Bank Market Power and Interest Rate Risk *

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Abstract

How does relative market power in funding and lending shape bank interest rate risk exposure and monetary transmission? We document a novel pricing fact: banks with less rate-sensitive funding charge higher fixed-rate loan spread over variable-rate loans, despite stable funding makes fixed-rate lending an attractive earnings hedge. Greater loan market concentration is associated with higher spreads conditional on funding sensitivity, and a weaker expansion of fixed-rate credit after monetary tightening. We develop a model with depositor search and bank entry in which relative market power governs a tradeoff between expected earnings and earnings risk. Banks can raise expected earnings by restricting fixed-rate lending and sustaining larger premiums, at the cost of forgone hedging and potential losses from adverse rate movements. A calibrated investment extension captures lower premiums and a higher fixed-rate share after a financing-rate increase implies a contraction in aggregate investment. An application shows that greater bank risk-bearing capacity can raise banks' expected earnings and earnings volatility while reducing fixed-rate lending and investment. Banks that can bear more risk become less willing to supply cheap borrower protection. These results link relative market power and bank risk management to monetary transmission.

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1 Introduction

The banking turmoil of March 2023, following the rapid rise in U.S. interest rates, renewed concerns about banks' exposure to interest rate risk. Deposit market power dampens the passthrough of higher policy rates to funding costs, limiting the increase in interest expense. However, the effect on bank earnings also depends on how interest income responds. This response reflects banks' portfolio choices and the pricing incentives they face in loan markets. How does bank market power on both sides of the balance sheet jointly shape bank's interest rate risk exposure? And how does bank risk management affect monetary transmission?

We document a novel pricing fact: banks with less rate-sensitive funding charge higher premiums on fixed-rate loans relative to variable-rate loans. This pattern is surprising because funding that barely reprices ordinarily makes fixed-rate lending attractive to a bank. Fixed-rate income then matches relatively insensitive funding costs, stabilising net interest earnings. To attract more fixed-rate borrowers, the bank should be willing to offer protection at a lower premium. Taken alone, the hedging incentive therefore predicts relatively cheap protection at banks with insensitive funding, the opposite of the observed pricing relationship.

We propose a mechanism in which relative market power in funding and lending determines banks' chosen exposure to interest rate risk. Funding market power governs the sensitivity of interest expense and hence the fixed-rate portfolio that hedges earnings. Lending market power can make it profitable to supply less fixed-rate credit than the full hedge requires, charging a larger spread over variable-rate loans and raising expected earnings. The cost is a less effective earnings hedge and potential losses following adverse interest rate movements. Banks therefore trade a higher expected level of earnings against greater earnings risk. This mechanism complements existing explanations of bank interest rate exposure (Di Tella & Kurlat, 2021; Hellwig, 1994) and extends the funding-based hedging motive of Drechsler et al. (2021) to strategic loan pricing.

We document the pricing pattern using U.S. bank regulatory reports and Small Business Administration (SBA) 7(a) loan records. A one-standard-deviation increase in interest expense sensitivity is associated with a fixed–variable premium that is approximately 6.3 basis points lower. Lending concentration provides additional information about this differential: conditional on funding sensitivity and observed loan and bank characteristics, a 0.10 increase in bank HHI is associated with a 10.1-basis-point larger premium. The corresponding association with variable-rate loan pricing is statistically indistinguishable from zero, while the conditional funding-sensitivity coefficient is imprecisely estimated. These findings suggest that the price of fixed-rate protection reflects lending-market conditions as well as banks' funding characteristics.

A second fact concerns the allocation of credit following monetary tightening. Using the monetary policy shocks of Jarociński and Karadi (2020), we find that fixed-rate loan stocks expand while variable-rate loan stocks initially contract. The fixed-rate response is weaker at banks with greater lending market power. Following a shock scaled to 100 basis points, the ten-quarter fixed-rate response is approximately 11% at low-HHI banks, compared with about 4.5% at high-HHI banks. These loan-stock responses combine lending, repayment and borrower-demand adjustments. Together with the pricing evidence, they motivate examining how lending competition interacts with bank risk management to shape monetary transmission.

To interpret these facts, we build a two-date model in which risk-averse banks choose the composition of lending and borrowers select fixed- or variable-rate loans. Depositors compare offers within local banking markets, generating funding-rate passthrough that increases with deposit competition. Banks compete in quantities in a wider fixed-rate lending market, while variable-rate finance is competitive. Equilibrium fixed-rate lending lies between the portfolio that fully hedges earnings and the lending quantity chosen by risk-neutral banks. Depending on relative market power, banks supply either less or more fixed-rate credit than the full hedge requires. Interest income consequently responds more or less strongly than interest expense, so earnings can rise or fall when rates increase.

The model distinguishes the effects of competition on the two sides of the balance sheet and explains how they move together through entry. Holding lending competition fixed, greater deposit competition makes funding costs more rate-sensitive, reducing fixed-rate lending and raising its premium. Greater lending competition instead expands fixed-rate credit and lowers premiums. Market growth induces entry, increasing both forms of competition. When lending competition increases sufficiently, its effect dominates the weaker hedging incentive: banks with more rate-sensitive funding then offer cheaper fixed-rate protection. The negative premium–sensitivity relationship can therefore arise from the joint movement of funding and lending competition, even though the funding channel alone predicts the opposite slope.

We extend the model to endogenous project investment, household saving and labour, with heterogeneous local markets connected through interbank funding. Fixed-rate protection permits borrowers to undertake larger projects, linking loan pricing to real activity. The effective cost of bank earnings risk rises with the expected financing rate, capturing a reduced-form deterioration in risk-bearing capacity. We calibrate three representative markets to funding sensitivities, loan premiums and fixed-rate shares. The calibration also targets a 3-basis-point decline in the mean premium and a 1.30-percentage-point increase in the fixed share of new loan volume after a 50-basis-point increase in the expected real rate. In this benchmark, fixed lending rises by 6.15%, while total investment falls by 0.66%.

Cheaper protection supports fixed-financed projects, but does not offset the contraction from higher overall financing costs.

Finally, we apply the framework to differences in banks' capacity to bear risk. Greater capacity lowers the cost of retaining earnings exposure, weakening the incentive to supply fixed-rate loans as a hedge. Banks can then restrict protection and preserve higher premiums even when funding and lending competition are unchanged. In an experiment holding expected rates, uncertainty and the inherited terminal wage fixed, an 80% increase in effective capacity reduces fixed-rate lending by 5.32% and investment by approximately 0.12%. Banking-sector expected earnings rise by 1.00%, while the standard deviation of earnings rises by 3.06%. Banks accept more earnings risk in exchange for a higher expected level of earnings. Greater dispersion in borrower risk aversion amplifies the lending and investment response locally.

Diversification and anticipated public support are possible sources of greater effective risk-bearing capacity. The application shows how banks that can bear more risk may provide less protection to borrowers, changing both the composition and quantity of credit. Assessing these changes requires considering lending terms and borrower investment alongside gains in bank resilience. Relative market power in funding and lending is central to this assessment because it determines how banks translate their capacity to bear risk into loan prices, portfolio choices and monetary transmission.

1.1 Related Literature

Our paper contributes to three strands of literature: theories of bank interest rate risk, lending market power, and the allocation of risk through loan contracts.

Theories of bank interest rate risk. Drechsler et al. (2021) show that a deposit franchise makes funding costs relatively insensitive to market rates, creating an incentive to hold fixed-rate assets that stabilise earnings. Di Tella and Kurlat (2021) explain banks' exposure through a dynamic hedging motive: higher rates increase the liquidity rents from deposit intermediation, making banks willing to accept contemporaneous capital losses in exchange for wealth in states with less profitable intermediation opportunities.[1] Varraso (2025) studies endogenous maturity choices in a competitive intermediation model, where asset-price movements change bank net worth, financial constraints, and the risk compensation required to hold long-duration assets. We identify a complementary mechanism operating through *loan-market pricing power*. Fixed-rate loans both alter banks' earnings sensitivity and provide protection for which borrowers are willing to pay. Risk-averse banks choose a portfolio

[1]The deposit market in Di Tella and Kurlat (2021) is competitive, but leverage constraints limit deposit supply and prevent liquidity spreads from being competed away. These rents act like market power for bankers collectively; their model does not feature strategic pricing of fixed-rate loans.

between the full earnings hedge and the lending allocation of risk-neutral banks. Relative funding and lending market power determines whether interest income responds more or less strongly than interest expense, generating positive or negative sensitivity gaps even when banks value stable earnings. Our contribution is to explain these departures from complete earnings hedging through the profitability of supplying borrower protection. The object is earnings exposure, distinct from the market-value sensitivity of bank franchises emphasised by DeMarzo et al. (2024).

Loan market power. Scharfstein and Sunderam (2016) show that concentration in mortgage lending weakens the transmission of market rates to mortgage rates and refinancing, while Bocola et al. (2026) connect lender-specific differences in corporate borrowing rates to local market shares and quantify their aggregate effects. Wang et al. (2022) jointly model deposit and loan market power in monetary transmission. We contribute *suggestive evidence of an asymmetry in lending market power across interest-rate contracts*. Using U.S. SBA 7(a) loan records, we document a positive relationship between banking concentration and the fixed–variable origination-rate differential, conditional on funding-cost sensitivity and observed loan, borrower, and bank characteristics. This pattern suggests greater scope for pricing power over fixed-rate than variable-rate credit, adding a contract dimension to the evidence on lending competition.[2] The distinction matters because banks can earn rents from fixing borrowers' repayments as well as from providing finance. Our model connects this contract-specific pricing incentive to banks' portfolio choices and their remaining exposure to interest rate risk.

Loan contracts and risk sharing. The allocation of interest rate risk through fixed- and variable-rate loans has long been studied in bank portfolio theory Santomero (1983). Vickery (2008) finds that financially constrained small firms are more likely to borrow at fixed rates, consistent with a demand for stable debt service. Kirti (2020) shows that banks with more rate-sensitive liabilities supply more floating-rate credit and price it more favourably relative to fixed-rate credit. Liu and Elenev (2025) study how mortgage fixation affects borrower default, intermediary net worth, and aggregate risk sharing, while Bretscher et al. (2018) examine the effects of interest rate uncertainty on corporate hedging and investment. We extend these accounts of borrower insurance demand and banks' funding incentives by jointly determining fixed-rate loan pricing, borrower contract choice, and project investment under strategic fixed-rate lending. Borrower protection affects project scale as well as the allocation of interest rate risk. In the application with an inherited wage, greater bank risk-

[2]Related evidence from Swiss mortgages links differences in fixed- and floating-rate adjustment to competitive conditions Cecchin (2011). Our evidence concerns concentration and business-loan rate differentials conditional on funding sensitivity. The differential does not establish the absence of pricing power in variable-rate lending.

bearing capacity weakens the incentive to hedge earnings through fixed-rate lending. Banks restrict fixed credit and raise premiums, accepting greater earnings risk in exchange for higher expected earnings. More expensive protection reduces investment. This conditional mechanism connects banks' capacity to bear risk to the supply of borrower protection and real activity.

2 Data and Empirical Facts

2.1 Data

Our empirical analysis and model calibration combine three main sources of data: bank Call Reports, the Federal Deposit Insurance Corporation's (FDIC) Summary of Deposits, and loan-level records from the U.S. Small Business Administration's (SBA) 7(a) programme. These sources provide information on banks' financial positions and interest flows, the geographic structure of their deposit markets, and the terms of individual business loans. We focus on 2010Q1–2024Q4, reflecting the availability of the fixed- versus variable-rate classification in our SBA data from 2010Q1.

2.1.1 Call Reports and FR Y-9C

We obtain quarterly balance-sheet and income-statement data from the FFIEC 031 Call Reports and the Federal Reserve's Consolidated Financial Statements for Holding Companies (FR Y-9C). Call Reports provide detailed financial information for individual reporting banks, including their assets, liabilities, capital, interest income and interest expense. The FR Y-9C provides corresponding information on a consolidated basis for reporting holding companies. These sources underpin our measures of banks' interest income and expense sensitivities and supply the balance-sheet characteristics used in the loan-pricing analysis.

We consolidate the data at the holding company level using institutional relationship information from the Federal Financial Institutions Examination Council (FFIEC). This unit of observation captures the scope for funding and asset allocation to be coordinated across affiliated institutions. A holding company can raise funds on behalf of its subsidiaries, while internal capital markets allow resources to be reallocated within the group, influencing subsidiaries' lending decisions (Campello, 2002). Analysing subsidiaries in isolation could therefore omit relevant group-level funding costs and obscure the financial resources supporting their lending. Throughout the paper, "bank" refers to the consolidated entity.

We measure interest income and expense as annualised quarterly flows divided by quarterly average assets. Total interest expense includes payments on deposits, wholesale funding and other liabilities. The resulting expense sensitivity therefore captures the response of

overall funding costs per dollar of assets. The regulatory reports also provide the bank size, capital and repricing information used as controls in the empirical analysis.

Following Drechsler et al. (2021), we estimate bank-specific interest expense sensitivities using a distributed-lag specification:

$$\Delta \text{IntExp}_{b,t} = \alpha_b + \eta_t + \sum_{\tau=0}^{3} \beta_{b,\tau}^{\text{exp}} \Delta \text{FedFunds}_{t-\tau} + \varepsilon_{b,t}. \tag{1}$$

Here, $\text{IntExp}_{b,t}$ is bank b's annualised interest expense rate: total quarterly interest expense, including payments on deposits, wholesale funding and other liabilities, divided by quarterly average assets and multiplied by four. FedFunds_t denotes the effective federal funds rate, and Δ denotes a quarterly change. The terms α_b and η_t are bank and quarter fixed effects, respectively, and $\varepsilon_{b,t}$ is an error term. The bank-specific coefficients allow funding costs to respond differently across banks, while the contemporaneous rate change and three lags capture adjustment over four quarters.

We summarise each bank's interest expense sensitivity by the sum of these coefficients,

$$\beta_b^{\text{exp}} = \sum_{\tau=0}^{3} \beta_{b,\tau}^{\text{exp}}. \tag{2}$$

This measure captures the sensitivity of total funding expense per dollar of assets, rather than the passthrough to deposit rates alone. We construct interest income sensitivity, β_b^{inc}, analogously, replacing the dependent variable with the quarterly change in the annualised interest income rate, defined as four times total quarterly interest income divided by quarterly average assets.

2.1.2 Summary of Deposits (SOD)

The FDIC Summary of Deposits (SOD) reports annual branch-level information of FDIC-insured institutions as of June 30. It records branch deposit balance, location and institutional identifiers, allowing us to characterise banks' geographic networks and measure local banking market concentration. We treat counties as local markets and branches belonging to the same holding company as a single competitor, consistent with Section 2.1.1.

For county c and year t, let $N_{b,c,t}$ denote bank b's number of branches in that county and let $N_{c,t} = \sum_b N_{b,c,t}$ denote the total number of bank branches in county c. We measure county-level concentration using the Herfindahl–Hirschman index (HHI),

$$\text{HHI}_{c,t} = \sum_b \left(\frac{N_{b,c,t}}{N_{c,t}} \right)^2. \tag{3}$$

We then construct a bank-level measure by averaging county HHIs across the bank's branch

network, $\mathcal{C}(b)$, weighting each county equally:

$$\mathrm{HHI}_{b,t} = \frac{1}{|\mathcal{C}(b)|} \sum_{c \in \mathcal{C}(b)} \mathrm{HHI}_{c,t}, \tag{4}$$

This measure summarises the concentration of banking markets across the bank's geographic network, which we use later as a proxy for bank lending market power, once conditional on bank funding sensitivity $\beta_b^{\exp}$.

We use $\mathrm{HHI}_{b,t}$ as a proxy for lending-market competition conditional on interest expense sensitivity, $\beta_b^{\exp}$. This is because local lending competition need not map one-for-one into bank-wide funding sensitivity. Bank holding companies allocate resources across affiliated institutions through internal capital markets, allowing lending in one location to draw on financial resources elsewhere in the group (Campello, 2002). Interest expense sensitivity consequently reflects funding raised across the bank's geographic network and wholesale markets, whereas competition for a particular borrower depends on locally available lending alternatives. [3] A bank obtaining most of its funding in competitive markets may therefore exhibit high interest expense sensitivity while facing limited lending competition in some counties it serves. Conditioning on $\beta_b^{\exp}$ accounts for this measured funding-sensitivity channel when assessing the relationship between concentration and loan pricing.

2.1.3 U.S. Small Business Administration 7(a) loans

We use loan-level administrative records covering the universe of approvals under the SBA's 7(a) loan programme. Under the programme, participating lenders extend credit to eligible small businesses, and the SBA guarantees a portion of each loan. Interest rates are negotiated between lenders and borrowers, subject to applicable programme limits, and loans may carry either fixed or variable rates.

