Monetary Policy Transmission, Bank Market Power, and Income Source*

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Abstract

We provide empirical evidence on banks' market power in financial services and its implications for monetary policy transmission through deposit rates. Banks with market power in financial services charge higher fees for their service and also offer lower deposit rates with less pass-through from monetary policy. We argue that this is the result of product tying: consumers must open a deposit account to access a bank's financial services. We develop and calibrate a quantitative model of the U.S. banking industry where banks generate non-interest income from services in addition to a standard loan-deposit model. We use the model to perform counterfactual exercises, quantifying the importance of non-interest income for credit supply, financial stability, and pricing.

JEL Classification: D43, E44, E52, G21, G51

Keywords: monetary policy, banks, pass-through, market power, product tying

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1 Introduction

This paper examines the role of bank non-interest income (NII) in determining deposit market power and the pass-through of monetary policy to deposit rates. We provide novel empirical evidence that banks with higher non-interest income have lower rate pass-through from monetary policy. Specifically, as monetary policy tightens, high-NII banks increase their deposit rates by less than their low-NII counterparts. We argue that this is the result of market power in financial services — such as checking, mobile banking, or branch access — which can only be accessed if consumers have a deposit account with the bank. By tying their services to deposit accounts, banks use market power in financial services to exert market power in deposit pricing.

Over the past few decades, non-interest income has become an important source of revenue for banks. In the United States, approximately 20% of aggregate bank operating income is generated through non-interest sources, with the majority coming from deposit account fees.[1] For deposit accounts, in particular, banks charge fees for financial services related to the management and transfer of funds. Cross-sectional variation in the quality and characteristics of these services suggests that this is an important margin along which banks can exert pricing power.

An extensive literature has focused on the pass-through of monetary policy to loan and deposit rates (e.g., Drechsler et al. 2017, d'Avernas et al. 2023, and Berger et al. 2005) but little focus has been devoted to the role of non-interest income. To address this gap, we use branch-level data and local projection methods à la Jordà (2005) to examine how bank rates respond to monetary policy, and if the relationship depends on bank NII. To do this, we interact conventional monetary policy shocks from Jarociński (2024) with a proxy for deposit account fees. While loan rates are unaffected, we find significant results for deposit rates. Specifically, deposit rates at high-NII banks increase by 15 basis points less compared to low-NII banks, given a 100 basis point monetary shock. These results are strongest for accounts which are most associated with financial services, such as checking and savings accounts. Thus, we identify non-interest income and financial services as a factor affecting deposit rate pass-through in addition to characteristics such as market concentration or size.

In addition to our pass-through results, we document that banks with high non-interest income shares exhibit pricing power by setting higher fees and lower deposit rates. We argue that this

[1]In the largest euro area countries, the share of non-interest income is similar, or higher, and has been increasing since the Great Financial Crisis (World Bank, 2025).

bank-level correlation is the result of product tying: in order to access the financial services of a particular bank, depositors must first open an account. Thus, a bank with inelastic demand for its services can offer a higher fee *and* a lower deposit rate. This mechanism is consistent with findings in the industrial organization literature whereby non-rate characteristics affect depositor demand (e.g., Egan et al. 2017 and Wang et al. 2022). To better illustrate this mechanism, we postulate a simple model where demand for financial services influences deposit pricing through a tying constraint.

We next develop and calibrate a quantitative model of the U.S. banking industry with the novel feature that banks offer services alongside deposits. The key assumption used, based on insights from the simple model, is that bank-level demand is correlated across services and deposits.[2] We use this model to perform counterfactual analyses to understand the role of bank non-interest income for bank profitability, financial stability, pricing, and credit supply. In the first exercise, we show that the loss of non-interest income leads to a contraction in bank lending and an increase in balance sheet risk. Further, and somewhat paradoxically, low-NII banks are more sensitive to a loss of non-interest income. This result occurs because low non-interest income banks have less market power, making them more sensitive to the counterfactual.

In the second exercise, we demonstrate how non-interest income acts as a risk-free endowment, insulating banks from risks such as interest rate uncertainty. In particular, when interest rate uncertainty increases, all banks contract their lending but low-NII banks contract lending by more. This result holds in the cross-section of the baseline model but also at the bank level (i.e. in counterfactual exercises when banks lose their non-interest income). Last, we examine how changes in the interest rate environment affect banks in the cross-section. Specifically, a decline in the neutral interest rate or slope of the yield curve compresses net interest margins and increases bank risk. While this result is similar to other findings in the literature (e.g., Whited et al. 2021), non-interest income can be a mitigating factor to stabilize profits and bank risk. Overall, the model findings suggest that non-interest income plays a stabilizing role for banks and supports credit supply.

Related Literature. Our research contributes to a vast literature assessing the effect of monetary policy on bank pricing and balance sheet items (e.g., Kashyap and Stein 2000, Bruno and Shin 2015, Altavilla et al. 2020 and Jimenez et al. 2012). We extend this literature by examining

[2]For example, a bank with inelastic demand for financial services is also more likely to have inelastic demand for deposits.

the impact of bank non-interest income on the transmission of monetary policy.[3] More recently, considerable focus has been given to the role of bank characteristics, such as market concentration or size, in determining bank pricing power and incomplete pass-through from monetary policy (e.g., Drechsler et al. 2017, Gödl-Hanisch 2023, Wang et al. 2022, Xiao 2020, and Scharfstein and Sunderam 2016). We add to this literature by examining how variation in bank non-interest income has meaningful implications for deposit rate pass-through as well as the level of rates and fees associated with deposit accounts.

To perform counterfactual analysis, we utilize a dynamic bank model where banks have pricing power. As such, we contribute to a growing class of related models (e.g., Corbae and D'Erasmo 2021, Dempsey 2024, Ulate 2021, Pancost and Robatto 2023, Morelli et al. 2024, and Koby and Brunnermeier 2023).[4] We augment the prototypical loan-deposit bank model by including the provision of financial services and, thus, non-interest income for services.

In large part, we interpret our empirical findings and use of certain model assumptions through the lens of findings from the bank industrial organization literature (e.g. Egan et al. 2017, d'Avernas et al. 2023, Allen et al. 2019, Benetton et al. 2025, and Haddad et al. 2023). In these models, demand for bank deposits or loans is based upon interest rates as well as non-rate characteristics, related to the quality of the bank's product. In this paper, we view variation in the quality of financial services as the ultimate source of bank market power and the reason banks exert pricing power in both deposit rates and the setting of fees.[5]

In addition, our research relates to an empirical literature which examines the relationship between non-interest income and bank risk (e.g., Brunnermeier et al. 2020; DeYoung and Roland 2001; Lepetit et al. 2008; Stiroh 2004, 2006; Stiroh and Rumble 2006). This literature mostly finds a positive relationship and also cites non-interest income as a volatile income source, relative to traditional net interest income. While this may be true for nontraditional activities related to brokerage, insurance, and investment banking, we focus on non-interest income directly related to depositor accounts and services. In our application, we find a different result: non-interest income is a stabilizing income source for banks.

[3]On the deposit side, stickiness in rates and a sluggish pass-through have been documented, particularly upwards. For example, papers documenting this include Berger and Hannan (1989), Diebold and Sharpe (1990), Neumark and Sharpe (1992), Driscoll and Judson (2013), Berlin and Mester (2015), and Yankov (2023).

[4]See also Begenau and Landvoigt 2022, Bianchi and Bigio 2022, Faria-e Castro 2020, and Gertler et al. 2020.

[5]Our simple model also makes use of the literature on product tying (e.g., Tirole 1988, Adams and Yellen 1976, Burstein 1960, Weinberg 1996, Loranth and Morrison 2012).

