
- **Rate volatility/Risk-aversion**: $\gamma \uparrow \rightarrow \frac{\tau}{\gamma} \downarrow \rightarrow \alpha^*_{\text{int}} \downarrow, \tilde{\tau} \uparrow$
- **Profitability target**: $\kappa \uparrow \rightarrow \tilde{\tau} \uparrow$

Discussion of Assumptions

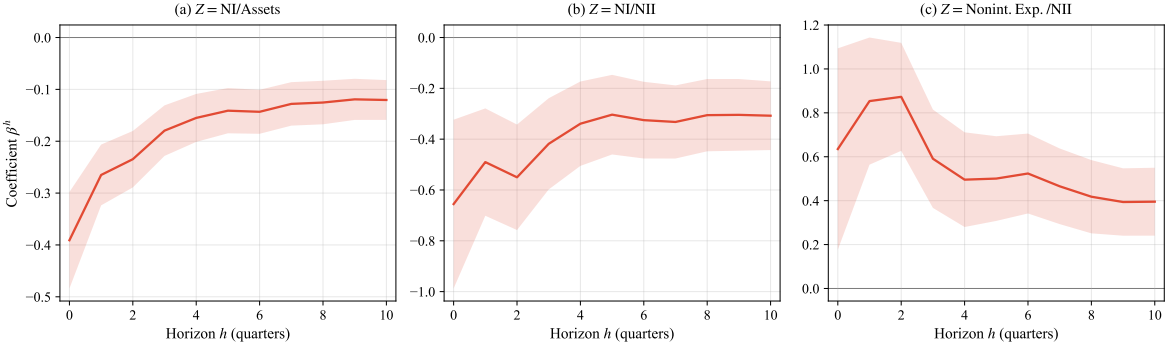
Back

- **Portfolio restriction**:
  - Baseline model assumes $\alpha \in [0, 1]$: relax to $\alpha \in [0, \overline{\alpha}]$
  - Bank borrows in wholesale market up to leverage constraint
  - Shifts unprofitability region, key results unchanged
- **Fixed deposits**:
  - Endogenous deposit choice: deposits strictly cheaper than wholesale funding
  - Bank issues deposits up to leverage capacity; scale separates from portfolio choice
  - Baseline analysis goes through unchanged (per unit of assets)

Dynamic Response Maturity Gap

Back

$$y_{i,t+h} = \phi_t^h + \beta^h Z_{i,t-1} + \theta_1^h y_{i,t-1} + \theta_2^h Z_{i,t-2} + u_{i,t}^h$$



95% confidence bands. Two-way clustered standard errors by bank and time. Sample: 1997:Q2–2026:Q1.

Decomposition Maturity

Back

$$y_{i,t} = \phi_t + \beta Z_{i,t-1} + \theta_1 y_{i,t-1} + \theta_2 Z_{i,t-2} + u_{i,t}$$

	(i) Maturity Gap	(ii) Mat.Assets	(iii) Mat.Liab.	(iv) Mat.Sec.	(v) Mat.Loans
NI/Assets	-0.39***	-0.39***	-0.00	-0.34***	-0.19***
	(0.05)	(0.05)	(0.00)	(0.12)	(0.04)
Time FE	✓	✓	✓	✓	✓
Partial R^2	0.04	0.04	0.03	0.04	0.02
Observations	516,792	516,792	516,792	687,538	717,054
Number of Banks	10,989	10,989	10,989	11,696	11,873

Columns (i)–(iii) estimated on a common sample. Two-way clustered standard errors by bank and time.
Sample: 1997:Q2–2026:Q1.

Income & Asset-Composition Responses

Back

$$y_{i,t} = \phi_t + \beta Z_{i,t-1} + \theta_1 y_{i,t-1} + \theta_2 Z_{i,t-2} + u_{i,t}$$