The records identify the lender by name and, for FDIC-insured institutions, certificate number. Loan characteristics include the approval date, total approved amount, SBA-guaranteed amount, initial interest rate at approval, fixed- or variable-rate indicator, and term in months. Borrower information includes the state, ZIP code, six-digit North American Industry Classification System (NAICS) code, and reported jobs supported. The last variable records the lender's estimate of jobs to be created or retained, as reported in the loan application.

These data allow us to compare loan pricing across fixed- and variable-rate contracts while accounting for observed loan and borrower characteristics. Linking lenders to the regulatory reports and SOD data connects individual loan terms to the lender's funding

[3] The relevance of locality for lending is particularly strong in the SBA 7(a) market. Di and Pattison (2020) report that 71% of loans in their matched 2017 sample were extended to businesses located within ten miles of a branch of their lender.

sensitivity, balance-sheet characteristics and exposure to local banking concentration.

2.2 Empirical Facts

We document two sets of facts about the pricing and allocation of fixed-rate credit. First, fixed-rate premiums are negatively related to banks' interest expense sensitivity, while greater local banking concentration is associated with a larger fixed–variable rate differential conditional on funding sensitivity. Second, fixed- and variable-rate loan stocks respond differently to monetary tightening: fixed-rate lending expands while variable-rate lending initially contracts, and the expansion of fixed-rate credit is smaller at banks with greater lending market power. Together, these patterns suggest that funding characteristics and lending competition jointly shape the price and quantity of borrowers' interest-rate protection.

2.2.1 Fixed-rate loan pricing and market concentration

We measure the fixed-rate premium as the difference between fixed- and variable-rate loan rates at origination. Figure 1 shows a negative relationship between this premium and bank interest expense sensitivity, β_b^{exp}. A one-standard-deviation increase in expense sensitivity is associated with a premium that is approximately 6.3 basis points lower.

This relationship is difficult to explain through earnings hedging alone. A bank whose funding costs respond little to interest rates can stabilise earnings by holding more fixed-rate loans. Attracting borrowers to these contracts requires offering a lower premium. Holding lending competition and borrower demand fixed, this mechanism therefore predicts lower premiums at banks with less rate-sensitive funding, and hence a positive premium–sensitivity relationship. The negative relationship in the figure suggests that funding sensitivity also covaries with other determinants of loan pricing. We examine lending-market concentration as one such determinant.

Using the SBA loan-level data, we relate origination rates to the bank's interest expense sensitivity and the branch-count HHI defined in Section 2.1.2. Conditioning on funding sensitivity allows us to examine the concentration–pricing relationship beyond differences in measured funding-cost sensitivity. For loan i of rate type $k \in \{F, V\}$, issued by bank b at time t, we estimate

$$\begin{aligned} r_{i,k,b,t} = \delta F_i + \alpha_\beta \beta_b^{exp} + \alpha_H \mathrm{HHI}_{b,t} + d_\beta F_i \beta_b^{exp} + d_H F_i \mathrm{HHI}_{b,t} \\ + X_i'\gamma + F_i X_i'\gamma_F + W_{b,t}'\psi + F_i W_{b,t}'\psi_F + \eta_{state,t} + \eta_{industry} + \varepsilon_i. \end{aligned} \tag{5}$$

Here $F_i = \mathbf{1}\{k = F\}$ indicates a fixed-rate loan. The vectors X_i and $W_{b,t}$ contain loan and bank characteristics, respectively: loan controls include the guaranteed share, jobs supported and term in months, while bank controls include asset size and the equity-to-assets ratio. Their interactions with F_i allow these characteristics to have different associations with

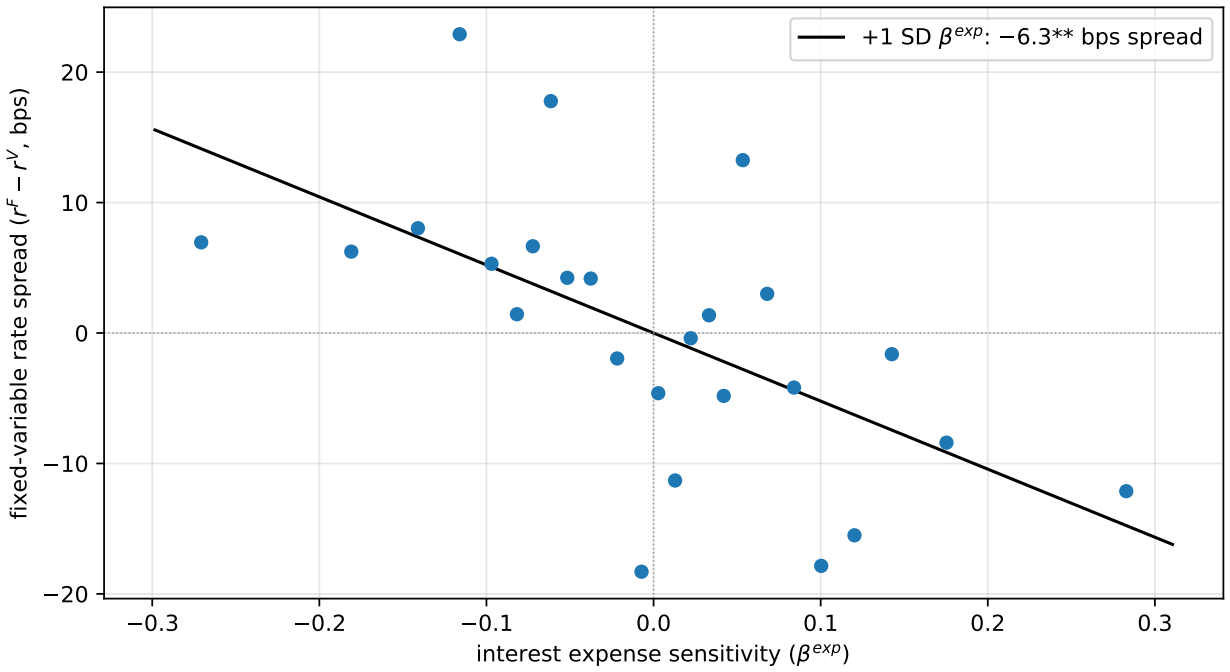


Figure 1: Bank interest expense sensitivity and the fixed-rate premium

Notes: The figure plots the fixed–variable origination-rate differential against bank interest expense sensitivity. Dots represent binned observations, and the solid line is the fitted relationship. The annotation reports the premium change associated with a one-standard-deviation increase in expense sensitivity. Sources: FFIEC 031 Call Reports and FR Y-9C consolidated financial statements for bank holding companies, and the Small Business Administration (SBA) 7(a) loan programme, 2010Q1–2024Q4.

fixed- and variable-rate pricing. The terms $\eta_{state,t}$ and $\eta_{industry}$ denote state-by-quarter and borrower-industry fixed effects. Standard errors are clustered by bank. The coefficient d_H measures how concentration is associated with the fixed–variable rate differential, whereas α_H captures its association with variable-rate pricing.

Table 1: Fixed-variable loan rate spread

Dependent variable: initial contract rate $r_{i,k,b,t}$ (%)	(1) OLS	(2) quarter, industry FE	(3) state×qtr, industry FE	(4) loan-level controls	(5) bank-level controls
Fixed-rate loan (F_i)	-0.109	-0.169	-0.200*	-1.939***	-1.824***
	(0.117)	(0.113)	(0.112)	(0.228)	(0.300)
Interest expense sensitivity ($\hat{\beta}_b$)	0.073	-0.121	-0.090	0.003	0.324
	(0.459)	(0.259)	(0.270)	(0.262)	(0.249)
Branch-count HHI ($H_{b,t}$)	-0.067	0.081	-0.382	-0.419	-0.247
	(1.009)	(0.484)	(0.457)	(0.441)	(0.428)
$F_i\times$ interest expense sensitivity	-0.405	-0.260	-0.306	-0.216	-0.104
	(0.269)	(0.261)	(0.260)	(0.250)	(0.291)
$F_i\times$ branch-count HHI	0.976**	1.010**	1.242***	0.974**	1.012**
	(0.489)	(0.482)	(0.466)	(0.442)	(0.443)
Loan-level characteristics (X_i, F_iX_i)	No	No	No	Yes	Yes
Bank-level characteristics ($W_{b,t}$, $F_iW_{b,t}$)	No	No	No	No	Yes
Industry FE	No	Yes	Yes	Yes	Yes
State × quarter FE	No	No	Yes	Yes	Yes
Observations	117,143	117,143	117,143	117,143	117,143
Bank-year cells	1,641	1,641	1,641	1,641	1,641
Banks	421	421	421	421	421
R^2	0.002	0.715	0.763	0.772	0.775

Standard errors clustered by banks in parentheses; *, **, ***: $p < 0.10$, 0.05, 0.01. Sample: SBA 7(a) Guaranty loans approved 2009Q4–2025Q4. The contract rate is winsorized at the 1st/99th percentiles within rate type; jobs, equity/assets and the HHI at the 1st/99th percentiles of the analysis sample.

Table 1 reports a positive and statistically significant fixed-rate–HHI interaction across all five specifications. In the preferred specification, Column 5, the coefficient is 1.012 with a standard error of 0.443. A 0.10 increase in bank HHI is therefore associated with a 10.1-basis-point larger fixed–variable origination-rate differential, holding funding sensitivity and the included characteristics constant. The corresponding coefficient for variable-rate loans is statistically indistinguishable from zero.

The fixed-rate interaction with interest expense sensitivity is negative but imprecisely estimated in Column 5: its coefficient is -0.104 with a standard error of 0.291. Thus the negative graphical relationship does not establish a separate, precisely estimated effect of funding sensitivity once these controls are included. The concentration interaction remains significant, indicating that measured funding sensitivity alone does not account for the relative pricing of fixed-rate credit. These conditional associations are consistent with banks in more concentrated lending markets having greater scope to charge for fixed-rate protection, although they do not isolate a causal effect of market concentration.

2.2.2 Fixed-rate and variable-rate lending

We next examine whether financing type and lending-market concentration also matter for the response of credit quantities to monetary policy. We use the monetary policy shock series of Jarociński and Karadi (2020) and report responses to a contractionary shock scaled to 100 basis points. The outcomes are stocks of outstanding fixed- and variable-rate loans, rather than new loan originations.

To examine heterogeneity across banks, let $l^k_{b,t}$ denote the stock of loans of rate type $k \in \{F, V\}$ held by bank b at time t. The local-projection specification is

$$\begin{aligned}\log l^k_{b,t+h} - \log l^k_{b,t-1} = \phi^k_h\big(\epsilon^{MP}_t \times \hat{\beta}^{exp}_b\big) + \theta^k_h\big(\epsilon^{MP}_t \times \mathrm{HHI}_{b,t-1}\big) \\ + \big(\epsilon^{MP}_t \times W_{b,t-1}\big)'\Gamma^k_h + Z'_{b,t-1}\Lambda^k_h + \alpha^k_{t,h} + \alpha^k_b + \varepsilon^k_{b,t,h},\end{aligned} \tag{6}$$

where h is the horizon in quarters and ϵ^{MP}_t is the monetary policy shock. The vector $W_{b,t-1}$ includes bank characteristics such as asset size and leverage, and $Z_{b,t-1}$ collects lagged bank controls. Bank fixed effects are denoted by α^k_b, while the horizon-specific time effects $\alpha^k_{t,h}$ absorb common macroeconomic conditions, including lagged macroeconomic controls. These time effects also absorb the component of the shock response common across banks. The interaction coefficients therefore identify response heterogeneity associated with funding sensitivity and concentration, conditional on the other included characteristics.

Panel (a) of Figure 2 shows markedly different responses by contract type. Fixed-rate lending rises after the tightening shock: its response reaches approximately 5.5% after four quarters and about 8% after ten quarters. Variable-rate lending initially contracts, with a response of roughly -5.5% after four to five quarters. It subsequently recovers, with the point estimate turning positive around the ninth quarter, although the longer-horizon estimates are less precise. The initial response therefore shifts the composition of outstanding lending towards fixed-rate credit.

Panel (b) shows that the expansion of fixed-rate lending is smaller at banks with greater lending market power, measured by bank-level HHI. The responses are similar on impact but diverge over subsequent quarters. At a ten-quarter horizon, the fixed-rate response is approximately 11% for banks with low lending market power, compared with about 4.5% for banks with high lending market power. The gap persists through the end of the twelve-quarter horizon. These point estimates complement the pricing evidence: banks in more concentrated markets charge higher relative fixed rates and display a weaker expansion of fixed-rate credit following monetary tightening.

Loan stocks reflect new lending as well as repayments and prepayments, and their responses also depend on borrower demand. The estimates therefore describe how credit composition changes across banks and contract types; identifying a separate loan-supply effect would require additional restrictions.

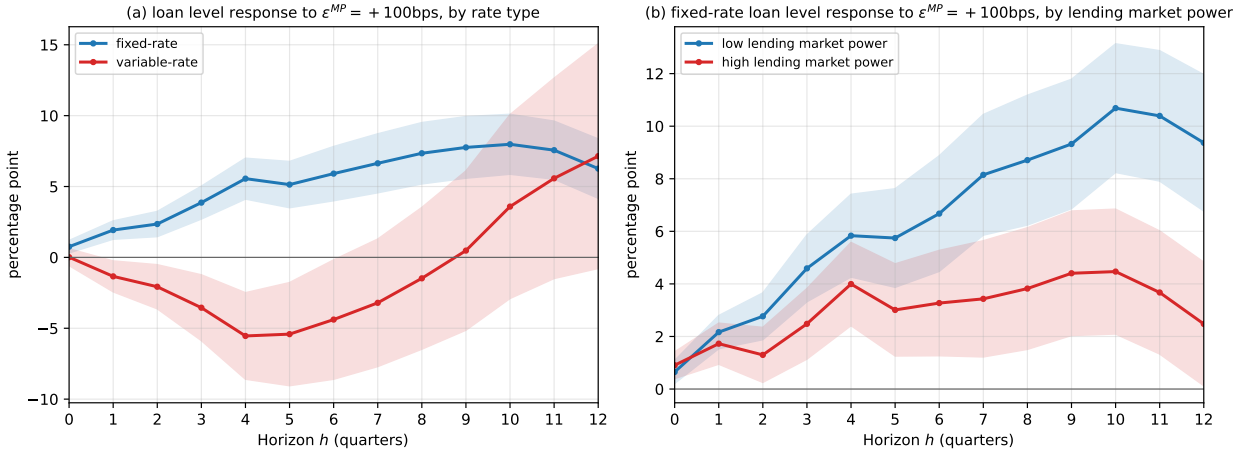


Figure 2: Fixed- and variable-rate lending following monetary tightening

Notes: Local-projection responses to a contractionary monetary policy shock from Jarociński and Karadi (2020), scaled to 100 basis points. Panel (a) compares fixed- and variable-rate loan stocks; Panel (b) compares fixed-rate loan stocks at banks with low and high lending market power, measured by bank-level HHI. Responses are expressed as 100 times cumulative log changes and can be read approximately as percentage changes in loan stocks. Horizons are in quarters, and shaded bands are 68% confidence intervals. Sources: FFIEC 031 Call Reports and FR Y-9C consolidated financial statements for bank holding companies, 2010Q1–2024Q4.

Taken together, the pricing and quantity evidence motivates a model in which banks' funding characteristics and lending incentives jointly determine the provision of fixed-rate protection. Stable funding makes fixed-rate loans useful for hedging bank earnings, encouraging banks to supply protection at lower premiums. Lending market power creates a competing incentive to restrict fixed-rate credit and preserve pricing margins. The higher premiums and weaker fixed-rate lending response observed at more concentrated banks are consistent with this second incentive. The model in Section 3 formalises the tradeoff, allowing funding and lending competition to move together and determining both borrowers' access to protection and the interest rate risk retained by banks.

3 Model

This section develops a two-date model in which banks balance profit stability against lending rents. When deposit costs respond little to interest rates, fixed-rate loans help stabilise earnings. Banks therefore have a reason to supply borrowers with protection at a low premium. Lending market power creates a competing incentive: expanding fixed-rate lending lowers the premium earned on the bank's other fixed-rate loans. The portfolio that best hedges earnings need not be the portfolio that maximises expected profits. We first characterise this tradeoff for given numbers of local deposit competitors and lenders, then use entry to explain how competition on both sides of the balance sheet moves together.

3.1 Setup

The economy has two dates. Loans originate at $t = 0$ and pay at $t = 1$. The only aggregate uncertainty is the benchmark interest rate:

$$r_1 = r_0 + \sigma Z, \qquad \Pr(Z = 1) = \Pr(Z = -1) = \tfrac{1}{2}, \qquad 0 < \sigma < r_0.$$

Thus $\mathbb{E}r_1 = r_0$ and $\mathrm{Var}(r_1) = \sigma^2$. All contracts are chosen before Z is realised. The parameters and distributions below are common knowledge.

Entrepreneurs. A unit mass of entrepreneurs each borrows one unit to finance a project with deterministic output. Let y denote output net of principal repayment, assumed sufficient to ensure participation and repayment in both states. Total lending is fixed at one. Borrowers choose between fixed-rate and variable-rate contracts without access to additional hedging instruments or deposit income.