2 Data Description

The primary source for rates and fees is RateWatch, provided by S&P Global Market Intelligence since 2018. RateWatch regularly surveys 76,000 financial institution locations and collects quotes of deposits, mortgages, consumer loan rates, and fees at the branch and product level. The set of rates contains several deposit products: savings, money market, CDs of various maturities, and also conditions upon the size of accounts. While this data has been used extensively, we are the first to incorporate RateWatch's collected information on monthly service charges, transaction fees, cash checks, and many more. We further merge the data with the Statistics on Depository Institutions from the Federal Deposit Insurance Corporation (FDIC) and Call Reports to obtain bank characteristics related to income and the balance sheet. We mostly focus on a sample period between 2000 and 2024.

Table 1 provides summary statistics for bank income with a particular focus on non-interest income (NII). On average, non-interest income accounts for 13.2% of banks' total income and exhibits considerable variation in the cross-section of banks. We partition non-interest income into four different categories: *Non-traditional NII*, *Asset NII*, *Depositor Services NII* and a residual category called *Other NII*.[6] Depositor Services NII refers to fee income generated from financial services provided to owners of deposit accounts and includes payment services, branch services, mobile banking, and penalty fees.[7] On average, financial services to depositors account for approximately half of all bank non-interest income making it a crucial source of bank income.

[6]Non-traditional income is generated from activities such as brokerage, insurance, proprietary trading, and investment banking. Asset income is generated from servicing fees, loan origination, and monitoring fees, as well as asset value gains/losses.

[7]Examples of penalty fees include overdraft fees, minimum balance fees, and charges for the premature closing of accounts.

TABLE 1

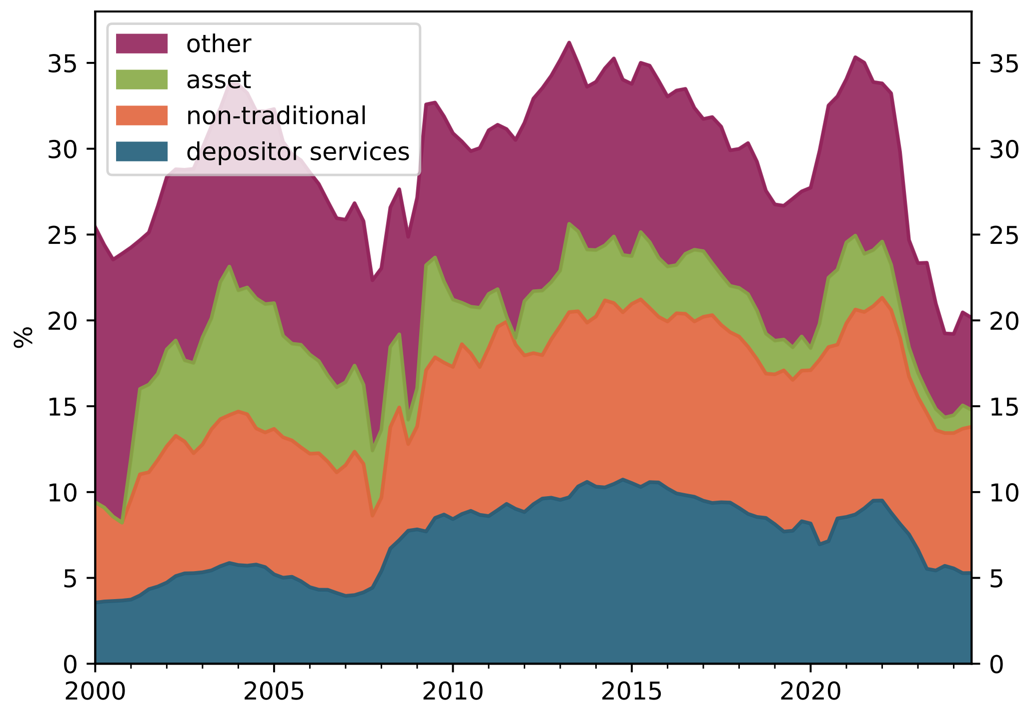
Bank-Level Income Statistics: 2000-2024

Moment	Mean	5p	10p	25p	50p	75p	90p	95p
Int Income to Total Income	86.4	65.3	77.3	84.7	89.5	93.2	96.1	98
Non-Int Income (NII) to Total Income	13.2	2.1	3.8	6.5	10.1	14.7	21.6	32.8
Non-traditional NII to NII	10.5	0	0	0.4	3.9	12.5	28.3	44.2
Asset NII to NII	8.7	-12.8	-3.7	0	2.2	14.8	34.2	51.0
Other NII to NII	31.0	5.7	9.3	15.1	24.0	40.0	66.3	89.7
Depositor Services NII to NII	49.5	0	3.4	29.8	52.4	70.9	83.0	88.9
Deposit Account	88.6	62.2	69.8	81.1	93.4	100	100	100
Payments	5.2	0	0.3	2.2	4.6	7.3	10.4	12.6

Notes: Cross-section of banks using bank-level time average. Non-traditional NII includes income from brokerage, insurance, proprietary trading, and investment banking. Asset NII includes servicing fees, loan origination fees, monitoring fees, and asset value gains/losses. Depositor Services NII includes fee income generated from financial services provided to owners of deposit accounts and includes payment services, branch services, mobile banking, and penalty fees. Other NII is a residual category. Source: Call Report.

Figure 1 uses aggregate income from the banking sector to decompose the non-interest income share over time. Non-interest income share of banks as well as its sub-components are fairly stable over time. Further, there is limited time variation in income from depositor financial services. When the share does vary, it appears to coincide with periods of monetary loosening or tightening such as 2007-2008 and 2022-2023, respectively. This suggests that non-interest income from depositor services may play a stabilizing role for bank profits during periods of changing interest rates. Figure A.5 further shows that bank fees (and fee income), in levels, are relatively stable over time and invariant to monetary policy.

Figure 1: Decomposition of Non-Interest Income Share Over Time



Notes: Decomposition of non-interest income shares over time. Nontraditional NII includes income from brokerage, insurance, proprietary trading, and investment banking. Asset NII includes servicing fees, loan origination fees, monitoring fees, and asset value gains/losses. Depositor Services NII includes fee income generated from financial services provided to owners of deposit accounts and includes payment services, branch services, mobile banking, and penalty fees. Other NII is a residual category. Source: Call Report.

3 Empirical Evidence

This section uses branch-level and bank-level data to present novel empirical evidence on the relationship between non-interest income, fees, and deposit rates over time. We provide evidence that banks with market power in deposits, as measured by lower deposit rates and lower pass-through from monetary policy, tend to have a higher reliance on non-interest income and more market power in their financial services, as measured by higher fees. As mentioned in Section 2, we focus on non-interest income which is directly related to depositors and their accounts.

3.1 Empirical Strategy

We use state-dependent local projections to assess the pass-through of monetary policy to deposit rates across banks with different non-interest income shares. We interpret non-interest income shares as a measure of bank's dependence on fee income. At each horizon h, we estimate the following regression equation for bank i's branch c at time t:

$$r_{t+h,i,c} - r_{t-1,i,c} = \alpha_{i,c}^h + \beta^h s_t + \gamma^h s_t \times X_{t,i} + \theta^h X_{t,i} + \eta^h Z_t + \epsilon_{t+h,i,c}, \tag{1}$$

where $r_{t+h,i,c} - r_{t-1,i,c}$ represents the cumulative rate change, $\alpha_{i,c}^h$ reflects a bank-branch fixed effect, s_t stands for a standard monetary policy surprise taken from Jarociński (2024),[8] $X_{t,i}$ reflects the five-year average non-interest income share,[9] and $Z_{t,i}$ is a vector of macroeconomic and financial controls. The vector of macroeconomic and financial controls contains the unemployment rate, industrial production growth rate, CPI inflation, VIX, excess bond premium, and a dummy for the zero lower bound period. As a robustness check, we additionally control for the relevance of other bank-level characteristics. Specifically, we control for the size (log assets) and capitalization (equity ratio) in those specifications with bank-level controls and additionally interact these with the policy surprise.[10] Thus, we can clearly argue that non-interest income is independently important for monetary transmission, *in addition* to size, and capitalization.