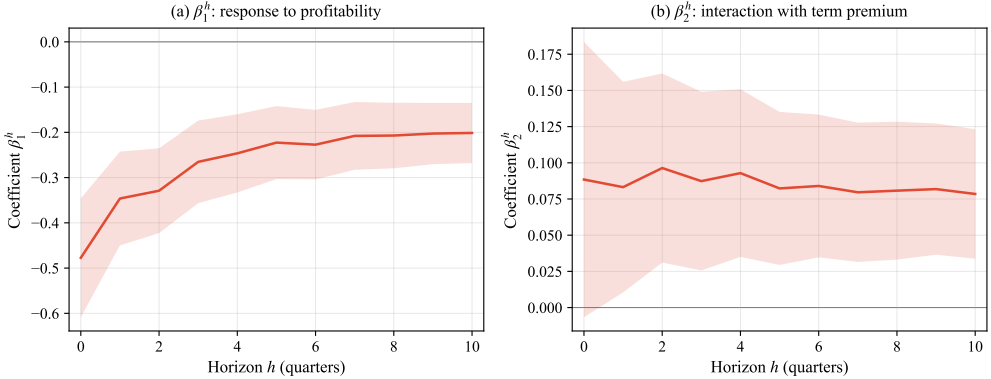
	(i) Int.Sec.	(ii) Int.Loans	(iii) NIM	(iv) Sec./Assets	(v) Loans/Assets
NI/Assets	-0.53*	-0.70***	-0.54***	-0.02**	-0.04**
	(0.28)	(0.10)	(0.08)	(0.01)	(0.02)
Time FE	✓	✓	✓	✓	✓
Partial R^2	0.28	0.17	0.1	0.03	0.06
Observations	699,625	708,519	712,110	725,254	725,254
Number of Banks	11,825	11,809	11,870	11,946	11,946

Two-way clustered standard errors by bank and time. Sample: 1997:Q2–2026:Q1.

Interaction with Term Premium

Back

$$y_{i,t+h} = \phi_t^h + \beta_1^h Z_{i,t-1} + \beta_2^h Z_{i,t-1} \cdot TP_{t-1} + \theta_1^h y_{i,t-1} + \theta_2^h Z_{i,t-2} + u_{i,t}^h$$

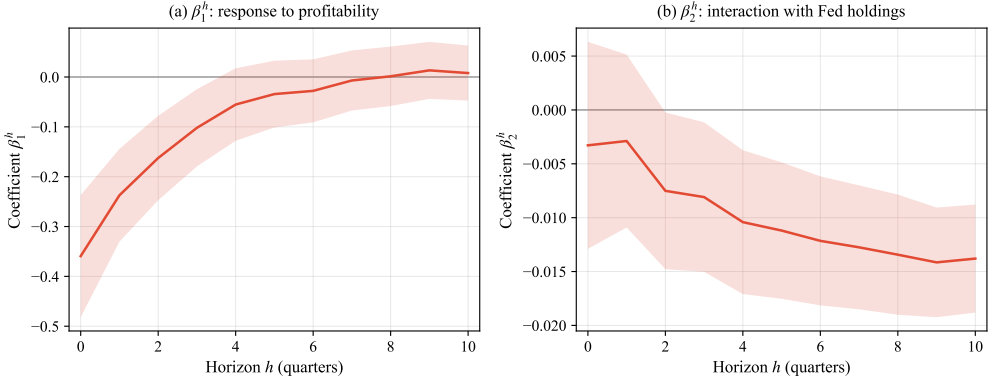


10y term premium from Adrian, Crump, and Moench (2013). 95% confidence bands. Two-way clustered standard errors by bank and time. Sample: 1997:Q2–2026:Q1.

Interaction with Federal Reserve Holdings

Back

$$y_{i,t+h} = \phi_t^h + \beta_1^h z_{i,t-1} + \beta_2^h z_{i,t-1} \cdot \mathrm{SOMA}_{t-1}/\mathrm{GDP}_{t-1} + \theta_1^h y_{i,t-1} + \theta_2^h z_{i,t-2} + u_{i,t}^h$$



$\mathrm{SOMA}_{t-1}/\mathrm{GDP}_{t-1}$: Federal Reserve holdings of Treasury and agency securities relative to GDP. 95% confidence bands. Two-way clustered standard errors by bank and time. Sample: 1997:Q2–2026:Q1.