Entrepreneurs have mean–variance preferences over terminal wealth and heterogeneous risk aversion, $\tilde{\theta} \sim U[0, 2\theta]$, with $\theta > 0$. Each knows its type. A fixed-rate loan charges $r^F = r_0 + s$, where s is the premium set at origination; a variable-rate loan charges $r^V = r_1$. Their certainty equivalents are

$$CE^F = y - r_0 - s, \qquad CE^V(\tilde{\theta}) = y - r_0 - \frac{\tilde{\theta}}{2}\sigma^2.$$

Borrowers choose a fixed rate when $\tilde{\theta} \geq \theta^* \equiv 2s/\sigma^2$. For an interior allocation, fixed-rate demand and its inverse are

$$L^F = 1 - \frac{s}{\theta\sigma^2}, \qquad s(L^F, \sigma) = \theta\sigma^2(1 - L^F), \qquad \theta^* = 2\theta(1 - L^F). \tag{7}$$

Demand is one for $s \leq 0$ and zero for $s \geq \theta\sigma^2$; equilibrium will be interior. Expanding fixed-rate lending requires attracting less risk-averse borrowers, who will buy protection only at a lower premium. Throughout, $s = r^F - \mathbb{E}r^V$ denotes the expected fixed-minus-variable premium.

Deposit and lending markets. There are $N \geq 1$ banks. In the analytical benchmark they are partitioned into $M = N/n$ local deposit markets, each with n banks; n and M are positive integers and $N = Mn$. Depositors compare banks locally, whereas borrowers can obtain loans from any of the N banks in the common lending market. Thus n counts banks per local market, M counts local markets, and N counts all banks. We initially treat n and M as primitives. Section 4 allows heterogeneous local markets and segments lending as well as deposits; its quantitative illustration groups markets by deposit beta.

Total deposits are one, divided equally across banks, each with predetermined loan capacity $1/N$. Depositors have increasing preferences over terminal wealth and an outside savings return $r_a > 0$. This exogenous reservation rate is known at origination and fixed across interest-rate states, bank counts, and market sizes. Its provider and pricing are outside the model. Households cannot directly access the wholesale benchmark r_1. We impose

$$r_0 - r_a > \max\{\sigma, \gamma\sigma^2\},$$

where $\gamma > 0$ is bank risk aversion, defined below. The first restriction ensures $r_1 > r_a$ in both states; the second supports the deposit-pricing incentives.

Deposit search and pricing. Each depositor may contact one of the $n-1$ rival local banks before a decision deadline. Independent contact opportunities arrive at rate λ per rival, and an independent exponential deadline also arrives at rate $\lambda > 0$. If contact precedes the deadline, the depositor compares the incumbent and the first rival; otherwise only the incumbent is available. Search is independent of Z and borrower types. With a continuum of accounts, the fraction facing a rival offer is

$$p(n) = \frac{\lambda(n-1)}{\lambda + \lambda(n-1)} = 1 - \frac{1}{n}. \tag{8}$$

Search opportunities are exogenous. Equal contact and deadline hazards make the link between bank counts and pass-through tractable; other relative hazards need not preserve the constant market-breadth threshold below.

Eligible banks observe an account's comparison set and quote personalised indexed contracts $r_a + \alpha(r_1 - r_a)$, with $\alpha \geq 0$. Depositors prefer larger α and remain with the incumbent when offers tie, including a tie with outside savings. Quotation is costless and separate fees are excluded. Banks can replace a lost deposit by borrowing at r_1, and invest a newly acquired surplus deposit at r_1. Households cannot access this wholesale market. It accommodates deposit movements against committed loan books, rather than allowing banks to expand lending or buy additional hedges.

In the deposit continuation, uncontested accounts receive r_a, contested accounts receive r_1, and all accounts remain with their incumbents. Competition removes the funding advantage on contested accounts. Appendix B.1 verifies the bidding incentives, including possible deviations to reduce earnings risk. Average funding costs and pass-through are

$$r^d = (1 - \beta^d) r_a + \beta^d r_1, \qquad \beta^d \equiv \frac{\partial r^d}{\partial r_1} = p(n) = 1 - \frac{1}{n}. \tag{9}$$

More local competitors expose more accounts to rival offers, making funding costs more responsive to rates. The exogenous r_a sets the funding-cost floor without directly changing

pass-through; a rate-sensitive outside return would change this conclusion. The construction uses personalised bids and observable comparison sets, rather than a Burdett–Judd posted-rate equilibrium.

Lending and bank preferences. Bank i chooses its fixed-rate portfolio share $l_i^F \in [0,1]$. Its fixed quantity and aggregate fixed lending are

$$q_i^F = \frac{l_i^F}{N}, \qquad L^F = \sum_{i=1}^{N} q_i^F = \frac{1}{N}\sum_{i=1}^{N} l_i^F.$$

The remainder of its book is lent at the variable rate. Banks commit to fixed quantities and compete in Cournot fashion, internalising $\partial s/\partial l_i^F = -\theta\sigma^2/N$. All borrowers face the same fixed premium, while banks take $r^V = r_1$ as given. Borrower types can be allocated across banks to fill their capacities.

With retained deposits, net interest earnings per unit of assets are

$$\begin{aligned}\pi_i &= l_i^F r^F + (1 - l_i^F) r^V - r^d \\ &= (1-\beta^d)(r_0 - r_a) + l_i^F s(L^F, \sigma) + (1 - \beta^d - l_i^F)\sigma Z.\end{aligned} \tag{10}$$

Principal repayments cancel. The sensitivity gap is

$$G_i \equiv \frac{\partial \pi_i}{\partial r_1} = (1 - l_i^F) - \beta^d, \tag{11}$$

so earnings variance is $\sigma^2 G_i^2$. The gap is the model counterpart to the difference between interest income and interest expense sensitivities in the empirical section. A positive gap means that higher rates raise bank earnings; a negative gap means that they lower earnings. Banks maximise

$$\max_{l_i^F \in [0,1]} \left\{ \mathbb{E}\pi_i - \frac{\gamma}{2} \operatorname{Var}(\pi_i) \right\}.$$

Throughout, γ applies to earnings per unit of assets.[4] Credit losses, capital requirements, prepayment, separate origination fees, and additional hedging instruments are excluded.

Timing. Comparison sets are realised and observed by eligible banks before the rate shock. Banks then choose fixed-loan quantities, anticipating the deposit continuation. The fixed premium clears the loan market and entrepreneurs select contracts. Eligible banks subsequently quote indexed deposit contracts, depositors choose their accounts, and wholesale funding accommodates any movement. All contracts settle after Z is realised. In the selected

[4] If a bank has asset size d_i and total earnings $\Pi_i = d_i \pi_i$, its total value is $d_i[\mathbb{E}\pi_i - \gamma \operatorname{Var}(\pi_i)/2] = \mathbb{E}\Pi_i - [\gamma/(2d_i)] \operatorname{Var}(\Pi_i)$. Risk tolerance is proportional to size. Holding dollar-profit risk aversion fixed as bank size changes would be a different model.

continuation all deposits are retained and wholesale positions are zero.

3.2 Equilibrium

For given n, N, banks choose portfolios taking rivals' quantities as given and anticipating optimal deposit bids after every feasible portfolio profile. Borrowers and depositors choose their preferred available contracts, and loan and funding balances clear. We select the deposit retention continuation above and focus on symmetric lending, with $l_i^F = L^F$ and $G = 1 - \beta^d - L^F$.

The second derivative of the bank's objective is $-\sigma^2(2\theta/N + \gamma) < 0$, so the objective is strictly concave in its own share. The symmetric first-order condition is

$$s = \underbrace{\frac{\theta\sigma^2 L^F}{N}}_{\text{Cournot term}} - \underbrace{\gamma\sigma^2 G}_{\text{marginal hedging benefit}}. \tag{12}$$

The two terms capture the bank's competing incentives. If funding costs barely change with rates while loan income remains rate-sensitive ($G > 0$), replacing variable-rate loans with fixed-rate loans stabilises earnings. This hedging benefit makes the bank willing to accept a lower premium for protecting borrowers. But attracting another fixed-rate borrower requires a lower premium on all fixed-rate loans the bank supplies. The Cournot term measures this loss of revenue on its other loans, which the bank weighs against the hedging benefit and income from the additional loan. These quantities and the common premium are chosen at origination; existing contracts are not subsequently repriced.

With lending power, the bank can therefore prefer to supply less protection and tolerate earnings fluctuations in order to earn higher expected profits. Stable funding gives it a reason to supply protection cheaply, while lending power rewards restricting that supply. This hedging argument applies while $G > 0$: once fixed lending exceeds the full hedge, $G < 0$ and additional protection increases the bank's earnings risk, requiring compensation. The exogenous r_a affects expected funding costs but, conditional on bank counts, neither marginal incentive in (12).

Proposition 1 (Equilibrium and earnings exposure)**.** *Conditional on the deposit retention equilibrium, there is a unique symmetric lending equilibrium. Let* $D = \theta(1 + 1/N) + \gamma$ *and* $\beta^d = 1 - 1/n$*. Then*

$$\begin{aligned} L^F &= \frac{\theta + \gamma(1-\beta^d)}{D} = \frac{\theta + \gamma/n}{D}, \\ s &= \theta\sigma^2 \frac{\theta/N + \gamma\beta^d}{D}, \qquad G = \frac{\theta[1 - (N+1)\beta^d]}{ND}. \end{aligned} \tag{13}$$

The allocation is interior, with $0 < L^F < 1$ *and* $0 < s < \theta\sigma^2$*. The sensitivity gap is positive,*

zero, or negative as β^d is below, equal to, or above $1/(N+1)$.

Proof. Combine (7) and (12) to obtain $DL^F = \theta + \gamma(1-\beta^d) > 0$. The difference between D and this numerator is $\theta/N + \gamma\beta^d > 0$, establishing interiority. Strict own concavity makes the first-order condition sufficient. The symmetric linear equation has one solution, while the symmetric all-zero and all-one portfolios fail the boundary optimality conditions. Substitution gives the premium and the gap. □

Two portfolio targets explain the allocation. Full earnings hedging requires $L_H = 1-\beta^d = 1/n$, while a risk-neutral bank chooses $L_C = N/(N+1)$. Equilibrium satisfies

$$L^F = \omega L_H + (1-\omega)L_C, \qquad \omega = \frac{\gamma}{D} \in (0,1).$$

When $L_H > L_C$, preserving lending rents leads banks to stop short of the full hedge: they retain $G > 0$ and forgo some profit stability. When $L_H < L_C$, earning premium income instead draws them beyond the full hedge, leaving $G < 0$. In both cases, banks accept earnings risk to raise expected profits relative to the perfectly hedged portfolio. Greater risk aversion raises the weight on L_H, but complete hedging occurs only when the two targets coincide.

3.3 Competition and the premium–beta relationship

Deposit and lending competition change different sides of this tradeoff. More responsive funding reduces the fixed-rate share needed to stabilise earnings, weakening banks' willingness to supply borrower protection. More lenders instead reduce each bank's incentive to restrict supply to preserve the premium. Holding the other margin fixed gives

$$s_{\beta^d} = \frac{\theta\gamma\sigma^2}{D} > 0, \qquad s_N = -\frac{\theta^2\sigma^2[\theta + \gamma(1-\beta^d)]}{N^2D^2} < 0. \tag{14}$$

Since $d\beta^d/dn = 1/n^2 > 0$, more local deposit competition alone raises the premium. A negative premium–beta relationship requires lending competition to increase enough to offset this funding effect. Derivatives interpolate bank counts; comparisons between actual configurations respect their integer restrictions.

To characterise joint changes, hold relative market breadth fixed:

$$M \equiv \frac{N}{n} \geq 1, \qquad N = Mn = \frac{M}{1-\beta^d}.$$

Here M is the number of local deposit markets accessible to borrowers, held fixed in this

comparison. Writing $g = \gamma/\theta$, substitution into (13) gives

$$\frac{s(\beta^d; M)}{\theta\sigma^2} = \frac{1 + (gM - 1)\beta^d}{1 + M(1 + g) - \beta^d}. \tag{15}$$

Proposition 2 (Market breadth and the premium slope)**.** *Along symmetric configurations with a fixed ratio $M = N/n$, the fixed premium is decreasing in deposit beta if*

$$M = \frac{N}{n} < \frac{\theta^2}{\gamma(\theta + \gamma)}, \tag{16}$$

increasing if the inequality is reversed, and constant at equality. The sign holds over $\beta^d \in [0, 1)$ and orders the feasible integer-count configurations.

Proof. Differentiating (15) at fixed M yields

$$\frac{ds}{d\beta^d} = \theta\sigma^2 \frac{M[gM(1 + g) - 1]}{[1 + M(1 + g) - \beta^d]^2}. \tag{17}$$

The denominator is positive, giving the result. □

When borrowers rely on a narrow lending market, entry can substantially reduce the rents banks preserve by restricting fixed lending. The resulting expansion of protection can outweigh the loss of the hedging incentive as funding becomes more rate-sensitive. When borrowers already access many lenders, there is less lending power left to erode, so the funding effect dominates. A negative slope is feasible for $M \geq 1$ only if $\gamma/\theta < (\sqrt{5} - 1)/2$. Figure 3 illustrates both regimes; the premium itself remains positive.

Price-taking lending. Let $N \to \infty$ while holding n, and hence beta, fixed. The Cournot term in (12) disappears and

$$s_\infty(\beta^d) = \frac{\theta\gamma\sigma^2}{\theta + \gamma}\beta^d. \tag{18}$$

Without the incentive to restrict supply, stable funding translates into cheaper protection: the premium falls to zero as $\beta^d \to 0$. For positive beta, a positive premium compensates banks for taking fixed lending beyond their full hedge. This limit holds deposit competition fixed; taking $n \to \infty$ at fixed M also sends beta to one. Deposit rents can survive price-taking lending because banks choose the composition of predetermined books.

Price, quantity, and risk. Because $L^F = 1 - s/(\theta\sigma^2)$, fixed-rate take-up rises with beta in the negative-slope regime and falls in the positive-slope regime. These are supply responses along unchanged borrower demand. Both deposit and lending competition reduce the sensitivity gap: $G_{\beta^d} = -\theta(1+1/N)/D < 0$ and $G_N = -\partial L^F/\partial N < 0$. Earnings variance

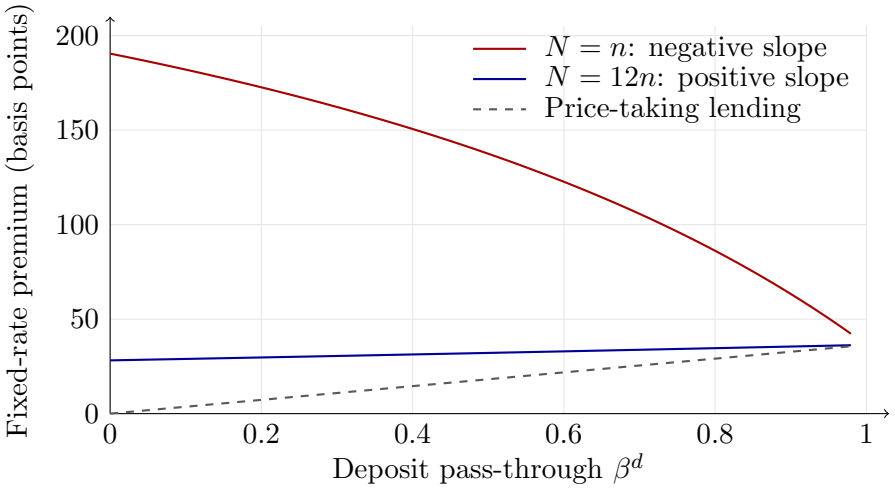


Figure 3: Fixed-rate premiums and deposit pass-through. The illustration uses $\theta = 1600$, $\gamma = 160$, and $\sigma = 0.005$, giving a breadth threshold of 9.09. Solid curves hold N/n fixed and interpolate bank counts; the dashed curve takes $N \to \infty$ at a fixed beta. The curves are theoretical illustrations, not estimates.

nevertheless depends on G^2, so a lower gap need not mean less earnings risk. Holding n, N fixed, the mean–variance specification implies that L^F and G are independent of σ, while $\partial s/\partial\sigma = 2s/\sigma > 0$.

3.4 Market size and endogenous entry

Entry provides a common source of variation in deposit and lending competition. Let $A > 0$ be both the mass of one-unit borrowers and total deposits, and fix the number M of local deposit communities, each supplying deposits A/M. A larger market offers more business over which to spread a bank's participation cost. Comparison opportunities remain uncongested, so market size changes pass-through through entry rather than directly through search.

Each community has a pool of potential local banks. A bank chooses whether to operate in its home deposit community and serve the common lending market. Participation costs $F > 0$, independent of beta and market size, and an inactive bank receives zero. The fee is paid from owners' outside resources, in terminal-value units. Conditional on participation, deposits are assigned equally among active local banks before search. This equal-sharing rule extends the predetermined funding allocation above; the model does not separately price the acquisition of an incumbent franchise. We focus on configurations in which every community has an active bank.