The pass-through of monetary policy to deposit rates is defined as the derivative of the change in the deposit rate to the monetary policy surprise and corresponds to the sum of $\beta^h + \gamma^h X_{t,i}$. For the visualization of the results, we focus on two states of $X_{t,i}$: low and high non-interest income shares defined as the 10th and 90th percentile of the non-interest income share distribution.

3.2 Empirical Results

Figure 2 shows that the estimated pass-through of monetary policy shocks to deposit rates is dependent upon a bank's non-interest income share. The figure plots pass-through for four different types of accounts: savings accounts, money market accounts, interest checking accounts, and

[8] The standard monetary policy captures unexpected movements in the short-end of the yield curve and isolates any information effect. The monetary policy shock is scaled to increase the federal funds rate by one percentage point after 12 months.

[9] Using the five-year lagged average instead of the contemporaneous share addresses the potential endogeneity concern that banks actively adjust their non-interest income shares to monetary policy.

[10] We use the deviation from the period average to account for secular trends in the size and capitalization.

certificates of deposit. The key finding is that deposit rate pass-through is lower for banks with higher non-interest income shares.[11]

Even though high non-interest income banks exhibit lower pass-through, they experience similar deposit outflows when compared to low non-interest banks (see Figure A.1). Thus, they are able to maintain similar levels of funding but at a cheaper rate. This allows them to generate higher net interest margin and a higher return on assets (Figure A.1). To sum up, banks with a larger dependence on financial services fee income (as proxied by non-interest income shares) have greater deposit market power as measured by rate pass-through.

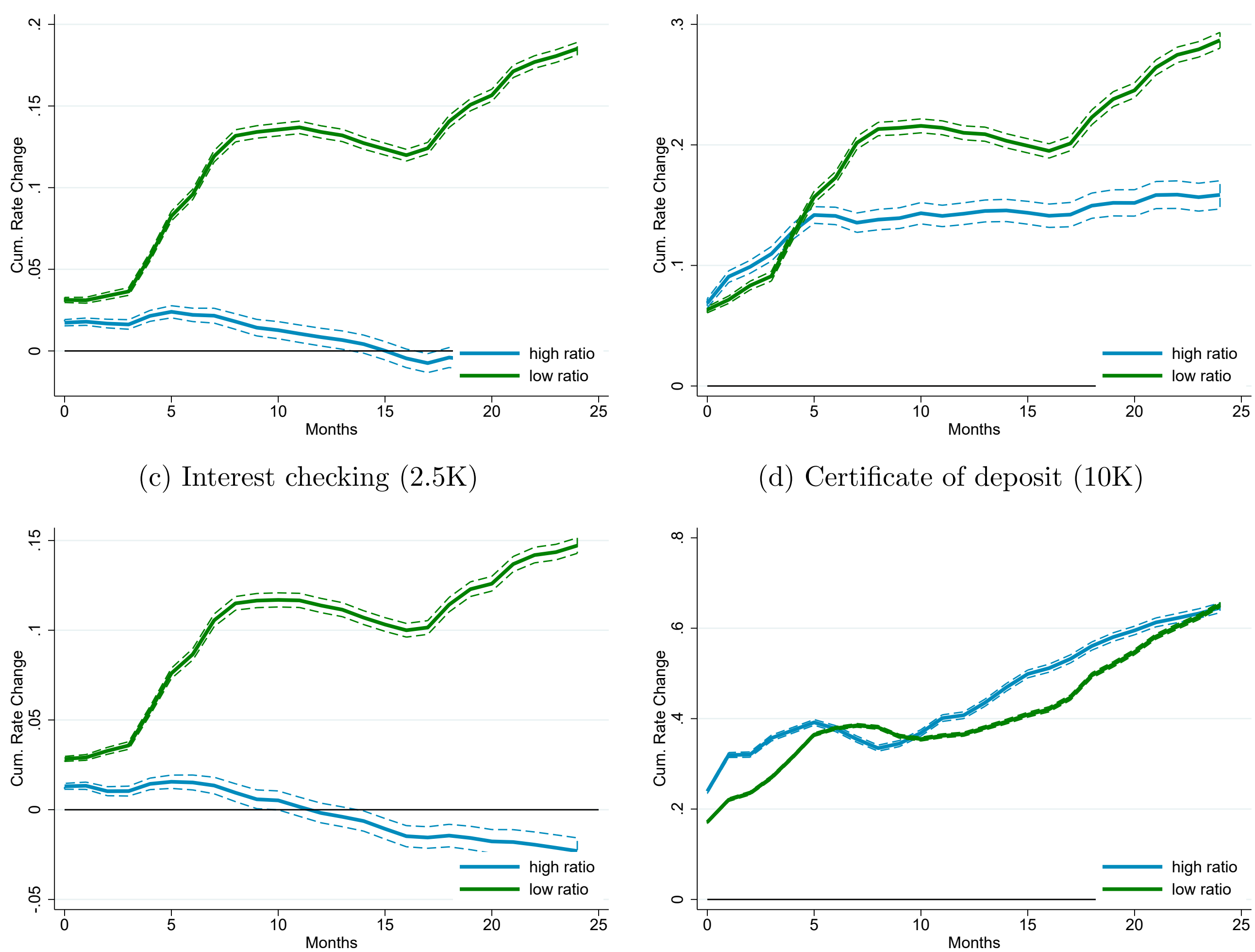
Figure 2: Local projections of deposit rates to monetary policy shock

(a) Savings (2.5K)

(b) Money Market (10K)

(c) Interest checking (2.5K)

(d) Certificate of deposit (10K)



Notes: Impulse responses of deposit rates (savings accounts, money market accounts, interest checking accounts, and certificates of deposit) to a monetary policy shock at both high (blue) and low (green) shares of non-interest income to interest rate income. Horizon is in months. 90% confidence intervals.

[11] Refer to Appendix Figure A.8 for estimated pass-through across a wider range of deposit accounts.

The results are most pronounced for savings and interest checking accounts which are exactly the types of accounts which are most clearly linked to depositor financial services, such as payment services, mobile banking, and branch services. Conversely, certificates of deposit (CDs), which offer a very limited set of services to depositors, show little difference in pass-through.

We also find differences in the level of pass-through *across* different deposit accounts: The pass-through of monetary policy is the strongest for time deposits, followed by money market accounts, savings accounts, and interest checking accounts, which is in line with findings from Drechsler et al. (2017). While there is almost a complete pass-through to time deposits, particularly for large denominations, savings account rates barely respond. The limited pass-through to savings accounts is due to banks exploiting the non-elastic demand of depositors of savings accounts. Moreover, we find that our main empirical finding holds whether we consider only the (i) deposit component or the (ii) non-traditional component of bank non-interest income (Figure A.11).

Robustness. To strengthen the validity of the results and to provide further evidence in support of our channel of financial services relevance for monetary transmission, we perform several cross-checks: (i) using the number of branches and the fee price as a proxy for the quality of financial services instead of the share of non-interest income, (ii) examining the pass-through of internet banks (which offer a very limited range of financial services), and (iii) examining pass-through at the headquarter level.