Reaching for Credit Risk

Back

- Loans yield $r_\ell + \sigma_0 - \frac{\chi}{2}\alpha_L$ with $\chi \geq 0$ (downward-sloping credit demand)
  $\rightarrow$ spread income $S(\alpha_L) = \sigma_0 \alpha_L - \frac{\chi}{2}\alpha_L^2$, credit-loss shock η with variance σ_η^2

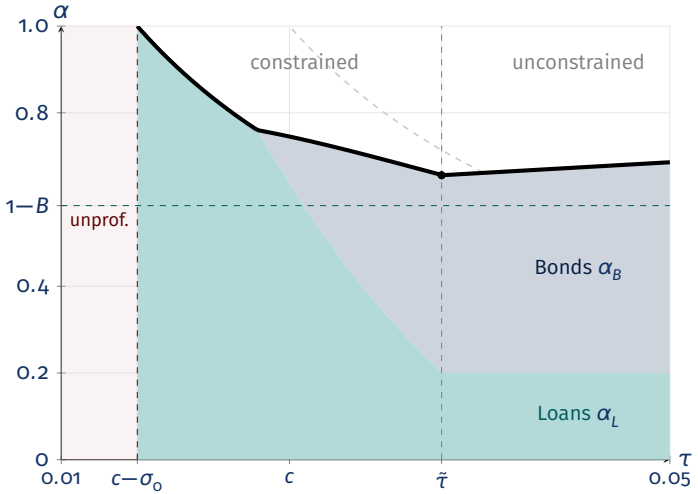
- Terminal payout accounts for potential credit losses

$$\Pi_2 = \underbrace{2\,NI_1}_{\text{expected payout}} + \underbrace{(\lambda - \alpha)\varepsilon}_{\text{interest rate risk}} - \underbrace{\alpha_L \eta}_{\text{credit risk}} \quad \text{with } NI_1 = \lambda r_{s,0} + \alpha\tau + S(\alpha_L) - c$$

- Two polar cases: $\chi = 0$ (pure credit risk) & $\sigma_\eta^2 = 0$ (pure diminishing returns)

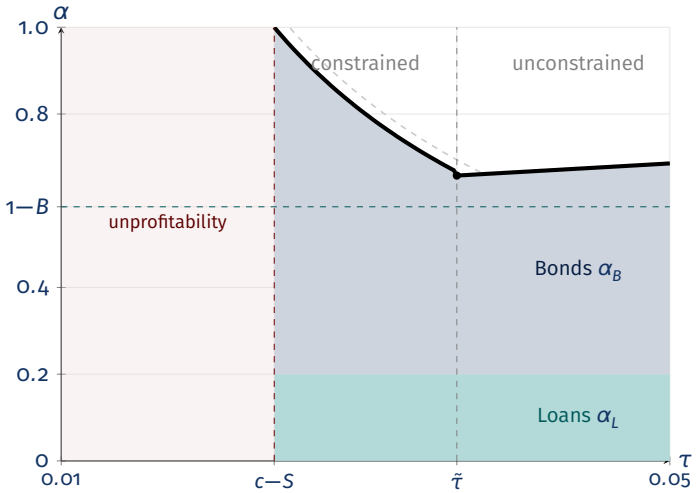
Pure Credit Risk: $\chi = 0$

Back



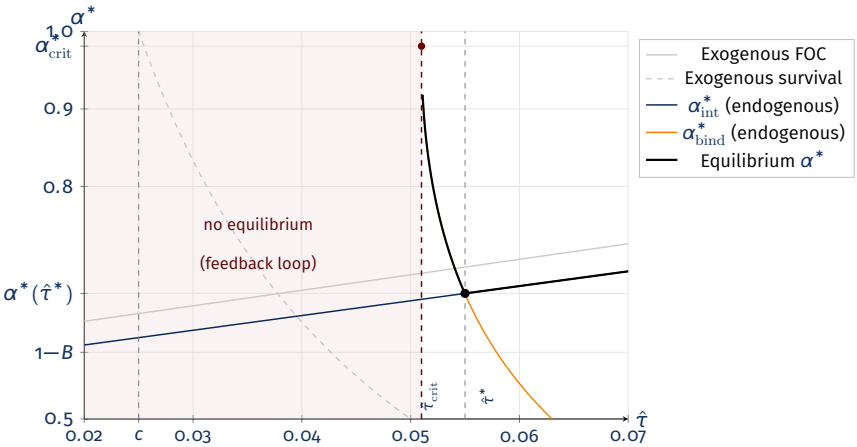
Pure Diminishing Returns: $\sigma_\eta^2 = 0$