In a symmetric configuration with n banks per community, $N = Mn$ and each bank has assets $A/(Mn)$. Let L^F denote the fraction of total lending that is fixed, so its quantity is AL^F. Equation (7) and all per-asset continuation outcomes remain unchanged. Define the

value per unit of bank assets before participation costs by

$$W(n;M) = \frac{r_0 - r_a}{n} + L^F(n;M)s(n;M) - \frac{\gamma}{2}\sigma^2\left[\frac{1}{n} - L^F(n;M)\right]^2, \tag{19}$$

and value per bank per unit of market size by $v(n;M) = W(n;M)/(Mn)$. A participating bank's net value is $Av(n;M) - F$, accounting for both expected profits and earnings risk. The outside return matters for entry even though it leaves portfolios unchanged at given bank counts: $\partial W/\partial r_a = -1/n$. Raising r_a reduces deposit rents and hence the value of participation. The market-size comparisons below hold r_a fixed.

A single local market: exact integer entry. When $M = 1$, an additional bank changes the common count from n to $n+1$, and all banks reoptimise at the new deposit beta and lending competition. An active integer free-entry equilibrium is a count $n \geq 1$, together with the deposit and lending continuations above, satisfying

$$Av(n;1) \geq F \geq Av(n+1;1). \tag{20}$$

These conditions respectively ensure participation and rule out profitable entry. If $Av(1;1) < F$, the market is inactive; at equality both inactivity and one active bank satisfy weak entry incentives.

Proposition 3 (Market size and participation)**.** *Under the maintained parameter restrictions, $W(n;M) > 0$ and $W_n(n;M) < 0$ for every real $n \geq 1$ and $M \geq 1$. Consequently $v(n;M)$ is strictly decreasing and tends to zero.*

For $M = 1$, the integer entry conditions (20) *select a count that is nondecreasing in A, with at most two adjacent counts at indifference thresholds. Deposit beta and the number of lenders are therefore nondecreasing in market size. Premiums move across the selected counts with the sign in Proposition 2.*

For any fixed $M \geq 1$, the continuous symmetric participation equation

$$\frac{A}{Mn}W(n;M) = F \tag{21}$$

has a unique solution $n > 1$ whenever $AW(1;M)/M > F$. Along this approximation,

$$\frac{dn}{dA} = \frac{n/A}{1 - nW_n/W} > 0, \qquad \frac{d\beta^d}{dA} = \frac{1}{n^2}\frac{dn}{dA} > 0, \qquad \frac{dN}{dA} = M\frac{dn}{dA} > 0. \tag{22}$$

The premium–beta slope is again given by Proposition 2.

Proof. Appendix B.2 proves the value inequalities. Since v is continuous, strictly decreasing, and vanishes at infinity, the continuous equation has one interior solution under the

stated activity condition. For integer entry with $M = 1$, define $A_m = F/v(m;1)$. These thresholds are strictly increasing and unbounded, and count m satisfies (20) exactly when $A \in [A_m, A_{m+1}]$. Differentiating (21) gives (22); the beta and lender-count responses follow from $\beta^d = 1 - 1/n$ and $N = Mn$. □

Entry balances a larger customer base against smaller rents per customer. At unchanged bank counts, market growth raises each bank's volume of business and makes the fixed participation cost easier to cover. Entry then divides that business among more banks and reduces franchise value: more depositors receive competing offers, while more lenders compete to supply fixed-rate protection. These effects limit further entry. Market size therefore provides a common economic source of higher deposit beta and stronger lending competition, without requiring participation costs to depend on beta.

Endogenising participation does not change the basic economic forces governing the premium–beta relationship. Higher deposit beta reduces the fixed-rate share needed to hedge earnings, weakening banks' willingness to supply protection and pushing its premium up. Stronger lending competition works in the opposite direction: it weakens the incentive to restrict fixed-rate supply to preserve lending rents, pushing the premium down. Along symmetric configurations with fixed market breadth M, entry selects bank counts on the same premium–beta curve derived in Section 3.3. The threshold in Proposition 2 is therefore unchanged. When the lending-competition effect dominates, a larger market has higher beta but cheaper borrower protection; when the funding effect dominates, beta and the premium rise together. Entry explains why the two forms of competition move together, while their relative effects still determine the sign of the relationship.

Several local markets: unilateral entry. For $M > 1$, equation (21) is a symmetric continuous approximation, not the exact unilateral-entry condition. A single bank enters one community, changing its local count while leaving other community counts unchanged. The resulting banks differ in deposit beta and asset size. Their portfolios must be reoptimised before evaluating entry.

Let $\mathbf{n} = (n_1, \ldots, n_M)$ be a positive integer vector of local counts, with $N = \sum_{j=1}^{M} n_j$, and let $v_j(\mathbf{n})$ denote a bank's risk-adjusted continuation value in community j, per unit of aggregate market size. Appendix B.3 derives this continuation. An active integer entry equilibrium satisfies, for each community,

$$Av_j(\mathbf{n}) \geq F, \qquad Av_j(\mathbf{n} + \mathbf{e}_j) \leq F, \tag{23}$$

where $\mathbf{e}_j$ adds one bank to community j. Potential banks are local, so relocation across communities is not an additional action. The conditions are ex ante: choosing not to participate gives zero, while an additional entrant anticipates the reoptimised continuation. We do not

impose recovery of sunk costs after entry.

For a symmetric configuration, the first value in (23) is $v(n; M)$, but the entrant's value must be computed at $(n+1, n, \ldots, n)$, not at $(n+1, \ldots, n+1)$. Appendix B.4 illustrates both premium-slope regimes with configurations satisfying the unilateral-entry conditions.

4 Investment and the price of fixed-rate protection

This section extends Section 3 to endogenous investment, household saving and labour. Banks retain the same tradeoff between stabilising earnings and preserving lending rents. Fixed-rate protection now affects project scale, while an interbank market reallocates funding across local markets. We present the equilibrium conditions, calibration and financing-rate experiment here; Appendix C provides supporting derivations, the numerical solution method and sensitivity checks.

4.1 Environment and households

There are two dates and M local markets, indexed by $m = 1, \ldots, M$. Market m has n_m banks and a mass $\omega_m > 0$ of entrepreneurs, with $\sum_m \omega_m = 1$. Total banks are $N = \sum_{m=1}^{M} n_m$. In the equal-count benchmark, $n_m = n$ and $M = N/n$; with unequal counts, N/M is their average, not a common local count. Markets need not be symmetric. Unlike Section 3's common lending market, each market here has its own deposit and lending competition; borrowers obtain credit locally, while interbank funding moves across markets. The benchmark and deposit rates are

$$\begin{aligned} r_1 &= r_0 + \sigma Z, \qquad \Pr(Z = \pm 1) = \tfrac{1}{2}, \\ r_m^d &= (1 - \beta_m^d) r_a + \beta_m^d r_1, \qquad \beta_m^d = \frac{\zeta_m (n_m - 1)}{1 + \zeta_m (n_m - 1)}. \end{aligned} \tag{24}$$

The same banks take deposits and lend, but customers face different search frictions. Depositors encounter rival offers before a decision deadline; $\zeta_m > 0$ is the market-specific ratio of the contact rate per rival to the deadline rate. Borrowers seeking new credit can approach all n_m local banks. Deposit beta therefore reflects both bank counts and deposit search, while the Cournot term depends on the local lender count. Section 3's equal-hazard assumption is the special case $\zeta_m = 1$; Appendix C.1 derives the general mapping.

All quantities, prices and financial repayments are expressed in final-good units. The interbank benchmark is the real floating rate r_1, with r_0 its exogenous expected value over the financing horizon; r_a remains the state-independent real outside savings return. The deposit-pricing continuation is maintained rather than rederived with interbank borrowing. Market counts and search frictions are fixed in the financing-rate experiment.

Monopolistically competitive retailers operate at both dates. Date-0 retail supply prices are contracted in final-good units before an unexpected change in r_0; date-1 prices are flexible. These enforceable supply commitments implement the maintained current-price rigidity without changing the financial or resource accounts. We study a higher expected real financing rate, holding these contracts and uncertainty σ fixed. Investment, loan contracts, and employment at both dates are chosen after the change in r_0 but before the rate fixing; terminal wages and employment are enforceable commitments. The floating benchmark is fixed before terminal interest accrues, and all contracts settle at date 1.

A representative household family saves through fixed local deposit relationships. Of total deposits $\mathcal{D}$, market m receives $\mathcal{D}_m = \omega_m \mathcal{D}$, split equally across its banks: $d_m = \mathcal{D}_m / n_m$. Using the same weights for borrowers and deposits is a maintained restriction; quantities below are actual market totals, not per-market averages. The family cannot redirect saving to the highest-paying market. Its preferences are

$$\begin{aligned} \mathcal{U} &= u_\eta(C_0) - \frac{\chi_0 L_0^{1+\nu_0}}{1+\nu_0} + \delta_H \, \mathbb{E}\left[u_\eta(C_1) - \frac{\chi_1 L_1^{1+\nu_1}}{1+\nu_1} \right], \\ u_\eta(C) &= \frac{C^{1-\eta} - 1}{1-\eta}, \qquad u_1(C) = \log C. \end{aligned} \tag{25}$$

Here $0 < \delta_H < 1$ is the household discount factor and $\eta > 0$ is the common consumption CRRA coefficient at both dates. Labour-disutility scales and curvatures may differ by date; all are positive.

The household owns retailers and receives their profits Ω_t^R at both dates, taking dividends as given in its individual choices. Competitive intermediate producers earn zero profits at date 0. Writing $w = w_1$ and $R_z^d = \sum_m \omega_m [1 + r_m^d(z)]$, household budgets are

$$C_0 + \mathcal{D} = w_0 L_0 + \Omega_0^R, \qquad C_{1z} = w L_1 + R_z^d \mathcal{D} + \Omega_1^R, \quad z \in \{-1, 1\}. \tag{26}$$

Entrepreneurs and bank owners separately receive their terminal profits. Household saving and labour commitments satisfy

$$\begin{aligned} C_0^{-\eta} &= \delta_H \, \mathbb{E}[R_Z^d C_{1Z}^{-\eta}], \\ \chi_0 L_0^{\nu_0} &= w_0 C_0^{-\eta}, \qquad \chi_1 L_1^{\nu_1} = w \, \mathbb{E}[C_{1Z}^{-\eta}]. \end{aligned} \tag{27}$$

Saving depends on the value of consumption in both rate states. For committed labour, a lower wage discourages work, while lower terminal consumption raises the value of labour income.

4.2 Production, retail pricing and investment

A competitive final-good aggregator combines differentiated retail varieties with elasticity $\varepsilon > 1$. Retailers transform the homogeneous intermediate good one for one. Let p_t be its price relative to the final good. Under symmetric retail prices, competitive date-0 production and flexible date-1 retail pricing imply

$$\begin{aligned} p_0 &= w_0/A_0, \qquad p_1 = \bar{p} \equiv (\varepsilon - 1)/\varepsilon, \\ Y_0 &= A_0 L_0, \qquad Y_1 = A\ell(w)^{1-\alpha} I, \\ \Omega_0^R &= (1 - p_0)Y_0, \qquad \Omega_1^R = (1 - \bar{p})Y_1. \end{aligned} \tag{28}$$

The baseline satisfies $p_0 = \bar{p}$, making the contracted retail price optimal under initial information. After an unexpected financing-rate change, current retail supply prices stay fixed while p_0 and the realised markup adjust. Appendix C.1 derives these conditions. The supply commitment is a substantive restriction: allowing current retailers to reprice would impose a different equilibrium condition.

Entrepreneurs are price-taking intermediate producers with a common distribution F_θ of absolute risk aversion. The quantitative specification assumes $\log \tilde{\theta} \sim N(\log \theta - \tau^2/2, \tau^2)$: θ denotes mean risk aversion and τ controls dispersion. There is no atom of risk-neutral borrowers. They borrow the entire investment cost k through a fixed-rate contract $r_m^F = r_0 + s_m$ or a floating-rate contract $r^V = r_1$. A project produces $Ak^\alpha e^{1-\alpha}$ intermediate goods and incurs expansion costs $\kappa k^2/2$ in terminal final goods. Here e denotes project employment; n_m is reserved for bank counts. Capital fully depreciates. Optimising committed employment gives

$$\begin{aligned} e &= \ell(w)k, \qquad \ell(w) = \left[\frac{(1-\alpha)\bar{p}A}{w}\right]^{1/\alpha}, \\ a(w) &= \alpha\bar{p}A\ell(w)^{1-\alpha} - 1, \qquad \mu(w) = a(w) - r_0. \end{aligned} \tag{29}$$

The subtraction of one accounts for principal repayment. Committed wages make operating surplus nonstochastic, preserving the investment problem conditional on w. Under mean–variance preferences, optimal scale and the fixed-contract cutoff are

$$\begin{aligned} k_F(s_m) &= \frac{\mu - s_m}{\kappa}, \qquad & k_V(\tilde{\theta}) &= \frac{\mu}{\kappa + \tilde{\theta}\sigma^2}, \\ \theta^*(s_m) &= \frac{\kappa}{\sigma^2}\left[\left(\frac{\mu}{\mu - s_m}\right)^2 - 1\right]. \end{aligned} \tag{30}$$

These expressions apply on the positive-premium, mixed-contract branch. Types $\tilde{\theta} \geq \theta^*(s_m)$ choose fixed financing. Protection allows a given entrepreneur to undertake a larger project; a higher premium reduces investment through both project scale and switching into floating finance.

4.3 Banks and the price of protection

Within each market, its n_m banks choose fixed lending strategically, taking local deposits and aggregate wages as given. Floating loans and signed interbank positions x_{im} both pay r_1; $x_{im} > 0$ denotes lending and $x_{im} < 0$ borrowing. There are no interbank spreads or borrowing limits, and no outside fixed-rate hedge. Let $l^F_{im} = q^F_{im}/d_m$ and $G_{im} = 1 - \beta^d_m - l^F_{im}$. The bank's balance sheet and earnings per unit of initial deposits are

$$\begin{aligned} q^F_{im} + q^V_{im} + x_{im} &= d_m, \\ \pi_{im} &= (1 - \beta^d_m)(r_0 - r_a) + l^F_{im} s_m + G_{im}\sigma Z. \end{aligned} \tag{31}$$

The bank maximises $\mathbb{E}\pi_{im} - \gamma(r_0)\,\mathrm{Var}(\pi_{im})/2$, with

$$\gamma(r_0) = \bar{\gamma}\exp\{\xi(r_0 - \bar{r}_0)\}, \qquad \bar{\gamma} > 0, \quad \xi \geq 0.$$

Here $\bar{r}_0$ is the baseline rate. The schedule captures an increase in the effective cost of earnings risk when rates rise, for example through reduced risk-bearing capital following losses on legacy assets. This is a reduced-form risk-capacity channel, not a model of bank capital or an additional resource loss. A deterministic wealth loss alone would have no portfolio effect under constant mean–variance preferences. The case $\xi = 0$ recovers constant bank risk aversion.

With interbank borrowing, the coefficient is normalised by initial deposits rather than gross assets, and l^F_{im} may exceed one. Let $s_m(Q;\mu) = s(Q/\omega_m;\mu)$ be market m's inverse fixed-credit demand, where s is inverse demand for a unit borrower mass. Symmetry within each market, without symmetry across markets, gives

$$s_m = \underbrace{-\frac{Q^F_m}{n_m} s_{m,Q}(Q^F_m;\mu)}_{\text{Cournot term}} \underbrace{-\,\gamma(r_0)\sigma^2\left(1 - \beta^d_m - \frac{Q^F_m}{\mathcal{D}_m}\right)}_{\text{marginal hedging benefit}}. \tag{32}$$

Stable funding encourages banks to supply protection, but expanding fixed lending reduces the premium earned on their other fixed loans. Interbank trading reallocates funding without removing this tradeoff. Lognormal heterogeneity need not give concave inverse demand. We check bank optimality and conditional lending stability and follow the equilibrium continuously from the baseline; Appendix C.3 describes these checks. Global uniqueness is not claimed.