Consistently, banks with a broader branch network - and therefore more financial services available - pass through monetary policy by less (Figure A.13). The difference between the impulse responses of banks with a high vs. low number of branches (10th vs. 90th percentile) is statistically significant but smaller than when considering the share of non-interest income.[12] Alternatively, using the fee price (service charges on deposit accounts relative to deposits) as a proxy confirms that banks with high fees pass through monetary policy less (Figure A.14).[13] Similarly, bricks-and-mortar banks — whether commercial banks, credit unions or savings and loans associations — that offer a wider range of financial services pass through monetary policy to deposit rates by less than internet banks (Figures A.15 - A.17).[14] Our estimates at the headquarter level are very

[12]Of course, the number of branches does not change in the event of a monetary policy shock, but can be regarded as exogenous and therefore serves as a good proxy and instrument.

[13]Our preferred proxy is the non-interest income share, as it is less subject to potential measurement error than price data.

[14]The sample of internet banks is too small to allow state-dependent local projections. Instead, we compare the pass-through of monetary policy to deposit rates across bank types.

similar to those at the branch level (Figure A.18).

Other Bank-level Outcomes. Figures A.1 and A.3 show the responses of bank-level deposit flows, lending, assets, net interest margins, and bank profitability (ROA, ROE) to monetary policy for banks with high and low shares of non-interest income. The profitability of banks with high non-interest income rises in response to monetary tightening. Intuitively, if banks with high non-interest income increase deposit spreads in response to monetary tightening, this increases net interest margins and total profitability. There are small effects on deposit and asset flows and on lending: all contract slightly in response to monetary tightening. For the most part, the effects are not statistically different between high and low non-interest income banks. For all banks, the increase in deposit spreads leads to an outflow of deposits and fewer resources for lending. Further, lending rates also increase (Figure A.10), adding to the contraction in lending.

Compared to bank lending, we observe a larger contraction in mortgage-backed securities (MBS) and U.S. government agency obligations in response to a monetary tightening (Figures A.2 and A.4) which can have implications for mortgage origination activity and pricing, as argued by Drechsler, Savov, Schnabl, and Supera (2024). In our application, banks with high non-interest income reduce MBS by less, offsetting the larger effects on aggregate bank lending. Further, there are some compositional changes and shifts from MBS and government agencies to U.S. treasury securities.

3.3 Characteristics of High Non-Interest Income Banks

Table 2 documents average bank characteristics when splitting the sample of banks into categories of *high* and *low* non-interest income share banks (Columns 1 and 2) as well as other partitions. We observe that high share banks charge a higher average fee for depositor financial services *and* a larger deposit spread. Our fee measure is derived from the ratio of deposit services charges to total savings deposits and expressed as a percentage. Thus, a fee of 1.23 for high share banks suggests banks generate 1.23 cents in gross income from depositor financial services for every $1 in deposits.

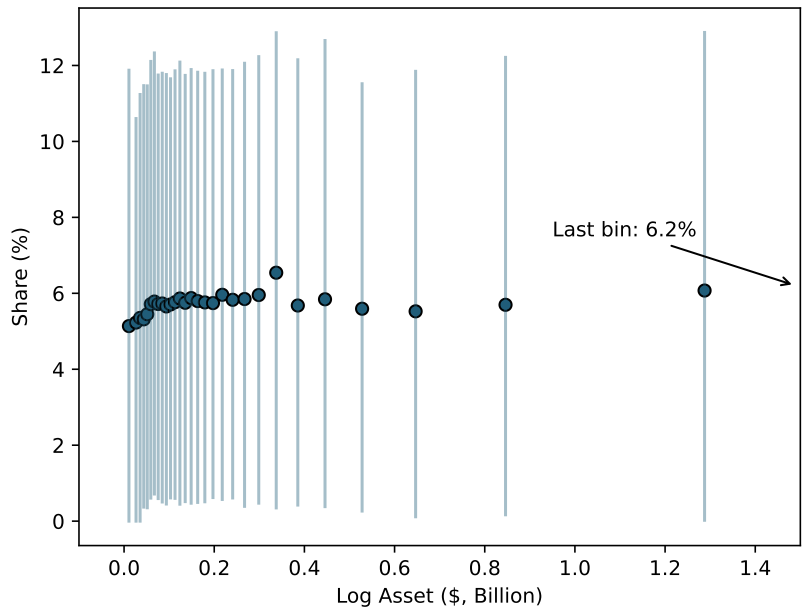
TABLE 2
EMPIRICAL MOMENTS: 2000 Q1-2024 Q1

	Non-Int Share		By Spread		By Fee		By Designation		
Moment	High	Low	Large	Small	Large	Small	GSIB	RBO	CBO
Fee	1.23	0.36	1.10	0.73	1.37	0.36	1.06	0.73	0.99
Deposit Spread	3.45	3.32	4.26	2.39	3.49	3.29	3.54	3.32	3.20
Deposit-to-Asset	75.0	65.3	71.5	71.9	73.9	68.7	70.5	70.9	76.0
Dividend Yield	0.68	0.58	0.70	0.58	0.72	0.54	0.68	0.68	0.48
ROE	10.0	9.5	10.0	9.7	10.5	9.0	10.3	9.7	9.1
ROA	0.98	1.00	0.98	1.00	1.03	0.93	1.00	1.00	0.95
Total NII Share	31.5	23.4	28.2	29.2	33.4	22.5	34.7	27.3	16.2
Depositor Services NII Share	9.0	3.1	8.3	5.5	9.4	3.8	6.8	7.9	5.9
TCE Ratio	7.6	9.4	7.8	8.7	7.6	9.1	7.5	8.3	9.9
RW Capital Ratio	13.6	17.7	14.5	15.7	13.7	16.8	14.4	15.1	16.4
Equity Issuance Rate	5.3	12.3	5.0	12.5	4.7	12.6	11.3	30.8	8.4

Notes: Unless otherwise specified, all objects are annualized and computed as asset-weighted averages. *Fee Non-Int Share Dep* measures non-interest income using only the deposit service charge line item. The *TCE Ratio* represents the tangible common equity ratio which accounts for unrealized losses. Source: Call Report.

Importantly, we also consider other data partitions such as *size* as measured by bank designation in the last three columns. d'Avernas, Eisfeldt, Huang, Stanton, and Wallace (2023) emphasize that bank liquidity services increase in bank size and this is a source of market power for banks. While our summary statistics are consistent with this finding (i.e. large banks have higher fees, lower deposit spreads, and higher non-interest income), our findings in Section 3.2 hold even after controlling for bank size. Thus, our evidence suggests that bank size alone is not a sufficient indicator of the quality of financial services or non-interest income dependence. This point is further emphasized in the binned scatter Figure 3 which plots bank size and depositor service non-interest income shares.

Figure 3: Non-Interest Income Share from Depositor Financial Services and Bank Size



Notes: Dots reflect mean non-interest income share by log assets. Bars reflect the 10th to 90th percentile of non-interest income share by log assets. Source: Call Report.

While high non-interest income banks set higher fees for financial services, it is unclear whether these banks actually have pricing power in financial services. For example, banks may simply spend more for high-quality services and, thus, charge higher fees in a way that is *not* margin-increasing. To address this, we first look at bank-level, time-varying correlations between non-interest income shares, fees and return on equity (see Figure A.6). The results show that banks with high fees and high non-interest income also generate higher return on equity, suggesting they are able to maintain larger profit margins.