Back



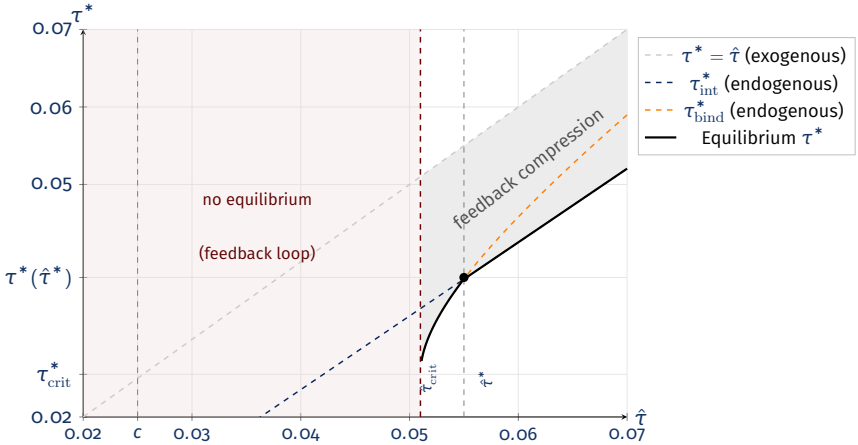
Endogenous Term Premium: $\tau(\alpha) = \hat{\tau} - \mu \cdot \alpha$

Back



Endogenous Term Premium: $\tau(\alpha) = \hat{\tau} - \mu \cdot \alpha$

Back



Dynamic Model: Additional Details

Back

- **Polar cases** (closed forms): constraint always slack (AU) or always binding (C)
  - AU: $\xi^{AU} = \exp\left(\Omega^{AU}(t) + \Lambda^{AU}(t)\, r_{s,t}\right)$ with semi-elasticity
    $$\xi_r^{AU}/\xi^{AU} = \Lambda^{AU}(t) = \frac{1-\rho}{\kappa_r}\left[1+\delta(1-\beta)\right]\left(1-e^{-\kappa_r(T-t)}\right)$$
  - C: $\xi^{C} = \exp\left(\Omega^{C}(t) + \Lambda^{C}(t)\, r_{s,t} + \Psi^{C}(t)\, r_{s,t}^2\right)$ → semi-elasticity more negative than AU: low expected returns & volatile wealth when constrained

- **Mapping to baseline model**: $1+(1-\beta)\delta = \lambda/e$, long-asset share of assets $= \frac{\alpha_t}{1+\delta}$, $\kappa^{\text{2-period}} = e\kappa$, $c^{\text{2-period}} = c(1-e) \Rightarrow \alpha_t^C/(1+\delta)$ nests α^*_{bind} exactly

- **Hedging portfolio** (dV/V immune to rate shocks): $\alpha^{H,*} = \frac{\xi_r^*/\xi^*}{1-\rho} \cdot \frac{\sigma_r}{\sigma_\ell}$
  → generalizes $\alpha = \lambda$ from the two-period model

- **Numerical solution**: $q \equiv \log \xi$, implicit Euler backward from $q(T, r) = 0$, nonlinear system across r-grid, policy $\alpha^*(t, r) = \max\{\alpha^U(t, r), \alpha^C(r)\}$

Dynamic Model: Calibration

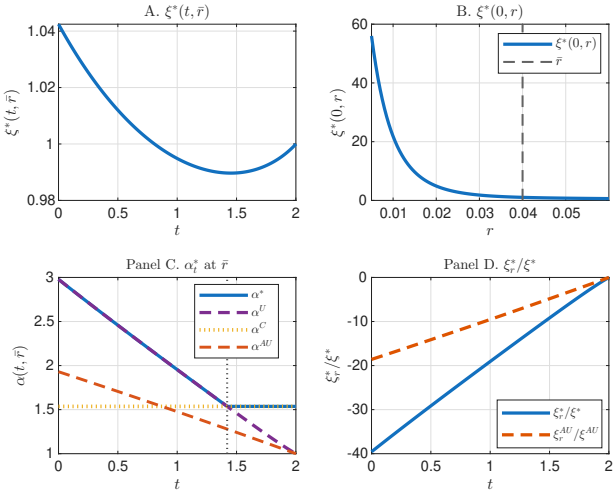
Back

Symbol	Value	Description
ω	0.04	Discount rate
ρ	2.0	Risk aversion
β	0.44	Deposit pass-through
δ	15.67	Deposit-to-net-worth ratio
c	0.025	Cost per unit of deposits
κ_r	0.05	Mean reversion of the short rate
$\bar{r}$	0.04	Long-run short rate
σ_r	0.01	Short-rate volatility
σ_ℓ	0.10	Exposure of long asset to rate shocks
τ	0.02	Term premium
κ	0.03	Profitability bound

Chosen to match the two-period model as closely as possible; κ_r, $\bar{r}$, σ_r match persistence, mean & volatility of the short rate; $\kappa = 3\%$ as plausible lower bound for banks' ROE.