4.4 Aggregation and equilibrium

Let $\theta_m^* = \theta^*(s_m)$ and $f_m^F = 1 - F_\theta(\theta_m^*)$ be local fixed-contract take-up. Market credit and investment are

$$\begin{aligned} Q_m^F &= \omega_m f_m^F \frac{\mu - s_m}{\kappa}, \qquad Q_m^V = \omega_m \int_0^{\theta_m^*} \frac{\mu}{\kappa + t\sigma^2} \, \mathrm{d}F_\theta(t), \\ I_m &= Q_m^F + Q_m^V. \end{aligned} \tag{33}$$

The interbank market is closed and there is no outside asset: $B^V = 0$. Define $X_m = \sum_{i=1}^{n_m} x_{im}$ and the aggregate second moment of investment $J_2 = \sum_m \omega_m \int_0^\infty k_m(t)^2 \, \mathrm{d}F_\theta(t)$. Let C_{1z}^E and C_{1z}^B denote aggregate terminal consumption of entrepreneurs and bank owners; C_{1z} remains household consumption. Market clearing requires

$$\begin{aligned} I &= \sum_{m=1}^M I_m = \mathcal{D}, & X_m &= \mathcal{D}_m - I_m, \quad \sum_m X_m = 0, \\ Y_0 &= C_0 + I = A_0 L_0, & L_1 &= \ell(w) I, \\ Y_1 &= C_{1z} + C_{1z}^E + C_{1z}^B + \frac{\kappa}{2} J_2, & z &\in \{-1, 1\}. \end{aligned} \tag{34}$$

The date-1 resource cost is the expansion cost; principal and interest are transfers, and fully depreciated capital has no terminal recovery. Retail profits accrue to households and must not be added again as separate consumption. Appendix C.4 verifies the statewise cancellation of loan, deposit and interbank payments. Funding accounts concern one project cohort, rather than identifying deposit stocks with annual investment flows. The aggregate fixed-credit share is $L^{F,\mathrm{agg}} = \sum_m Q_m^F / I$, whereas borrower take-up is $f^{F,\mathrm{agg}} = \sum_m \omega_m f_m^F$.

Definition 1 (Investment and lending equilibrium)**.** *Fix primitives, including deposit search $\{\zeta_m\}$, market counts and sizes $\{n_m, \omega_m\}_{m=1}^M$, the real-rate distribution, and inherited retail supply contracts. An equilibrium consists of household consumption $C_0, \{C_{1z}\}$, deposits $\mathcal{D}$ and labour L_0, L_1; wages w_0, w, intermediate prices p_0, p_1, output and retail dividends; entrepreneur contracts, investment and employment; local premiums $\{s_m\}$; bank portfolios $\{q_{im}^F, q_{im}^V, x_{im}\}$; and terminal owner consumption, such that:*

1. *Households maximise* (25) *subject to* (26)*, taking prices, dividends and the deposit allocation rule as given.*

2. *Entrepreneurs optimise local financing, project scale and committed employment. Intermediate producers, retailers and the final-good aggregator optimise subject to inherited current supply prices and flexible terminal pricing.*

3. *Banks play a Cournot equilibrium in each local fixed-credit market, taking deposits, wages and rival quantities as given. Banks within market m are symmetric, with $q_{im}^F =$*

Q_m^F/n_m *and* $q_{im}^V = Q_m^V/n_m$*; deposit returns follow* (24)*.*

4. *Loan and bank balance sheets clear, and goods, labour and interbank markets satisfy* (34) *in both rate states. Consumption and repayments are feasible.*

Retail supply contracts are optimal under the initial information used to construct the baseline. After a change in r_0*, those contracts, bank counts, search frictions and the parameters* $(\bar{\gamma}, \xi)$ *remain fixed; investment, financing and labour commitments precede the rate fixing.*

Markets may differ in bank counts, deposit betas, size, premiums and net interbank positions. Common technology and household preferences retain the scalar aggregate solution in Appendix C.4: one outer root with M conditional local pricing calculations on the selected branch. The three beta groups used below are a quantitative approximation to this general market structure.

4.5 Calibration and the financing-rate experiment

We calibrate three representative local markets with equal borrower and deposit weights, $\omega_m = 1/3$. These weights describe the quantitative exercise rather than the percentile widths of the empirical beta groups. Financial moments discipline borrower heterogeneity, effective lender counts, deposit search frictions and the bank risk-capacity schedule. Technology and household preferences provide the real-side benchmark. Table 2 reports the parameter values, and Table 3 compares the financial targets with the model's predictions.

Real-side benchmarks and units. The experiment concerns one fully financed project cohort, not an accumulated capital stock. Rates and discounting refer to the same financing period; numerical values use an annual-rate convention. Full depreciation is a terminal project assumption, not an estimate of annual depreciation of aggregate capital. An empirical investment measure would distinguish newly financed projects from refinancing and existing-asset transfers.

We set $\alpha = 1/3$, giving a two-thirds labour share of intermediate revenue, and use the same consumption curvature $\eta = 0.8$ at both dates. The corresponding intertemporal elasticity is 1.25. The labour curvatures $\nu_0 = \nu_1 = 2$ give an intensive-margin Frisch elasticity of 0.5, consistent with the benchmark synthesis in Chetty, Guren, Manoli and Weber (2011). The discount factor $\delta_H = 0.96$ and retail elasticity $\varepsilon = 6$ are maintained benchmarks, not fitted financial moments. The flexible retail markup is $\varepsilon/(\varepsilon - 1) = 1.20$. Appendix C.5 considers a log-utility alternative.

We set the project-cost coefficient to $\kappa = 0.10$ and baseline surplus to $\mu^b = 0.0477243$. The latter implies a gross operating return after wages but before expansion costs of $1 + \bar{r}_0 + \mu^b = 1.0548243$. These values anchor project scale and returns; they are not measured

technology estimates. Given fitted borrower demand, they imply $I^b = \mathcal{D}^b = 0.473768$. We normalize baseline hours to $L_0^b = L_1^b = 1$. To reproduce these levels, first set $\ell^b = 1/I^b$ and recover

$$A = \frac{1 + \bar{r}_0 + \mu^b}{\alpha \bar{p} (\ell^b)^{1-\alpha}}, \qquad w^b = (1-\alpha)\bar{p} A (\ell^b)^{-\alpha}, \qquad \chi_1 = \frac{w^b \mathbb{E}[(C_1^b)^{-\eta}]}{(L_1^b)^{\nu_1}}. \tag{35}$$

The Euler equation determines C_0^b. We then set $A_0 = C_0^b + I^b$ and $\chi_0 = \bar{p} A_0 / [(L_0^b)^{\nu_0} (C_0^b)^{\eta}]$, as derived in Appendix C.4. Thus the baseline labour conditions and initial retail-pricing condition hold exactly. These parameters are then fixed across all rate counterfactuals. Hours normalizations do not represent independently estimated hours targets.

An empirical production calibration would replace these anchors with project output and labour costs, investment levels and investment-cost elasticities. Wages and hours, together with household optimality and markups, discipline labour-disutility scales; consumption allocations discipline discounting. These moments must be imposed jointly, rather than treating every baseline ratio as a separate free target. In particular, borrower demand depends on $\tilde{\theta}\sigma^2/\kappa$, so revising project-cost curvature requires refitting financial parameters. Current preferences and technology provide a coherent benchmark, not evidence that the real-side response has been estimated.

Financial moments and parameter recovery. The baseline financial targets are deposit betas $(0.35, 0.46, 0.69)$, premiums $(24, 15, 3)$ basis points and new-loan fixed-volume shares $(14.8, 18.5, 23.6)\%$. Search frictions may differ across markets, and lending concentration is inferred rather than matched to measured HHI levels. The calibration takes these moments as given, without re-estimating them or quantifying their sampling uncertainty. Stock shares and borrower counts cannot substitute for new-loan volume shares. The response targets are a 3-basis-point decrease in the equally weighted premium, $\bar{s} = M^{-1} \sum_m s_m$, and a 1.30-percentage-point increase in the aggregate fixed-flow share, $L^{F,\text{agg}}$, following a 50-basis-point increase in the expected real rate, holding uncertainty fixed.

First, conditional on the three baseline premiums and the real-side anchors, we fit (θ, τ) by equally weighted squared errors in the three regional fixed-flow shares, expressed in percentage points. The shares are overidentifying moments and are only approximately matched. Let $q_m^b = Q_m^{F,b}/\omega_m$ denote baseline fixed lending per unit borrower mass, and let s_q be the derivative of the corresponding inverse demand $s(q; \mu^b)$. For any candidate $\bar{\gamma}$, the baseline pricing conditions recover effective lending concentration, $HHI_m = 1/n_m$, as

$$HHI_m(\bar{\gamma}) = \frac{s_m^b + \bar{\gamma}\sigma^2 G_m^b}{a_m^b}, \qquad a_m^b = -q_m^b s_q(q_m^b) > 0, \qquad G_m^b = 1 - \beta_m^d - \frac{q_m^b}{\mathcal{D}^b}. \tag{36}$$

We require $0 < HHI_m < 1$ and set $n_m = 1/HHI_m$. The deposit-beta mapping in (24) then gives $\zeta_m = \beta_m^d / [(1-\beta_m^d)(n_m - 1)]$. The total lender count $N = \sum_m n_m$ is derived, not

Table 2: Exogenous parameters of the quantitative benchmark

Parameter	Value	Discipline
$\bar{r}_0, r_a, \sigma$	$0.0071, 0.0010, 0.0050$	Baseline real rates; maintained two-state uncertainty
M; ω_m	3; 1/3	Three representative groups; equal borrower/deposit weights
θ	4.886×10^{12}	Common mean absolute risk aversion; conditional share fit
τ	7.8568	Standard deviation of log risk aversion; conditional share fit
$\bar{\gamma}$	17.8205	Joint price and fixed-flow response targets
ξ	58.9647	Joint price and fixed-flow response targets
n_1, n_2, n_3	3.513, 3.965, 5.228	Baseline premium conditions; effective lender counts
$\zeta_1, \zeta_2, \zeta_3$	0.214, 0.287, 0.526	Deposit betas $0.35, 0.46, 0.69$
α	1/3	Two-thirds labour share of intermediate revenue
η	0.8	Common CRRA; intertemporal elasticity 1.25
ν_0, ν_1	$2, 2$	Intensive-margin Frisch elasticity 1/2
δ_H	0.96	Benchmark discount factor over the financing period
ε	6	Benchmark flexible retail markup of 1.20
κ	0.10	Project-scale benchmark; not separately estimated
A_0, A	2.3323, 2.3078	Baseline hours normalizations and project-return anchor
χ_0, χ_1	1.1838, 0.6316	Baseline household labour FOCs and initial retail pricing

Notes: Values are inputs to each rate experiment. Effective lender counts and search frictions are calibrated parameters even though they are recovered from other parameters and moments. $N = \sum_m n_m$ and equilibrium prices, quantities, wages and shares are not additional exogenous parameters. The common lognormal median is approximately 0.1925; its very large mean reflects the fitted upper tail. Risk aversion is measured in the model's wealth units. ξ uses rates in decimals.

an additional free parameter. Premium levels therefore identify a schedule of concentration indices conditional on $\bar{\gamma}$, not $\bar{\gamma}$ alone.

Next, we solve jointly for $(\bar{\gamma}, \xi)$ using

$$\begin{aligned} \frac{1}{3}\sum_{m}\left[s_m(\bar{r}_0 + 0.005) - s_m(\bar{r}_0)\right] &= -0.0003, \\ L^{F,\text{agg}}(\bar{r}_0 + 0.005) - L^{F,\text{agg}}(\bar{r}_0) &= 0.013. \end{aligned} \tag{37}$$

For every candidate, its calibrated lender counts and search frictions remain fixed during the shock, and the same baseline household and production parameters apply. The calibration yields $\bar{\gamma} = 17.82$, $\xi = 58.96$ and $\gamma(\bar{r}_0 + 0.005) = 23.93$. Changes to household preferences or technology require recalibrating these financial parameters.

Table 3: Financial targets and model fit

Moment	Target	Model
Premium, group 1 (bp)	24.00	24.00
Premium, group 2 (bp)	15.00	15.00
Premium, group 3 (bp)	3.00	3.00
Fixed-flow share, group 1 (%)	14.80	15.65
Fixed-flow share, group 2 (%)	18.50	17.47
Fixed-flow share, group 3 (%)	23.60	23.80
Mean premium response (bp)	−3.00	−3.00
Aggregate fixed-flow response (pp)	1.30	1.30

Notes: Premiums are in basis points; shares are percentages of new loan volume; response shares are percentage-point changes. Betas match exactly through market-specific search frictions. Baseline premiums and the two response targets match exactly, while regional fixed-flow shares are fitted approximately. These targeted responses are not held-out validation.

Two moments for two parameters do not guarantee identification. We check that the local response Jacobian has full rank, but its columns are close to collinear: small changes in response targets can materially move the parameter estimates. The lognormal fit also has an extreme upper tail, with $\tau \simeq 7.86$ and mean risk aversion about 4.89×10^{12}. This is a limitation of the common-demand calibration, not an empirical claim about average borrower preferences. Alternative distributions and uncertainty in measured moments should be assessed before treating the coefficients as structural estimates.

Interpretation of the risk-capacity channel. The calibrated schedule describes the effective cost of bank earnings risk. If this coefficient were inversely proportional to risk-bearing capital per unit of deposits, a rise from $\bar{\gamma}$ to γ_1 would correspond to a capacity decline of $1 - \bar{\gamma}/\gamma_1$. Such a capital interpretation requires independent balance-sheet evidence; no capital destruction is inserted into goods-market clearing. For banks whose residual exposure

G is positive, reduced capacity increases the value of fixed-rate protection. Lending rents continue to limit its supply. Section 5 examines changes in risk-bearing capacity at a fixed expected financing rate.

The financing-rate experiment. Figure 4 follows the verified equilibrium as r_0 rises from 0.71% to 1.21%, keeping household and technology parameters, bank counts, search frictions, and $\sigma = 0.005$ fixed. The fixed-flow share rises from 18.99% to 20.29% and the mean premium falls from 14 to 11 basis points. Fixed lending grows by 6.15%, whereas floating lending changes by -2.25%; aggregate investment changes by -0.66%. Employment changes by -0.59% at date 0 and -0.001% at date 1. Cheaper protection supports fixed-financed projects, but does not offset the aggregate contraction from more expensive financing. The constant-γ comparison holds all baseline parameters fixed and isolates the additional risk-capacity channel. These are comparative statics across separate rate experiments, not an impulse-response time path. Appendix C.5 reports numerical checks and sensitivity to household preferences.

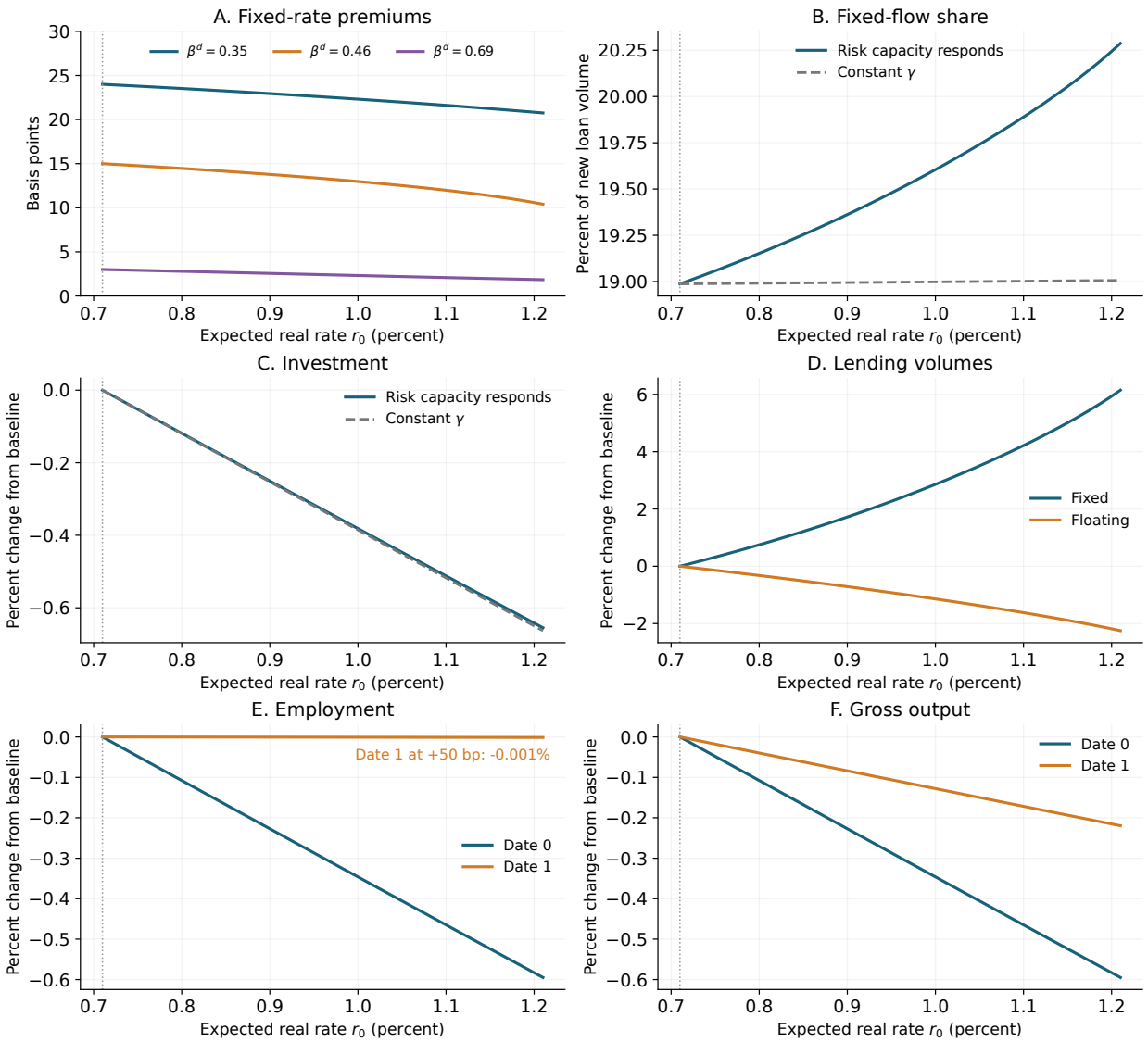


Figure 4: Real financing rates, loan composition and activity

Notes: The vertical dotted line marks $\bar{r}_0 = 0.71\%$. Solid curves use the calibrated schedule $\gamma(r_0)$; dashed curves in panels B and C hold $\gamma = \bar{\gamma}$. Uncertainty and all other calibrated primitives remain fixed. Premiums are fixed rates minus the expected floating benchmark. Fixed-flow shares use new loan volume; the response target for the mean premium uses equal market weights. Percentage changes are relative to the common baseline. The plotted equilibria pass market-clearing, bank-deviation and conditional lending-stability checks; global uniqueness is not asserted.