We also estimate empirical cost functions to derive fee markups in a method similar to Berger, Klapper, and Turk-Ariss (2017) and Corbae and D'Erasmo (2021). Specifically, for bank loan and deposit quantities $\{q_{it}^{\ell}, q_{it}^{d}\}$ we estimate a translog cost function

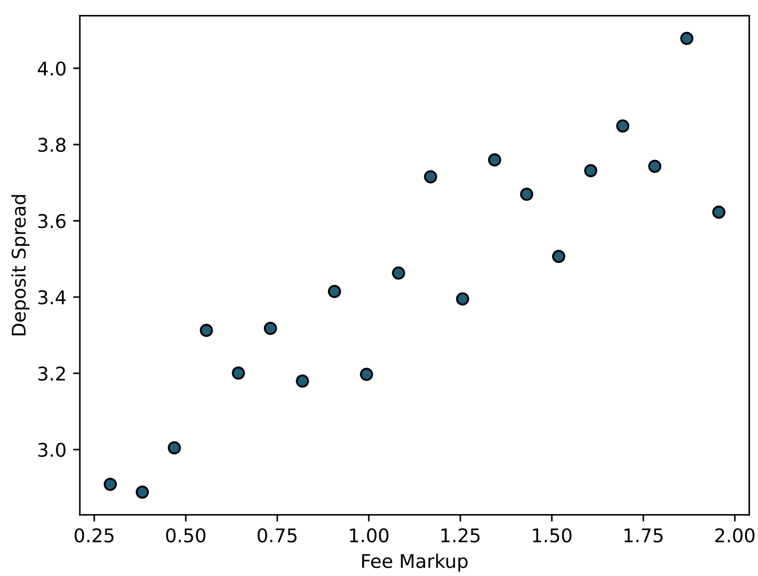
$$\begin{aligned} log\big(\text{Non-Int Expense}_{it}\big) = & \beta_1 log(q_{it}^{\ell}) + \beta_2 log(q_{it}^{d}) + \beta_3 log(q_{it}^{\ell})^2 + \beta_4 log(q_{it}^{d})^2 + \\ & \beta_5 log(q_{it}^{\ell}) log(q_{it}^{d}) + \sum_{j=1}^{3} \gamma_j^{\ell} log(w_{ijt}) log(q_{it}^{\ell}) + \sum_{j=1}^{3} \gamma_j^{d} log(w_{ijt}) log(q_{it}^{d}) + \\ & \sum_{j=1}^{3} \sum_{k=1}^{3} \phi_{jk} log(w_{ijt}) log(w_{ikt}) + \xi_i + \xi_t + \epsilon_{it} \end{aligned} \tag{1}$$

where ω_{ijt} is the input price of input j for bank i at time t. We consider three bank input prices: the wage cost of labor, interest expense of debt, and the cost of physical assets as measured by bank fixed assets. Then, the estimated marginal cost of providing financial services (which we take as proportional to the quantity of deposits) can be expressed as

$$\widehat{mc}_{it}^{services} = \frac{\text{Non-Int Expense}_{it}}{q_{it}^d}\left[\hat{\beta}_2 + 2\hat{\beta}_4 log(q_{it}^d) + \hat{\beta}_5 log(q_{it}^\ell) + \sum_{j=1}^{3} \hat{\gamma}_j^d log(w_{ijt})\right] \tag{2}$$

and the fee markup is measured as the ratio of fee price f_{it} to estimated marginal cost $\hat{mc}_{it}^{services}$. Figure 4 is a binned scatter plot of the relationship between the estimated fee markups and bank deposit spreads, as measured by the difference between the federal funds rate and the rate on savings deposits. It shows a strong, positive relationship: banks with fee pricing power in financial services also have pricing power in deposit rates.[15] This finding is also consistent with the negative branch-level correlation between deposit rates and deposit account fees, documented in Figure A.7.

Figure 4: Fee Markups and Deposit Spreads Binned Scatter



Notes: Markup measures ratio of *fee* minus *marginal cost* to *marginal cost*. Bin averages are based upon bank-year observations. Source: Call Report.

Taking Stock. We find that banks with higher non-interest income shares exhibit signs of market power in the level and pass-through of deposit rates, as well as the setting of fees for financial

[15]It is not an issue that estimated fee markups are less than 1. What matters for the bank is total profitability. For example, the bank may be willing to take financial losses on the services it provides if it generates larger, offsetting profits within the deposit-taking and lending arms of the bank.

services. Implicitly, banks provide two different products in the form of financial services and deposit accounts which are *tied* together: consumers must open a deposit account to access high quality financial services of the bank.

Strictly as a savings option, insured bank deposits are a relatively homogeneous product across banks. Thus, in isolation, one would expect deposit products to be priced competitively and uniformly across banks. Instead, there exists significant cross-sectional variation in deposit pricing. We argue this is due to product tying: banks exert deposit market power *through* their financial services market power. Section 4 provides a simple model to illustrate this mechanism.

4 Illustrative Model

In this section, we provide a simple banking model to demonstrate the type of demand behavior that rationalizes the empirical results presented in Section 3. Specifically, we consider a monopolistically competitive banking sector, in which banks provide deposit accounts — a savings vehicle — as well as financial services. We show that when the two products are *tied* (i.e. a consumer must open a deposit account in order to access a bank's services) the bank can exert its services market power in the deposit market and thereby generate lower deposit rates and lower deposit rate pass-through.

Consumer preferences are linear in consumption $\{c, c'\}$ and bank services q^n, where q^n is a CES aggregator over different banks indexed by i with elasticity ϵ^n

$$c + \beta c' + q^n, \tag{1}$$

and c' is next-period consumption. Consumers choose consumption, deposit savings $\{q_i^d\}$, and services that satisfy a budget constraint

$$c + \sum_i \frac{q_i^d}{1 + r_i^d} + \sum_i f_i q_i^n = \omega, \tag{2}$$

where ω is an initial endowment and r_i^d the bank-specific offered net nominal interest rate. We assume a bank-level *tying* constraint

$$q_i^n \leqslant \phi q_i^d \tag{3}$$

which requires consumers to hold some quantity of deposits in order to access bank services.[16] In

[16]Unlike the tying literature reviewed in Section 1, we are not explicit about the strategic decision of banks to

the case of a binding constraint, the consumer's first order condition with respect to deposits can be stated as:

$$\beta \left(\frac{q_i^d}{q^d} \right)^{-\frac{1}{\epsilon^d}} + \phi \left(\frac{q_i^d}{\tilde{q}^d} \right)^{-\frac{1}{\epsilon^n}} = \frac{1}{1 + r_i^d} + \phi f_i, \tag{4}$$

where $\tilde{q}^d = \left(\sum_i q_i^{d\frac{\epsilon^n - 1}{\epsilon^n}} \right)^{\frac{\epsilon^n}{\epsilon^n - 1}}$.[17] When the tying constraint binds, demand for bank deposits becomes a function of both the deposit and services demand elasticity, creating a new *effective* demand elasticity $\tilde{\epsilon}^d$ which is different than the primitive elasticity ϵ^d.

Intuitively, when the tying constraint binds, a consumer may demand additional units of deposits (above their preferred unconstrained amount) in order to obtain more financial services.[18] In this case, the bank is able to exert its service market power on deposit pricing and create an *effective* deposit rate elasticity $\tilde{\epsilon}^d$ which is lower than the *primitive* elasticity parameter ϵ^d.

Special Case. Consider a simplified version of the illustrative model in which $\phi = 1$, $\beta = 1$ and aggregate demand is normalized such that $q^d = q^n = 1$. Further, assume that the primitive demand elasticities are the same (i.e. $\epsilon^d = \epsilon^n = \epsilon$). Then, from equation (4), deposit demand can be expressed as $q_i^d = \left(\frac{f_i + \frac{1}{1+r_i^d}}{2}\right)^{-\epsilon}$ and the deposit demand rate elasticity as

$$\frac{\partial q_i^d}{\partial r_i^d} \frac{1 + r_i^d}{q_i^d} = \underbrace{\epsilon \frac{\frac{1}{1+r_i^d}}{f_i + \frac{1}{1+r_i^d}}}_{\widetilde{\epsilon}} < \epsilon \tag{5}$$

such that depositors are relatively more inelastic under the tying regime, i.e. the effective demand elasticity $\widetilde{\epsilon}$ is lower than the primitive demand elasticities ϵ.