Global Solution: Value Function & Policy

Back



A: $\xi^*(t,\bar{r})$ over time. B: $\xi^*(o,r)$ across states. C: global policy α_t^* vs. unconstrained candidate α_t^U, lower bound α^C, always-unconstrained α_t^{AU}. D: semi-elasticity ξ_r^*/ξ^* (hedging demand).

From Model to Maturity Gap

Back

- **Long-asset share of total assets**: $L_t + B_t = (1+\delta)N_t \Rightarrow \frac{L_t}{L_t+B_t} = \frac{\alpha_t}{1+\delta}$
- **Implied duration of long-term asset**: rate shock $\sigma_r \, dW_{r,t}$ moves long-asset return by $-\sigma_\ell \, dW_{r,t} \Rightarrow$ modified duration $D_L = \sigma_\ell / \sigma_r = 10$ years
  $\rightarrow$ zero-coupon approximation: duration $=$ maturity
- **Liabilities**: instantaneous $\Rightarrow$ maturity of zero

$$\Rightarrow \quad MG_t = \frac{\alpha_t}{1+\delta} \cdot \frac{\sigma_\ell}{\sigma_r}$$

From Model to Maturity Gap

Back

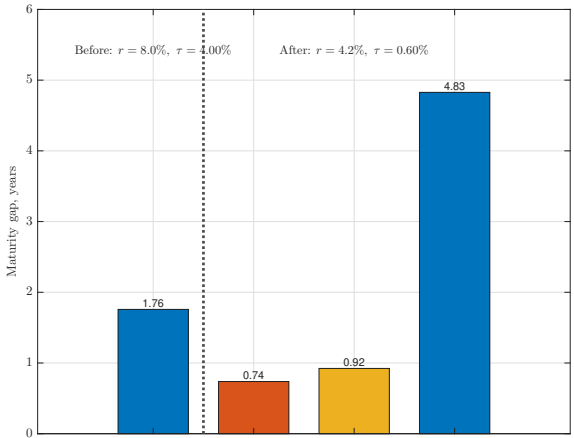
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- **Environments** (federal funds rate & 10-year term premium):
  1985: $r_s = 8\%$, $\tau = 4\%$ vs. 2025: $r_s = 4.2\%$, $\tau = 0.6\%$
- **Attribution** (Aumann–Shapley, order-independent):
  $\approx$ 55% decline in level of rates, $\approx$ 45% decline in term premium

Maturity Gap: Role of the Constraint

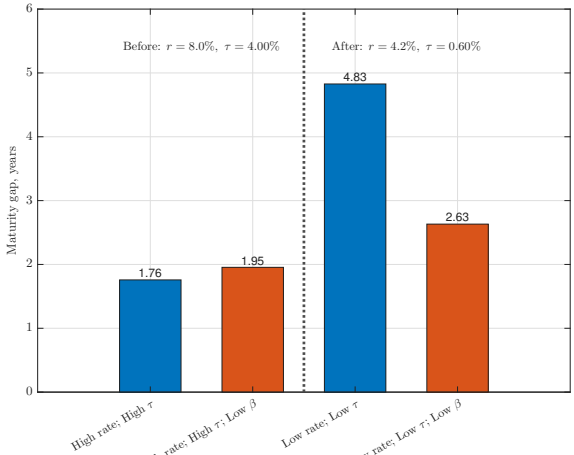
Back



Model-implied maturity gap under the always-unconstrained (AU), constrained, and global policies. The rise in the gap is driven entirely by profitability concerns: absent the constraint, the bank would *decrease* its maturity gap as r_s & τ decline.

Alternative Explanation: Deposit Market Power

Back



Red bars: deposit beta cut in half ($\beta = 0.22$ vs. 0.44). Stronger hedging motive (↑ gap) vs. alleviated profitability concerns (↓ gap): higher market power barely moves the gap when rates are high & *lowers* it in the low-rate environment.

Penalized profit constraint

Back

- Instead of imposing a hard floor, we let the bank fall short of it at a cost. Assume bank pays flow cost θS_t with $S_t \equiv max\{\pi - (\alpha_t \tau_t + Kr_t - c\delta), 0\}$