5 Applications

Greater bank risk-bearing capacity need not translate into a larger supply of interest-rate protection for borrowers. A bank that can tolerate more earnings volatility has less reason to use fixed-rate lending to hedge its funding exposure. With lending market power, it can instead restrict protection and preserve lending rents. This section illustrates that channel and its implications for investment, and discusses diversification and anticipated public support as possible sources of greater effective risk-bearing capacity.

Let $c > 0$ index capacity, with $c = 1$ at the calibrated baseline. Holding the expected financing rate at $\bar{r}_0$, the bank's objective becomes

$$\mathbb{E}\pi_{im} - \frac{\bar{\gamma}}{2c}\,\mathrm{Var}(\pi_{im}). \tag{38}$$

Higher c lowers the effective cost of earnings risk. We retain the mean–variance preferences, lognormal borrower distribution, technologies and household preferences of Section 4. Rates (r_0, r_a), uncertainty σ, deposit search and lender counts remain fixed. The experiment isolates changes in effective risk tolerance at the calibrated funding and competition parameters.

To study the short-run quantity response, terminal wages and household availability are contracted before an unexpected change in c. Firms subsequently choose employment at the inherited wage $\bar{w}$, and households supply the contracted hours demanded. Thus $\mu = \mu(\bar{w})$ remains fixed and $L_1 = \ell(\bar{w})I$. Relative to Section 4, the terminal household labour-supply condition is replaced by this enforceable availability commitment; household saving and current labour remain optimally chosen. Loan, funding and goods markets continue to clear, with $I = \mathcal{D}$. At $c = 1$ the original calibration is recovered exactly.

The local pricing condition is

$$s_m = -\frac{Q_m^F}{n_m} s_{m,Q} - \frac{\bar{\gamma}}{c}\sigma^2 \underbrace{\left(1 - \beta_m^d - \frac{Q_m^F}{\mathcal{D}_m}\right)}_{G_m}. \tag{39}$$

Banks retain positive exposure G_m along the reported equilibrium path: fixed loans hedge the floating income supported by relatively stable funding. An increase in capacity reduces the value of that hedge. Banks become less willing to lower the premium on their existing fixed loans to attract additional borrowers, so they supply less protection at higher premiums. Their market power has not increased; their willingness to sacrifice lending rents for earnings stability has fallen.

Figure 5 compares lower, baseline and higher dispersion of borrower risk aversion at a fixed mean θ. We retain $\log\tilde{\theta} \sim N(\log\theta - \tau^2/2, \tau^2)$ and set $\tau = (0.99, 1, 1.01)\bar{\tau}$, where $\bar{\tau} = 7.8568$, holding all other parameters and the inherited wage fixed. Premiums and fixed-loan shares are shown in levels; investment and fixed lending are measured relative to each distribution's own $c = 1$ equilibrium. Investment also equals total lending.

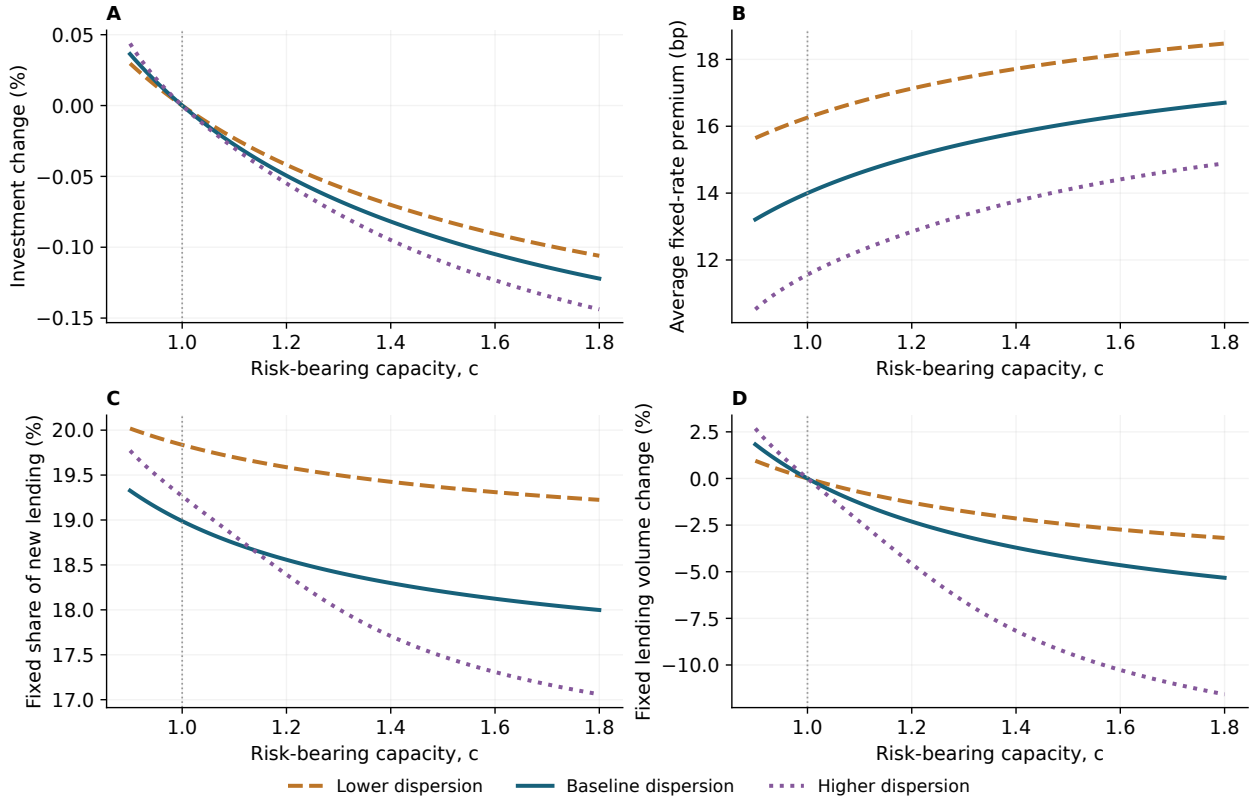


Figure 5: Bank risk-bearing capacity, borrower protection and investment

Notes: Capacity satisfies $\gamma_c = \bar{\gamma}/c$, with $\bar{\gamma} = 17.8205$. Panels A and D show percentage changes in investment (also total lending) and fixed lending relative to each distribution's own $c = 1$ equilibrium. Panels B and C show the equally weighted mean fixed-rate premium and aggregate fixed share of new lending in levels. Mean risk aversion is fixed, with $\tau = (0.99, 1, 1.01)\bar{\tau}$ and $\bar{\tau} = 7.8568$. The inherited terminal wage, $r_0 = 0.71\%$, $r_a = 0.10\%$, $\sigma = 0.50\%$ and other parameters are unchanged. Curves follow the baseline-connected equilibria on $[0.9, 1.8]$ and pass bank-deviation and market-clearing checks. This local comparison stays above the higher-dispersion turning point near $c = 0.8603$.

The blue curves show the calibrated benchmark. Raising capacity from 1 to 1.8 reduces investment by 0.122%, raises the mean fixed premium by 2.70 basis points and lowers the fixed-loan share by 0.99 percentage points. Fixed lending falls by 5.32%, while floating lending rises by 1.10%: contract substitution cushions the investment contraction. Expected bank profits and the standard deviation of earnings rise by 1.00% and 3.06%, respectively. Banks accept greater earnings risk to preserve lending rents, while the inherited wage prevents lower labour costs from offsetting the reduction in protection.

Greater borrower dispersion amplifies this response locally. At $c = 1.8$, investment falls by 0.106% under lower dispersion and 0.144% under higher dispersion; premiums rise by 2.22 and 3.33 basis points, and fixed-loan shares fall by 0.61 and 2.20 percentage points. Holding mean risk aversion fixed does not hold protection demand fixed. Greater dispersion places more borrowers at low risk aversion while concentrating risk aversion in the upper tail, changing both contract switching and the slope of inverse demand faced by banks. In this calibration, it strengthens the shift towards floating finance when banks become less willing to hedge. This is a statement about capacity responses: the initial fixed-loan share is not monotone in dispersion.

The exercises highlight how bank and borrower risk bearing interact. A more diversified portfolio can free risk-bearing capital or spread the relevant exposure across a larger capital base, raising effective capacity c. The link between bank risk management, capital allocation and loan pricing is emphasised by Froot and Stein (1998). Here, improved capacity allows banks to retain more risk themselves and rely less on fixed-rate lending as a hedge. The resulting loan portfolio reflects both their ability to bear risk and their incentive to earn lending rents.

Anticipated government support offers another application. Bailout expectations can change banks' choices before distress occurs (Chari & Kehoe, 2016). When credible support lowers the effective cost of retained earnings risk, the capacity channel predicts higher fixed-rate premiums and a shift towards floating lending. This identifies a pricing and portfolio response that can accompany the funding and recapitalisation effects of public support.

The central lesson is that strengthening banks' capacity to bear risk can reduce the protection they offer borrowers. Floating finance absorbs much of the adjustment, but borrowers who lose protection also reduce project scale, so total investment falls. Borrower heterogeneity governs how strongly these financial choices transmit to production: greater dispersion amplifies the response in this calibration. Evaluating diversification or support policies therefore calls for considering the terms and composition of lending alongside bank resilience; overall welfare also depends on the gains from resilience and any policy costs.

6 Conclusion

This paper shows how relative market power in funding and lending shapes banks' interest rate risk and monetary transmission. We document a novel pricing fact: banks with less rate-sensitive funding charge higher fixed–variable loan premiums, even though stable funding makes fixed-rate lending an attractive earnings hedge. Greater lending concentration is associated with higher premiums conditional on funding sensitivity and a weaker expansion of fixed-rate loan stocks following monetary tightening. These findings suggest that funding characteristics alone cannot explain the price and supply of borrower protection.

Our model connects these facts through a tradeoff between expected earnings and earnings risk. Banks can raise expected earnings by restricting fixed-rate lending and sustaining a larger premium over variable-rate loans, at the cost of forgone hedging and potential losses following adverse rate movements. Relative funding and lending market power determines how far banks depart from the full earnings hedge and whether earnings rise or fall when rates increase. Entry links competition on both sides of the balance sheet; when its lending effect dominates, more rate-sensitive funding is associated with cheaper fixed-rate protection.

The investment extension links this pricing mechanism to real activity. Calibrated to lower premiums and a higher fixed-rate share following an increase in the expected real financing rate, the model implies that fixed lending expands while aggregate investment contracts. Cheaper protection supports fixed-financed projects, but does not offset higher overall financing costs. Banks' risk management therefore shapes both the composition of credit and its transmission to investment.

The application shows that greater bank risk-bearing capacity can reduce the protection offered to borrowers. With expected rates, funding and lending competition, and the inherited terminal wage held fixed, greater capacity weakens the incentive to hedge through fixed-rate lending. Banks restrict protection and raise premiums, accepting greater earnings volatility in exchange for higher expected earnings. Substitution towards floating finance cushions the decline in total lending, but investment still falls. Greater dispersion in borrower risk aversion amplifies this response locally. Diversification and anticipated public support may affect lending through this channel. Assessing changes in banks' capacity to bear risk therefore requires considering lending terms and borrower investment alongside gains in bank resilience.

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A Empirical Appendix

A.1 Heterogeneous bank exposure to interest rate risk

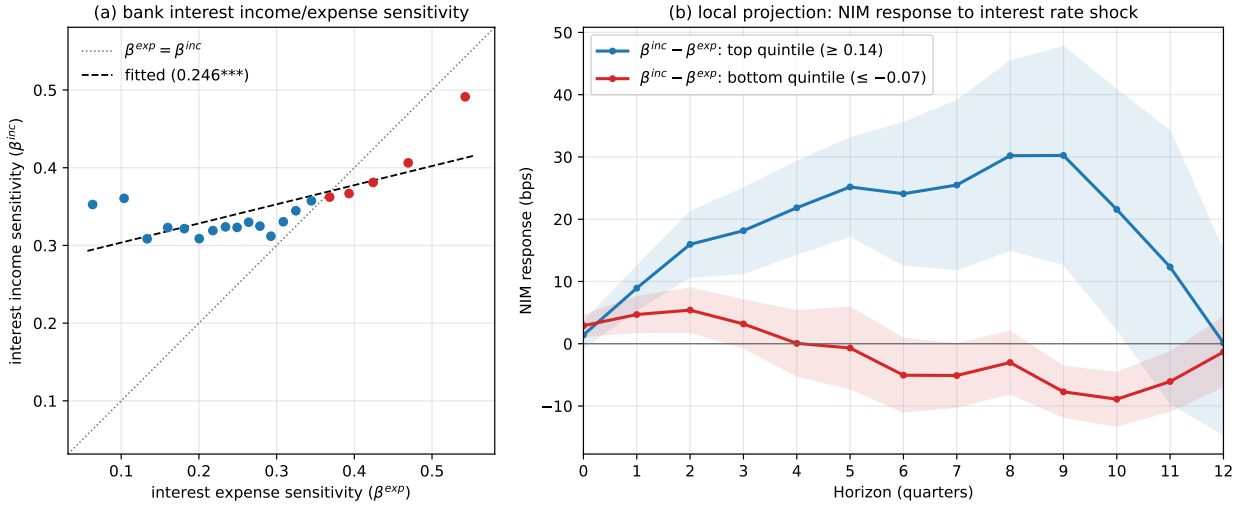


Figure 6

Notes: Panel (a) plots bank-level interest income sensitivity against interest expense sensitivity, grouping banks into 20 equal-sized bins by expense sensitivity. Both sensitivities are estimated from annualised interest flows divided by quarterly average assets. The dotted line denotes one-for-one matching, and the dashed line is the fitted relationship. Panel (b) reports local-projection responses of net interest margins (NIMs) to a contractionary monetary policy shock from Bauer and Swanson (2023), normalised to a 100 basis point increase in the policy rate. Banks are grouped by the difference between their interest income and expense sensitivities: the top quintile has a gap of at least 0.14, and the bottom quintile a gap of at most −0.07. Responses are in basis points, horizons are in quarters, and shaded areas are 90% confidence intervals. Sources: FFIEC 031 Call Reports and FR Y-9C consolidated financial statements for bank holding companies, 2010Q1–2024Q4.

Panel (a) of Figure 6 shows a positive relationship between interest income and expense sensitivities. Banks with more rate-sensitive funding also tend to earn more rate-sensitive income, consistent with an incentive to align the exposures of their assets and liabilities. However, the fitted slope of 0.246 is well below the one-for-one matching benchmark. At the lower end of the expense-sensitivity distribution, income sensitivity generally exceeds expense sensitivity; towards the upper end, the reverse holds. The positive co-movement of the two sensitivities therefore coexists with systematic departures from full matching.

To characterise these departures, define the income–expense sensitivity gap as

$$G_b \equiv \beta_b^{\text{inc}} - \beta_b^{\text{exp}}. \tag{40}$$

Because interest income and expense are scaled by the same asset denominator, G_b summarises the sensitivity of net interest income per dollar of assets. A positive gap indicates that higher rates increase interest income more than interest expense; a negative gap indicates the opposite. This heterogeneity is consistent with Williams (2020), who documents

substantial positive and negative NIM exposures across banks despite close matching at the median. The implication for our analysis is that an average matching relationship can conceal economically relevant differences in which banks benefit from, or are adversely affected by, interest rate increases.

Panel (b) of Figure 6 illustrates these differences using local projections with the monetary policy shocks of Bauer and Swanson (2023). Following a contractionary shock normalised to a 100 basis point increase in the policy rate, NIM rises persistently for banks in the highest quintile of G_b, reaching approximately 30 basis points after eight to nine quarters. Banks in the lowest quintile initially experience a modest increase, followed by margin compression: their response becomes negative after approximately four quarters and reaches about -9 basis points after ten quarters. Both responses move back towards zero by the end of the twelve-quarter horizon.