This simple model illustrates how bank fees and deposit rate pricing are intertwined: banks jointly price their services and deposit accounts as a function of demand parameters for both products. Thus, without conditioning upon the strategic behavior of banks, we would expect to see a negative bank-level correlation between measured demand elasticities $\{\tilde{\epsilon}_i^d, \tilde{\epsilon}_i^n\}$ which generates the negative correlation between fees and deposit rates.

tie products in order to generate increased market power but, instead, impose this constraint ad hoc.

[17] Our model nests the standard demand of deposits $q_i^d(r_i^d; \epsilon^d)$ when it is assumed that the constraint is not binding (ϕ=0): $q_i^d = \beta^{\epsilon^d}(1 + r_i^d)^{\epsilon^d} q^d$.

[18] This model can generalize to a more realistic scenario in which the tying constraint is binary and not linear, but we keep this specification for illustrative purposes.

5 Quantitative Model

In this section, we calibrate a quantitative model of the U.S. banking sector and use it to perform counterfactual analysis, testing the implications that bank non-interest income dependence has for bank profitability, financial stability, deposit pricing, and credit supply.

5.1 Bank Problem

Decisions, Constraints, and Technology. There exists I bank types with corresponding probability masses $(p_1, p_2, ..., p_I)$ who monopolistically compete for consumer deposits and financial services. Each bank i has a fixed set of technology and demand parameters. In practice, variation in bank demand could emerge from differences in the quality of financial services, such as the branch network, mobile banking technology, or customer service.

Banks earn profits from a standard deposit-loan balance sheet model as well as the provision of financial services. Each period, banks provide a quantity of financial services q_i^n at a fee price f_i. In addition, banks borrow deposits d_i at a rate r_i^d and originate one-period loans ℓ_i which generate an exogenous, risky return r^ℓ. Loan returns can be decomposed into two components

$$r^\ell = r(z_-, z) + \Delta^\ell \tag{7}$$

where $r(z_-, z)$ is the monetary policy rate, determined by a simple Taylor rule, and Δ^ℓ is a constant spread which is meant to capture a positive-sloping yield curve. The monetary policy rate is determined by the realization of the aggregate shock z in the current period and its value z_- in the previous period. We assume the aggregate shock follows an AR(1) process; specifically, $z = \rho_z z_- + \epsilon_z$ where ϵ_z is an iid, mean zero random variable with standard error σ_z.

Each period, banks must satisfy a budget constraint

$$\pi_i + \ell_i + C_i(\pi_i, q_i^n, \ell_i) = n_i + d_i + q_i^n f_i. \tag{8}$$

The right-hand side of equation (8) represents bank funding which consists of networth n, deposits d_i, and income from financial services $q_i^n f_i$. Beginning-of-period networth n_i can be thought of as retained earnings or beginning-of-period equity for the bank. Total deposits are determined by the demand function of the bank $d_i = q^d(r_i^d; r, \epsilon_i^d)$, where ϵ_i^d is a bank-specific elasticity parameter and, similar to Drechsler et al. (2021), demand is sensitive to the level of the monetary policy rate. In addition, demand for financial services is determined via $q_i^n = q^n(f_i; \epsilon_i^n)$ where ϵ_i^n is a bank-specific elasticity parameter. Unlike the illustrative model in Section 4, we keep the model tractable by not explicitly linking demand for services to demand for deposits, but by allowing the elasticity parameters to be correlated at the bank level.

The left-hand side of the budget constraint includes expenses for dividends π_i, loan origination ℓ_i, and operational costs $C_i(\pi_i, q_i^n, \ell_i)$ related equity issuance, loan origination, and the provision of financial services.[19]

The dynamics of the bank problem are captured through the law of motion for next-period networth n':

$$\begin{aligned} n_i' =& (1 + r^\ell)\ell_i - (1 + r_i^d)d_i \\ =& \left(1 + r(z, z') + \Delta\right)\ell_i - (1 + r_i^d)q^d\left(r_i^d; r(z_-, z), \epsilon_i^d\right) \end{aligned} \tag{9}$$

Note that next-period bank loan returns r^ℓ are stochastic and vary with the realized value of the monetary policy rate in the next period such that bank loan rates are adjustable.

Optimization. The bank's objective is to maximize the expected, discounted dividend stream to equity owners subject to the budget constraint, networth law of motion, and the aggregate shock law of motion. Thus, we can express the bank value function as:

$$\begin{aligned} v(n_i, z_-, z; i) = & \max_{\pi_i, r_i^d, f_i, \ell_i} \quad \pi_i + \beta E[v(n_i', z, z'; i)] \\ & s.t. \quad \pi_i + \ell_i + C_i(\pi_i, q_i^n, \ell_i) = n + q^d(r_i^d; r, \epsilon_i^d) + f_i q^n(f_i; \epsilon_i^n) \\ & s.t. \quad n_i' = \left(1 + r(z, z') + \Delta^\ell\right)\ell_i - (1 + r_i^d)q^d(r_i^d; r, \epsilon_i^d) \\ & s.t. \quad z' = \rho_z z + \epsilon_z \end{aligned} \tag{10}$$

Define a bank's state as $\mathbf{s}_i = (n_i, z_-, z; i)$ such that a policy function $y(\mathbf{s}_i)$ represents a current-period decision and $y(\mathbf{s}_i')$ represents a policy function based upon the next period's state. Let $\lambda(\mathbf{s}_i)$ be the shadow multiplier on the bank's current period budget constraint. The bank's first-order

[19] Equity or, more broadly, dividend adjustment costs introduce an important financial friction that helps capture the leverage dynamics faced by banks.

conditions with respect to pricing and loan origination can be stated as:

$$[r_i^d]: \quad \frac{\partial d_i}{\partial r_i^d}(\mathbf{s}_i) - E[m(\mathbf{s}_i')]\left(r_i^d(\mathbf{s}_i)\frac{\partial d_i}{\partial r_i^d}(\mathbf{s}_i) + d_i(\mathbf{s}_i)\right) = 0 \tag{11}$$

$$[f_i]: \quad f_i(\mathbf{s}_i)\frac{\partial q_i^n}{\partial f_i}(\mathbf{s}_i) + q_i^n(\mathbf{s}_i) - \frac{\partial C_i}{\partial q_i^n}\frac{\partial q_i^n}{\partial f_i}(\mathbf{s}_i) = 0 \tag{12}$$

$$[\ell_i]: \quad -\left(1 + \frac{\partial C_i}{\partial \ell_i}(\mathbf{s}_i)\right) + E\left(m(\mathbf{s}_i')\left(1 + r(z,z') + \Delta\right)\right) = 0, \tag{13}$$

where $m(\mathbf{s}_i')$ is the bank stochastic discount factor, defined as $m(\mathbf{s}_i') = \beta\frac{E[\lambda(\mathbf{s}_i')]}{\lambda(\mathbf{s}_i)}$ and $\lambda(\mathbf{s}_i)$ is determined by the dividend equilibrium condition $1 - \lambda(\mathbf{s}_i)\big(1 + \frac{\partial C_i}{\partial \pi_i}(\mathbf{s}_i)\big) = 0$.