The responses differ in both magnitude and, at medium horizons, direction. Thus, the same monetary tightening can raise the net interest margins of one group of banks while compressing those of another. These patterns motivate the question of why banks choose different asset sensitivities relative to their funding exposure. We next examine whether pricing in the fixed-rate loan market reveals an additional incentive relevant to those choices.

B Model Appendix

This appendix verifies deposit pricing, establishes the value inequalities used in the entry analysis, and characterises the continuation following entry into a single community.

B.1 Deposit-pricing continuation

Fix any feasible loan-portfolio profile. For an uncontested account, the incumbent offers $\alpha = 0$, matching r_a. For a contested account, both eligible banks offer $\alpha = 1$, and the incumbent retains it under the tie rule. Against the rival's benchmark offer, an incumbent bidding below one loses the deposit and replaces it at r_1, leaving financing costs unchanged. Bidding above one raises costs. A rival bidding below one does not win; bidding one earns zero incremental payoff; bidding above one attracts a deposit that can be invested only at r_1, generating a negative spread. An uncontested account is retained at r_a, so a higher offer raises expense.

To verify the risk-management incentive, normalise all changes by the bank's committed loan book. Relative to the proposed continuation, any costly unilateral bid deviation raises net funding expense by $t(r_1 - r_a)$ for some $t > 0$. Baseline exposure is $G_i = 1 - \beta^d - l_i^F \leq 1$. The objective changes by

$$\Delta U_i = -t(r_0 - r_a) + \gamma\sigma^2 G_i t - \frac{\gamma}{2}\sigma^2 t^2 < 0,$$

under $r_0 - r_a > \gamma\sigma^2$. Other unilateral bid deviations leave net earnings unchanged. Thus the proposed bids are best responses after every portfolio profile. This proof also applies with heterogeneous local bank counts, using each bank's own asset normalisation and local beta. In the selected continuation all deposits remain with incumbents, so balance-sheet quantities are those assigned before search. The equilibrium selection does not claim uniqueness of all possible deposit-bidding equilibria.

B.2 Franchise value and the participation comparative statics

Let $\mu = r_0 - r_a$, $x = 1 - \beta^d$, and $\widehat{W}(\beta^d, N)$ be symmetric per-asset value when beta and lender counts are treated as separate arguments. The portfolio condition implies

$$\widehat{W} = x\mu - \frac{\gamma}{2}\sigma^2 x^2 + \sigma^2 \left(\frac{\theta}{N} + \frac{\gamma}{2}\right)(L^F)^2. \tag{41}$$

The first two terms are nonnegative because $\mu > \gamma\sigma^2$ and $x \in [0,1]$, while the last is positive. Using $L^F_{\beta^d} = -\gamma/D$ and $L^F_N = \theta L^F/(N^2 D)$ gives

$$\widehat{W}_{\beta^d} = -\mu + \gamma\sigma^2 x - \frac{2\gamma\sigma^2(\theta/N + \gamma/2)L^F}{D} < 0, \tag{42}$$

$$\widehat{W}_N = -\frac{\theta^2\sigma^2(L^F)^2(1-1/N)}{N^2 D} \leq 0. \tag{43}$$

Along $\beta^d = 1 - 1/n$, $N = Mn$,

$$W_n = \frac{\widehat{W}_{\beta^d}}{n^2} + M\widehat{W}_N < 0, \qquad v_n = \frac{W_n}{Mn} - \frac{W}{Mn^2} < 0.$$

The per-asset value remains bounded as $n \to \infty$, so $v \to 0$. For $AW(1;M)/M > F$, continuity and monotonicity yield a unique real $n > 1$ solving (21). Log differentiation yields

$$\frac{d\log n}{d\log A} = \frac{1}{1 - nW_n/W} \in (0,1).$$

Entry grows less than proportionally with market size, but beta rises because it depends on the number of accessible local rivals rather than on deposits per bank. This establishes the continuous claims in Proposition 3; the exact single-market integer claims follow from the threshold argument in its proof.

B.3 Continuation equilibrium with unequal local counts

Take a vector $\mathbf{n} = (n_1, \ldots, n_M)$ with every $n_j \geq 1$ and $N = \sum_{j=1}^M n_j$. A bank in community j has assets $d_j = A/(Mn_j)$, global loan-capacity weight $w_j = d_j/A = 1/(Mn_j)$, and deposit beta $\beta^d_j = 1 - 1/n_j$. Banks in that community have identical primitives. Let l^F_j denote their common fixed share. Aggregate fixed lending as a fraction of total credit is $L^F = M^{-1}\sum_j l^F_j$.

Write $h = s/\sigma^2$. The portfolio condition, including boundary choices, gives

$$l^F_j(h) = \min\left\{1, \max\left\{0, \frac{h + \gamma/n_j}{\gamma + \theta/(Mn_j)}\right\}\right\}. \tag{44}$$

Market clearing requires

$$h = \theta\left[1 - \frac{1}{M}\sum_{j=1}^M l^F_j(h)\right]. \tag{45}$$

The left side minus the right side is continuous and strictly increasing. It is negative at $h = 0$, since $l^F_j(0) < 1$ for every j, and positive at $h = \theta$. Thus there is a unique root in $(0, \theta)$. Equation (44) gives global best responses by own concavity.

Uniqueness also holds without imposing within-community symmetry. Index all banks by i, with capacity weights $w_i > 0$ summing to one and $x_i = 1 - \beta^d_i$. The lending game has

the strictly concave weighted potential

$$\mathcal{P}(\mathbf{l}) = \theta \sum_i w_i l_i - \frac{\theta}{2}\left(\sum_i w_i l_i\right)^2 - \frac{\theta}{2}\sum_i w_i^2 l_i^2 + \gamma \sum_i w_i x_i l_i - \frac{\gamma}{2}\sum_i w_i l_i^2.$$

Its derivative divided by w_i equals the derivative of bank i's objective divided by σ^2. The Hessian is $-\theta \mathbf{w}\mathbf{w}' - \mathrm{diag}(\theta w_i^2 + \gamma w_i)$, which is negative definite. Hence the Nash portfolio allocation is unique and symmetric among banks with identical local primitives.

With the solution $h(\mathbf{n})$ and shares $l_j^F(\mathbf{n})$, define

$$v_j(\mathbf{n}) = \frac{1}{Mn_j}\left\{\frac{r_0 - r_a}{n_j} + \sigma^2 l_j^F h - \frac{\gamma}{2}\sigma^2\left(\frac{1}{n_j} - l_j^F\right)^2\right\}. \tag{46}$$

A bank's total continuation value before the fee is Av_j. Recompute (44)–(46) at $\mathbf{n} + \mathbf{e}_j$ to evaluate entry. The positive-count entry conditions (23) follow. For symmetric configurations, all communities face the same entry test. We analyse active configurations rather than characterise all equilibria with inactive communities.

B.4 Numerical illustration of integer entry

Table 4 reports symmetric configurations satisfying participation and no-profitable-entry conditions, using a constant participation cost F. The entrant's continuation is evaluated at $(n+1, n, \ldots, n)$, with all bank portfolios reoptimised. The examples establish that both premium-slope regimes can occur with unilateral entry.

Breadth M	Size A	Local banks n	Lenders N	Deposit beta	Premium (bp)
1	2	12	12	0.9167	59.15
1	4	18	18	0.9444	51.92
12	2	2	24	0.5000	32.12
12	4	3	36	0.6667	33.50

Table 4: Market size and integer entry. Parameters are $\theta = 1600$, $\gamma = 160$, $\sigma = 0.005$, $r_0 = 0.04$, $r_a = 0.01$, and $F = 0.001$. Each row satisfies participation and no-profitable-entry conditions after recomputing all loan portfolios following entry into one community. These are illustrative equilibria, not a calibration.

For all four rows in Table 4, evaluating these continuation values gives strictly positive incumbent net values and strictly negative entrant net values. These examples illustrate the entry conditions; they do not establish a general existence or uniqueness theorem for the multi-community entry game.

C Investment Model: Derivations and Checks

This appendix provides additional assumptions, derivations, equilibrium construction and numerical checks underlying Section 4. Section 4.5 presents the calibration. The numerical results are illustrative solutions of the stated model, not estimates.

C.1 Additional assumptions and household conditions

Real contracts and implementation. All quantities, prices and repayments are measured in final-good units. The interbank rate equals the real floating benchmark $r_1 = r_0 + \sigma Z$, with exogenous mean r_0. Gross loan repayments per unit invested are

$$R^F_{mz} = 1 + r_0 + s_m, \qquad R^V_z = 1 + r_0 + \sigma z. \tag{47}$$

The allocation can be implemented by enforceable date-0 retail supply contracts quoted in final-good units, agreed before the unexpected change in r_0, together with the stated real debt and labour contracts. Retailers meet orders at the contracted prices, intermediate prices and wages clear production and labour markets, and bank funding clears through household saving and net-zero interbank positions. This implementation retains a real contracting friction; it is not a claim that an arbitrary real rate clears a fully flexible-price economy. The experiment raises the expected financing rate while holding current supply contracts, rate uncertainty and the parameters of the risk-capacity schedule fixed. A rate fixing precedes terminal accrual and settlement. Each point is a separate financing-rate experiment rather than a time path.

Retailing at both dates. A competitive final-good aggregator combines a unit mass of retail varieties with elasticity $\varepsilon > 1$. Retailer j transforms one unit of the homogeneous intermediate good into one unit of its variety. Let $\varpi_t(j)$ be its price in final-good units and p_t the intermediate-good price in the same units. Final-good demand and the unit-expenditure normalization satisfy

$$\begin{aligned} Y_t &= \left[\int_0^1 y_t(j)^{(\varepsilon-1)/\varepsilon}\,\mathrm{d}j\right]^{\varepsilon/(\varepsilon-1)}, \\ y_t(j) &= \varpi_t(j)^{-\varepsilon} Y_t, \qquad 1 = \left[\int_0^1 \varpi_t(j)^{1-\varepsilon}\,\mathrm{d}j\right]^{1/(1-\varepsilon)}. \end{aligned} \tag{48}$$

The household owns retailers at both dates; the aggregator earns zero profits. Each retailer takes aggregate expenditure, intermediate costs and the household valuation of dividends as given. Date-0 supply prices are contracted before the financing-rate change. If $\mathbb{E}_{-1}$ denotes

expectations when contracts are agreed, retailer j solves

$$\max_{\varpi_0(j)>0} \mathbb{E}_{-1}\left[C_0^{-\eta}\left(\varpi_0(j)-p_0\right)\varpi_0(j)^{-\varepsilon}Y_0\right]. \tag{49}$$

At a symmetric contracted price $\varpi_0(j)=1$, the first-order condition is

$$1=\frac{\varepsilon}{\varepsilon-1}\frac{\mathbb{E}_{-1}[C_0^{-\eta}p_0Y_0]}{\mathbb{E}_{-1}[C_0^{-\eta}Y_0]}. \tag{50}$$

The baseline has no anticipated change in r_0 when supply contracts are agreed, so date-0 quantities are known at that time even though terminal rates remain uncertain. Hence $p_0^b=\bar{p}=(\varepsilon-1)/\varepsilon$. Counterfactual rate changes are surprises relative to that initial information. The same supply contracts remain in place in every counterfactual; we do not impose the baseline markup condition again after a surprise. Under a nondegenerate distribution of anticipated rate changes, the expectation condition above would replace this baseline construction.

Date-1 retail prices are flexible. A retailer sets $\varpi_1(j)=\varepsilon p_1/(\varepsilon-1)$, and symmetry gives $\varpi_1(j)=1$ and $p_1=\bar{p}$. Retail prices are symmetric at each date, so there is no price dispersion and aggregate final-good output equals aggregate intermediate production. Competitive date-0 producers satisfy

$$Y_0=A_0L_0, \qquad w_0=p_0A_0, \qquad \Omega_0^R=(1-p_0)Y_0=Y_0-w_0L_0. \tag{51}$$

They earn zero profits at their selling price p_0. Positive dividends arise from retail market power. At date 1, gross final output and retail dividends are

$$Y_1=A\ell(w)^{1-\alpha}I, \qquad \Omega_1^R=(1-\bar{p})Y_1\equiv h(w)I, \qquad h(w)=(1-\bar{p})A\ell(w)^{1-\alpha}. \tag{52}$$

Committed project employment and the constant terminal retail markup make these dividends nonstochastic conditional on r_0. Both Y_1 and Ω_1^R adjust across financing-rate experiments. Entrepreneurs' expansion costs use final goods after retailing, so dividends are a share of gross output, before these resource costs.

Household ownership and regional saving. There are M local markets, with n_m banks and borrower mass ω_m in market m, where $\sum_m \omega_m=1$. Thus $N=\sum_m n_m$; equal counts give $N=Mn$ and $M=N/n$. The household family allocates saving through fixed local relationships: $\mathcal{D}_m=\omega_m\mathcal{D}$ and $d_m=\mathcal{D}_m/n_m$ per bank. Deposits and borrower masses share the same weights, but local credit volumes are equilibrium outcomes. A market is a distinct deposit and lending arena; the three empirical beta groups approximate these markets rather than defining their number in the general model. Empirical bank-count quartiles do not

automatically identify borrower or deposit weights, and these maintained proportions must be assessed against the data.

With $r_0 - r_a > \sigma$ and positive betas, deposits dominate the outside savings option state by state, so no saving is placed at r_a in equilibrium. Literal bank counts are positive integers; the numerical illustration interpolates effective competition indices.

Deposit search and local lending competition. In market m, rival deposit contacts arrive at rate $\lambda_{c,m}$ per rival and the independent decision deadline at rate $\lambda_{d,m}$. Define $\zeta_m = \lambda_{c,m}/\lambda_{d,m}$. Under the maintained deposit-pricing continuation,

$$\beta_m^d = \frac{\zeta_m(n_m - 1)}{1 + \zeta_m(n_m - 1)}, \qquad \zeta_m = \frac{\beta_m^d}{(1 - \beta_m^d)(n_m - 1)}. \tag{53}$$

Uncontested accounts receive r_a, contested accounts receive r_1, and incumbents retain ties. This continuation is maintained rather than rederived with interbank borrowing. Only hazard ratios are identified. The equal-hazard case $\zeta_m = 1$ nests Section 3.

Borrowers can compare all local lenders, whereas depositors face account-search frictions. The same banks compete on both sides of the balance sheet, but deposit betas do not alone determine lending competition. The quantitative exercise allows both n_m and ζ_m to vary:

$$HHI_m = \frac{1}{n_m}, \qquad N = \sum_m n_m. \tag{54}$$

Here $1/n_m$ is an effective symmetric-Cournot concentration index, not a claim that observed bank-size heterogeneity is absent. Counts may be noninteger in this representative-market approximation. N is derived and adds no free parameter. After calibration, counts, search frictions, deposit betas and market weights remain fixed throughout the rate experiment.

Household consumption utility is $u_\eta(C) = (C^{1-\eta} - 1)/(1 - \eta)$ at both dates, with $u_1(C) = \log C$ and $u'_\eta(C) = C^{-\eta}$. Retail dividends enter both household budgets, but individual households take dividends as given when choosing labour and saving. Terminal entrepreneur and bank profits accrue to separate owners and do not enter the household Euler equation. In aggregate, wages plus date-0 retail dividends equal Y_0, so $C_0 + \mathcal{D} = Y_0$. All agents' terminal consumption must be feasible.

For $\bar{\beta} = \sum_m \omega_m \beta_m^d$, the household's gross deposit payoff is

$$R_z^d = 1 + (1 - \bar{\beta})r_a + \bar{\beta}(r_0 + \sigma z). \tag{55}$$

Marginal saving reduces C_0 by one and raises terminal consumption by R_z^d in state z. Differentiating expected utility gives the Euler condition in (27). Current labour earns w_0, whereas a unit of committed terminal labour earns the same contracted wage w in both states. Its

marginal benefit is therefore $\delta_H w \mathbb{E}[u'_\eta(C_1)]$, giving the other two conditions in (27). Allowing labour to be reoptimised after the shock would generally make wages and operating surplus state-dependent and would change the borrower formulas below.

Project labour and full depreciation. The employment choice maximises $\bar{p}Ak^\alpha e^{1-\alpha} - we$ at origination. Its first-order condition is

$$w = (1-\alpha)\bar{p}Ak^\alpha e^{-\alpha}, \qquad e = \ell(w)k, \qquad \ell(w) = \left[\frac{(1-\alpha)\bar{p}A}{w}\right]^{1/\alpha}. \tag{56}$$

Operating surplus after wages is $\alpha\bar{p}A\ell(w)^{1-\alpha}k$. Full depreciation leaves no capital recovery, so principal repayment subtracts k. Project surplus before interest is consequently $a(w)k - \kappa k^2/2$, with $a(w)$ as in (29). The expansion cost is paid in terminal goods and does not require additional borrowing at origination.

C.2 Investment demand and contract choice

Investment conditional on financing. With mean–variance preferences over terminal project wealth, certainty equivalents are

$$\begin{aligned} CE^F(k;s) &= (\mu - s)k - \frac{\kappa}{2}k^2, \\ CE^V(k;\tilde{\theta}) &= \mu k - \frac{\kappa + \tilde{\theta}\sigma^2}{2}k^2. \end{aligned} \tag{57}$$

The variable-rate interest bill has variance $\sigma^2 k^2$. Financing risk therefore becomes more costly as project scale increases. Optimal investments and their associated values are

$$\begin{aligned} k_F(s) &= \frac{(\mu - s)_+}{\kappa}, \quad V_F(s) = \frac{(\mu - s)_+^2}{2\kappa}, \\ k_V(\tilde{\theta}) &= \frac{\mu}{\kappa + \tilde{\theta}\sigma^2}, \quad V_V(\tilde{\theta}) = \frac{\mu^2}{2(\kappa + \tilde{\theta}\sigma^2)}. \end{aligned} \tag{58}$$

Here $(x)_+ = \max\{x, 0\}$. Fixed-rate borrowers limit scale because of expansion costs and the financing premium. Variable-rate borrowers also limit scale to contain earnings risk; more risk-averse types choose smaller projects under this contract. Since $V_V > 0$, all entrepreneurs invest. This extension has an intensive investment margin, but no project-entry margin.

Contract choice. Entrepreneurs compare the values of optimally sized projects. For $0 \leq s < \mu$, fixed-rate financing is preferred if

$$\tilde{\theta} \geq \theta^*(s) \equiv \frac{\kappa}{\sigma^2}\left[\left(\frac{\mu}{\mu - s}\right)^2 - 1\right]. \tag{59}$$

The cutoff θ^* retains its sorting interpretation, but differs from $2s/\sigma^2$ in the unit-loan model because the entrepreneur can adjust investment. Type $\tilde{\theta}$ is willing to pay at most

$$s^{\max}(\tilde{\theta}) = \mu\left[1 - \sqrt{\frac{\kappa}{\kappa + \tilde{\theta}\sigma^2}}\right]. \tag{60}$$

Higher risk aversion increases the value of protection. That protection also permits a larger project: whenever an entrepreneur chooses a fixed-rate loan at $s > 0$, $k_F(s) > k_V(\tilde{\theta})$. At the indifferent type,

$$k_V(\theta^*(s)) = \frac{(\mu - s)^2}{\kappa\mu} < \frac{\mu - s}{\kappa} = k_F(s). \tag{61}$$

The marginal entrepreneur is indifferent in utility, despite investing more with the fixed-rate contract. Ties involve a zero mass of borrowers and do not affect aggregates.

Credit demand under lognormal heterogeneity. Let F_θ be the common distribution of risk aversion, with $\log\tilde{\theta} \sim N(\log\theta - \tau^2/2, \tau^2)$. Thus $\mathbb{E}\tilde{\theta} = \theta$; its median is $\theta e^{-\tau^2/2}$. For a unit mass of borrowers and $0 < s < \mu$,

$$\begin{aligned} f^F(s) &= 1 - F_\theta(\theta^*(s)), & q(s) &= f^F(s)\frac{\mu - s}{\kappa}, \\ v(s) &= \int_0^{\theta^*(s)} \frac{\mu}{\kappa + t\sigma^2}\,\mathrm{d}F_\theta(t), & i(s) &= q(s) + v(s). \end{aligned} \tag{62}$$

Actual market totals are $Q_m^F = \omega_m q(s_m)$, $Q_m^V = \omega_m v(s_m)$ and $I_m = \omega_m i(s_m)$. Aggregate quantities sum these totals without additional weights. The density f_θ gives

$$i'(s) = -\frac{1 - F_\theta(\theta^*)}{\kappa} + f_\theta(\theta^*)\theta^{*\prime}(s)\left[k_V(\theta^*) - k_F(s)\right] < 0. \tag{63}$$

The two terms capture project-scale adjustment and switching into smaller floating-financed projects. At a zero premium all positive-risk-aversion borrowers choose fixed loans. Unlike a mixture with a risk-neutral atom, the lognormal specification has no zero-premium demand plateau.

For numerical integration, write $x = (\log\theta^* - \log\theta + \tau^2/2)/\tau$, let Φ, φ denote the standard normal cdf and density, and define

$$\begin{aligned} \ell_\theta &= \log(\theta\sigma^2/\kappa) - \tau^2/2, & R(x) &= e^{\ell_\theta + \tau x}, & y(x) &= (1 + R(x))^{-1/2}, \\ s(x) &= \mu[1 - y(x)], & q(x) &= \frac{\mu}{\kappa}\Phi(-x)y(x), & v(x) &= \frac{\mu}{\kappa}\int_{-\infty}^{x} \frac{\varphi(u)}{1 + e^{\ell_\theta + \tau u}}\,\mathrm{d}u. \end{aligned} \tag{64}$$

This parameterises inverse demand without repeatedly inverting a lognormal cdf. The floating-credit integral is evaluated by adaptive quadrature, splitting near the transition of the logistic integrand. Analytical derivatives of $s(x), q(x)$ give $s_q = s_x/q_x$ and $s_{qq} =$

$(s_{xx}q_x - s_x q_{xx})/q_x^3$; finite differences provide a separate numerical check. Demand is downward sloping, but its inverse need not be concave. For total unit-mass credit $q > \mu/\kappa$, every borrower chooses fixed financing and inverse demand continues as $s(q) = \mu - \kappa q$. This continuation is included when checking bank deviations.

C.3 Bank incentives, optimality and equilibrium selection

A bank's balance sheet is $q_{im}^F + q_{im}^V + x_{im} = d_m$, with $q_{im}^F, q_{im}^V \geq 0$ and unrestricted signed interbank positions. Its earnings per unit of initial deposits are

$$\pi_{im} = (1 - \beta_m^d)(r_0 - r_a) + \frac{q_{im}^F}{d_m} s_m + \left(1 - \beta_m^d - \frac{q_{im}^F}{d_m}\right) \sigma Z. \tag{65}$$

The bank maximises expected earnings less $\gamma(r_0)/2$ times their variance. It takes the rate and the effective risk coefficient as given when choosing its portfolio. Its interior first-order condition is

$$s_m + q_{im}^F s_{m,Q} + \gamma(r_0)\sigma^2 \left(1 - \beta_m^d - \frac{q_{im}^F}{d_m}\right) = 0. \tag{66}$$

The same condition preserves the central economic tradeoff: stable funding makes fixed lending attractive as a hedge, while market power makes expansion costly because it reduces the premium on other fixed loans. A higher effective cost of risk increases the hedging incentive when residual exposure is positive.

For a unit borrower mass, write $q = Q_m^F/\omega_m$ and $\lambda = \gamma(r_0)\sigma^2$. The symmetric condition and two derivatives are

$$\begin{aligned} \mathcal{F}_m(q) &= s(q) + \frac{q}{n_m} s_q(q) + \lambda \left(1 - \beta_m^d - \frac{q}{\mathcal{D}}\right) = 0, \\ \mathcal{F}_m'(q) &= (1 + 1/n_m) s_q + (q/n_m) s_{qq} - \lambda/\mathcal{D}, \\ C_m &= 2s_q + (q/n_m) s_{qq} - \lambda/(\mathcal{D}/n_m). \end{aligned} \tag{67}$$

C_m is proportional to a bank's own second derivative. Negative C_m is necessary for an interior optimum but does not establish global optimality or uniqueness. We explicitly maximise each bank's deviation payoff, including zero own lending and negative-premium all-fixed lending.

For the local lending adjustment check, holding aggregate wages and deposits fixed, the response to a common change in rivals' quantities has multiplier

$$\mathcal{B}_m = -(n_m - 1)\frac{s_q + (q/n_m) s_{qq}}{C_m}. \tag{68}$$

The reported branch satisfies $C_m < 0$ and $|\mathcal{B}_m| < 1$ at every plotted rate. This is a conditional best-response stability diagnostic, not a dynamic stability theorem for general equilibrium. The numerical experiment follows the equilibrium branch continuously from the baseline.

Other equilibria may exist under sufficiently convex inverse demand.

We also verify

$$\mu > 2\sigma, \qquad r_0 - r_a > \max\{\sigma, \gamma(r_0)\sigma^2\}, \qquad 0 < w_0 < A_0, \tag{69}$$

positive statewise owner income, bank repayment and goods-market clearing. The borrower repayment condition is sufficient: even the largest project can repay in the high-rate state. The deposit-pricing continuation remains a maintained assumption.

C.4 Aggregate equilibrium and numerical solution

Funding and goods-market clearing. The equilibrium is defined formally in Section 4.4, Definition 1. Under symmetry within each market, $q_{im}^V = Q_m^V/n_m$ and $x_{im} = X_m/n_m$, with $X_m = \mathcal{D}_m - I_m$. Summing actual market totals gives $\sum_m X_m = \mathcal{D} - I = 0$. There is no outside asset or external lender, $B^V = 0$, although gross interbank positions can be positive. Neither I_m nor X_m receives an additional population weight in these sums.

Current goods and terminal labour satisfy

$$Y_0 = C_0 + I = A_0 L_0, \qquad L_1 = \ell(w) I. \tag{70}$$

Current intermediate producers earn zero profits. Household wages plus retail dividends equal $w_0 L_0 + \Omega_0^R = Y_0$, so its budget gives $C_0 + \mathcal{D} = Y_0$. Interbank clearing gives $\mathcal{D} = I$, verifying date-0 goods clearing without an extra transfer or source of funding.

For date 1 define $Q^F = \sum_m Q_m^F$, $Q^V = \sum_m Q_m^V$, and $J_2 = \sum_m \omega_m \int_0^\infty k_m(t)^2 \, \mathrm{d}F_\theta(t)$. Aggregate loan repayment and deposit repayment in state z are

$$\begin{aligned} \mathcal{R}_z^L &= (1 + r_0) I + \sum_m s_m Q_m^F + \sigma z Q^V, \\ \mathcal{R}_z^D &= \sum_m [1 + r_m^d(z)] \mathcal{D}_m = R_z^d \mathcal{D}. \end{aligned} \tag{71}$$

The terminal income accounts are

$$\begin{aligned} C_{1z} &= w L_1 + \mathcal{R}_z^D + \Omega_1^R, \\ C_{1z}^E &= \bar{p} Y_1 - w L_1 - \frac{\kappa}{2} J_2 - \mathcal{R}_z^L, \\ C_{1z}^B &= \mathcal{R}_z^L - \mathcal{R}_z^D = \sum_m \sum_{i=1}^{n_m} d_m \pi_{im}(z). \end{aligned} \tag{72}$$

Interbank payments cancel because $\sum_m X_m = 0$ and all positions pay the same rate. Adding

the three accounts and using $\Omega_1^R = (1-\bar{p})Y_1$ yields

$$C_{1z} + C_{1z}^E + C_{1z}^B + \frac{\kappa}{2} J_2 = Y_1, \qquad z \in \{-1, 1\}. \tag{73}$$

Thus principal and interest are transfers, not resource costs. Retail dividends are already included in household consumption and cannot be counted again. Expansion costs are terminal final-good uses, and fully depreciated capital contributes no terminal recovery. Entrepreneur and bank-owner consumption is financed by their realised profits; individual repayment and nonnegative consumption are admissibility requirements.

Aggregation. Loan-volume shares, borrower take-up and premiums are distinct objects:

$$\begin{aligned} Q^{F,\text{agg}} &= \sum_m Q_m^F, \qquad L^{F,\text{agg}} = Q^{F,\text{agg}}/I, \\ f^{F,\text{agg}} &= \sum_m \omega_m f_m^F, \qquad s^{\text{agg}} = \frac{\sum_m Q_m^F s_m}{Q^{F,\text{agg}}}. \end{aligned} \tag{74}$$

Only borrower fractions receive the exogenous population weights here; actual credit totals already contain those weights. The loan-volume-weighted premium s^{agg} differs from the response target $\bar{s} = M^{-1}\sum_m s_m$. The calibration targets the responses of $\bar{s}$ and $L^{F,\text{agg}}$.

A scalar aggregate solution. For any candidate $(\mathcal{D}, w)$, solve the M local pricing equations on the selected branch and let $\mathcal{I}(\mathcal{D}, w; r_0) = \sum_m I_m$. Funding and terminal labour clearing reduce to

$$\begin{aligned} \mathcal{I}(\mathcal{D}, w; r_0) &= \mathcal{D}, \\ \chi_1[\ell(w)\mathcal{D}]^{\nu_1} &= \frac{w}{2} \sum_{z=\pm 1} \{\mathcal{D}[w\ell(w) + R_z^d + h(w)]\}^{-\eta}. \end{aligned} \tag{75}$$

The second equation gives funding explicitly as a function of the contracted wage:

$$\mathcal{D}(w) = \left[\frac{w}{\chi_1 \ell(w)^{\nu_1}} \frac{1}{2} \sum_{z=\pm 1} [w\ell(w) + R_z^d + h(w)]^{-\eta} \right]^{1/(\nu_1+\eta)}. \tag{76}$$

The remaining aggregate equation is

$$\mathcal{I}(\mathcal{D}(w), w; r_0) - \mathcal{D}(w) = 0. \tag{77}$$

This is one outer scalar root with M conditional local pricing calculations, rather than an elementary closed form for the whole economy. It retains both rate states exactly and requires no steady-state approximation. Recover $L_1 = \ell(w)\mathcal{D}$, $C_{1z} = \mathcal{D}[w\ell(w) + R_z^d + h(w)]$,

and then

$$\begin{aligned} C_0 &= \left\{\delta_H \mathbb{E}[R_Z^d C_{1Z}^{-\eta}]\right\}^{-1/\eta}, \quad Y_0 = C_0 + \mathcal{D}, \\ L_0 &= Y_0/A_0, \qquad\qquad\qquad w_0 = \chi_0 L_0^{\nu_0} C_0^{\eta}. \end{aligned} \tag{78}$$

Recover $p_0 = w_0/A_0$, $p_1 = \bar{p}$, and the dividends in (28). To initialise the preset-price experiment, solve the investment and terminal labour block at the baseline real rate r_0^b, recover C_0^b, L_0^b, and choose the date-0 labour-disutility scale to satisfy

$$\chi_0 = \frac{\bar{p} A_0}{(L_0^b)^{\nu_0} (C_0^b)^{\eta}}. \tag{79}$$

Then $w_0^b = \bar{p} A_0$ and the initial retail price is optimal. This is a baseline consistency fit, not an estimate of labour preferences. Once fitted, χ_0 is held fixed after every financing-rate change. In an empirical calibration, measured baseline wages, hours and retail markups must jointly satisfy this restriction; they cannot all be independent free targets.

Equation (77) and the admissibility checks define the quantitative solution; neither the scalar representation nor the local stability diagnostics establish global uniqueness.

C.5 Rate responses, numerical checks and limitations

Figure 4 reports separate real-rate experiments over 0.71%–1.21%. We hold household and technology parameters, deposit betas, lender counts, search frictions, market weights, rate uncertainty and the coefficients $(\bar{\gamma}, \xi)$ fixed. The effective coefficient changes only through its stated schedule. A constant-γ experiment starts at the same baseline and sets $\xi = 0$, without refitting the other parameters. It illustrates the contribution of changing risk capacity.

With the schedule, the two targeted financial responses are reproduced exactly. Investment changes by -0.66%, fixed credit by 6.15% and floating credit by -2.25%. The fixed-flow share rises even as total lending contracts. The fixed loan rate itself rises: the 50-basis-point increase in the benchmark is offset by a 3-basis-point decline in the mean premium, giving a 47-basis-point increase in the equally weighted fixed rate.

The numerical solution evaluates expectations over both rate states. We verify aggregate and statewise goods clearing, household budgets and first-order conditions, local bank repayment accounts, borrower indifference, global unilateral bank deviations, positive statewise owner income and conditional lending stability. Numerical accuracy is assessed by refining the quadrature and checking derivatives. The plotted path follows the equilibrium branch continuously from the baseline. These checks do not establish global uniqueness or dynamic stability of the whole economy.

The real-side signs are conditional. Employment responds to lower wages and to the income effect of lower consumption. The benchmark $\eta = 0.8$ modestly strengthens substitution relative to log utility, allowing employment to fall at both dates. In a separately

refitted log-utility benchmark, terminal employment instead rises slightly (about 0.017% after 50 basis points), while investment still falls. This alternative is a sensitivity result, not a calibration target. Real-side response data should ultimately discipline these preferences.

Finally, the current-production closure is substantive. Because current retail prices are contracted, δ_H changes current consumption and output but does not directly enter the terminal funding–labour block. Saving still satisfies $\mathcal{D} = Y_0 - C_0 = I$; this specification is a financing-rate experiment, not a general model of thrift-driven capital accumulation. Committed labour, fixed local deposit relationships, full project depreciation and absence of alternative fixed-rate hedges further delimit the interpretation. Investment, output and employment responses remain validation outcomes conditional on these assumptions.