For added context in how banks set prices, consider the case in which deposit and financial services demand are characterized by constant price elasticities of (e^d, e^n) where $e^d > 1$ and $e^n > 1$. Further, consider a non-stochastic equilibrium in which $\lambda(\mathbf{s}_i) = \lambda(\mathbf{s}_i')$ in all states. Then deposit rates and fees are respectively set as constant markdowns and markups:

$$[r_i^d]: \quad 1 + r_i^d = \frac{1}{\beta}\frac{e^d}{1+e^d} \tag{11a}$$

$$[f_i]: \quad f_i = \frac{e^n}{e^n - 1}\frac{\partial C_i}{\partial f_i} \tag{12a}$$

For deposits, the markdown is with respect to the inverse of the discount factor β^{-1} and in the case in which the monetary policy rate is defined as $1 + r = \beta^{-1}$, banks have a positive deposit spread $s^d = r - r^d = (1+r)\frac{1}{1+e^d}$ which has imperfect pass-through of monetary policy given $\frac{\partial s^d}{\partial r} = \frac{1}{1+e^d} < 1$.

5.2 Calibration

Functional Forms. For bank demand, we specify financial services demand as a CES demand function with elasticity ϵ_i^n such that $q_i^n = q^n(f_i; \epsilon_i^n) = q^n(f_i^n)^{-\epsilon_i^n}$ which provides a constant price elasticity of $-\epsilon_i^n$. Further, for deposit demand, we specify a logistic functional form

$$q^d(r_i^d; r, \epsilon_i^d, \xi_i^d) = \frac{exp(\epsilon_i^d r_i^d + \xi_i^d)}{exp(\epsilon_i^d r) + exp(\epsilon_i^d r_i^d + \xi_i^d)} \tag{13}$$

which is decreasing in the monetary policy rate r and ξ_i^d is added to represent non-rate characteristics that depositors value. We choose this functional form as it provides a tractable way to account for the monetary policy rate as an outside option for depositors, and it helps generate the pricing dynamics observed in the data. Further, the demand function can be restated in terms of the deposit spread $s_i^d = r - r_i^d$ such that $q^d(r_i^d; r, \epsilon_i^d, \xi_i^d) = \frac{exp(-\epsilon_i^d s_i^d + \xi_i^d)}{1+exp(-\epsilon_i^d s_i^d + \xi_i^d)}$.[20]

In terms of operational costs, we specify the following functional forms:

$$C_i(\pi_i, q_i^n, \ell_i) = \phi_i^\pi(\pi_i - \bar{\pi}_i)^2 + q^n(f_i; \epsilon_i^n) mc^f + mc^\ell \ell_i^2, \tag{14}$$

where banks have a convex cost in adjusting dividends away from their long-run target, a convex cost in loan origination, and linear costs in services.

As noted earlier, the aggregate shock process for loan returns is AR(1) and of form $z' = \rho_z z + \epsilon_z$ where ϵ_z is an iid, mean zero random variable with standard deviation σ^z. Further, monetary policy follows a Taylor rule

$$1 + r' = (1 + r^*)\left(\frac{z'}{z}\right)^{\phi_z} \epsilon^r, \tag{15}$$

where the log of ϵ^r is an iid monetary policy shock with zero mean and standard deviation σ^r and r^* represents the neutral rate of interest in the economy.

External Calibration. Model parameters can be summarized by the bank i-specific set

$$\Theta_i = \{ \underbrace{r^*, \phi_z, \sigma^r}_{\text{monetary policy}}, \underbrace{\rho_z, \sigma^z, \Delta^\ell}_{\text{loan returns}}, \underbrace{mc^\ell, mc_i^f, \phi_i^\pi, \bar{\pi}_i}_{\text{bank costs}}, \underbrace{\epsilon_i^d, \xi_i^d, \epsilon_i^n}_{\text{demand}}, \underbrace{\beta}_{\text{Discount}} \} \tag{16}$$

where most cost and demand parameters are unique to a bank's specific type $i \in I$. Specifically, there are six bank-specific parameters $\{mc_i^f, \phi_i^\pi, \bar{\pi}_i, \epsilon_i^d, \xi_i^d, \epsilon_i^n\}$. For the current calibration, we set $I = 2$ and partition banks according to their dependence on fee income, splitting banks into *high* and *low* non-interest income share buckets according to the median, as reported in Table 2.

The set of model parameters can be partitioned into those which will be externally calibrated and those which will be internally calibrated; i.e. values determined by matching model moments with empirical counterparts. Parameters related to monetary policy implementation $\{r^*, \phi_z, \sigma^r\}$

[20]This also allows for a simple representation of the rate elasticity $\frac{\partial q_i^d}{\partial r_i^d}\frac{r_i^d}{q_i^d} = \epsilon_i^d r_i^d(1 - q_i^d)$ and spread elasticity $\frac{\partial q_i^d}{\partial s_i^d}\frac{s_i^d}{q_i^d} = -\epsilon_i^d s_i^d(1 - q_i^d)$.

are externally calibrated based upon common values within the literature. Further, we externally estimate the values of $\{\rho_z, \sigma^z\}$ by filtering real GDP and then setting the loan return spread Δ^ℓ to achieve an average spread observed in the data. We set the neutral rate of interest in the monetary policy rule to the inverse of the discount factor such that $r^* = \beta^{-1} - 1$. The remaining external parameters are listed in Table 3.

TABLE 3
External Calibration Parameters

Parameter	Label	Value	Source/Target
β	Discount Factor	0.995	2% annual rate
ρ_z	Agg Shock Persistence	0.89	Fernald (2014)
σ_z	Agg Shock Volatility	0.0138	Real GDP Growth (1980s-Present)
ϕ_z	MP Exponential Term	0.9	Literature
Δ	Loan Spread	0.016	Corporate Loan Spread BofA

Note: Model parameters are set for a model in quarterly frequency.

Internal Calibration. The remaining set of parameters for the internal calibration are $\{\epsilon_i^d, \xi_i^d, \epsilon_i^n, \phi_i^\pi, mc_i^f, mc^\ell\}$. Given the functional form assumption for financial services demand, the equilibrium condition simplifies to

$$f_i = \frac{\epsilon_i^n}{\epsilon_i^n - 1} mc_i^f \tag{17}$$

such that total services profit enters the period budget constraint as $\pi_i^n = q_i^n(f_i; \epsilon_i^n)(f_i - mc_i^f)$ which is constant and invariant to the bank's state $\mathbf{s}_i$. In this way, services net income π_i^n acts as a risk-free period endowment. While this pricing condition may seem unrealistic, it is entirely consistent with the observed invariance of bank fees, as shown in Figure A.5. In the model, this generates an indeterminacy in the level of $\{mc_i^f, \epsilon_i^n\}$. To manage this, we set the marginal cost terms mc_i^f to the estimated values from the translog cost estimation in Section 3.3 at 1%. We then internally calibrate ϵ_i^n to match the moments related to bank non-interest income shares. As shown in Table 4, we recover $\epsilon_{high}^n = 1.025 < 1.055 = \epsilon_{low}^n$. While the implied markups are large, we care less about their levels and more about the cross-bank differences; mainly, the fact that high non-interest income banks have market power in financial services.

TABLE 4
INTERNAL CALIBRATION PARAMETERS

Parameter	Label	Value	Target	Data	Model
ϵ^d_{high}	Rate Elasticity	1.77	Deposit Spread	3.45	3.47
ϵ^n_{high}	Services Elasticity	1.025	Non-Int Share	32	34
ξ^d_{high}	Deposit Shifter	1.12	Deposit-Asset Ratio	75	75
ϕ^π_{high}	Dividend Adjustment	0.27	Dividend Ratio	1.55	1.12
ϵ^d_{low}	Rate Elasticity	1.64	Deposit Spread	3.32	3.33
ϵ^n_{low}	Services Elasticity	1.055	Non-Int Share	23	23
ξ^d_{low}	Deposit Shifter	0.67	Deposit-Asset Ratio	65	62
ϕ^π_{low}	Dividend Adjustment	0.42	Dividend Ratio	1.51	1.15
mc^ℓ	Loan Cost	0.014	Return on Equity	10	8.3

Note: Model parameters are set for a model in quarterly frequency. Data and Model moments are quoted in annualized terms.

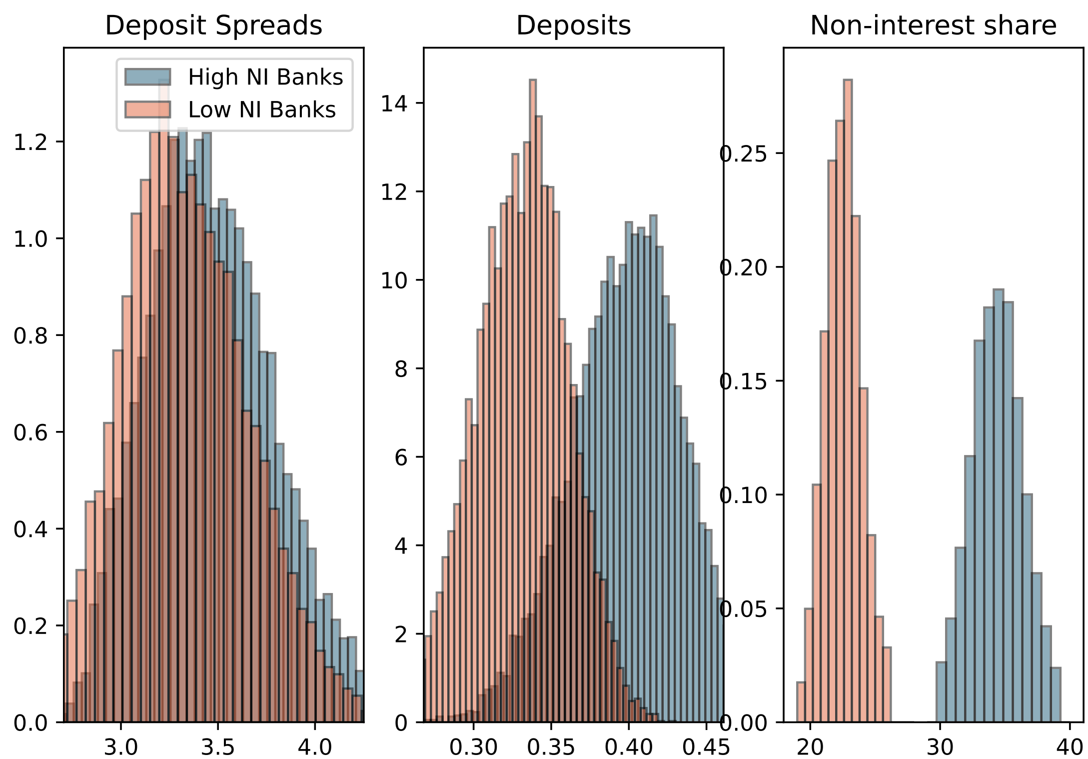
In terms of deposit demand, we set the rate elasticity parameter ϵ^d_i to target the average deposit spread $s^d_i = r - r^d_i$, and set the non-rate demand parameter ξ^d_i to target the average deposit-to-asset ratio. The calibrated parameters capture the feature that our empirical evidence in Section 3 supports: high non-interest income banks operate with market power in both financial services and deposits. From model simulations, the average rate elasticity with respect to deposits is 1.065 for high non-interest income banks and 1.099 for low non-interest income banks.

The dividend adjustment parameter ϕ^π_i affects the flexibility in which banks can issue equity and, thus, affects the rate at which banks can substitute between debt and equity funding over time. We set this parameter to target the ratio between the 90th and 10th percentile of bank dividends such that banks with low ϕ^π have less of a financial friction and larger variations in dividends.

Last, we set the loan marginal cost parameter to match the average return on equity for the entire banking sector. While the parameters for loan returns, monetary policy, and deposit demand determine a bank's net interest margin, variation in mc^ℓ affects total profitability as captured by measures such as return on equity (ROE) and return on assets (ROA).

Baseline Model Output and Validation. Figure 5 plots simulated cross-sectional moments from the calibrated quantitative model by bank type. Specifically, we see that high non-interest income banks operate with, on average, lower deposit rates and hence larger deposit spreads (left panel). Given the strength of their deposit demand, high non-interest income banks also use more deposit funding (center panel) compared to their low non-interest income counterparts.

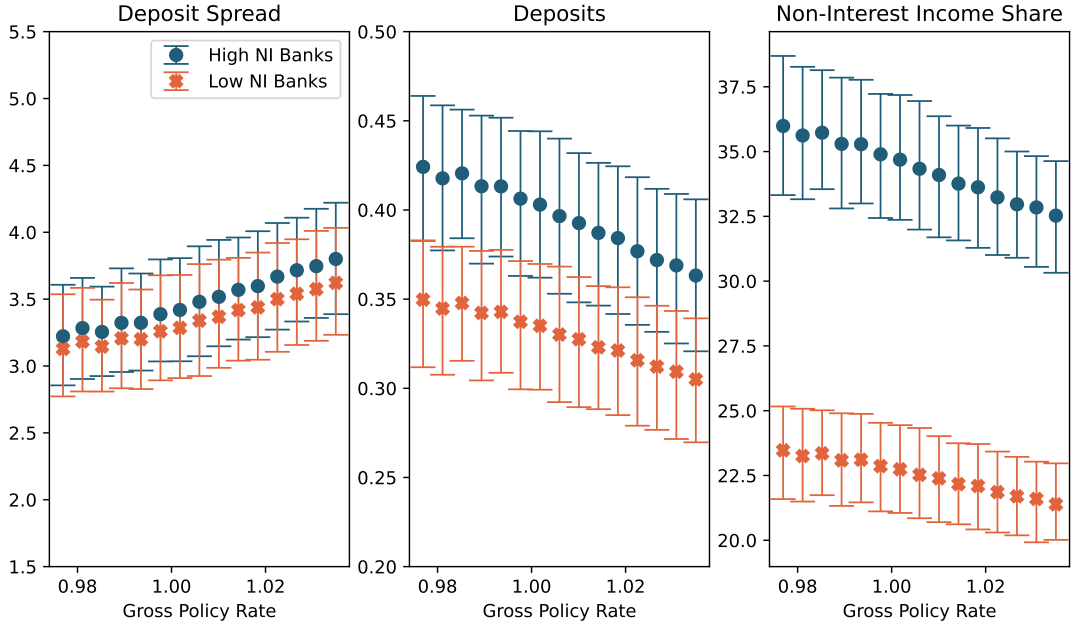
Figure 5: Simulated Cross-Sectional Moments



Notes: The left panel shows the distribution of deposit spreads for high and low non-interest income banks. The right panel shows the distribution of non-interest income shares for high and low non-interest income banks.

Figure 6 plots the simulated relationship between important bank moments and the monetary policy rate. For both types of banks, there is a positive relationship between the monetary policy rate and the deposit spread (left panel): as monetary policy rates increase, banks increase deposit rates to remain competitive with the outside option in $q^d(r_i^d; r, \epsilon_i^d, \xi_i^d)$ but the spread widens. Put differently, deposit rates exhibit incomplete pass-through from changes in the monetary policy rate. The net effect is that deposits flow out of the banking sector (center panel) as the policy rate increases.

Figure 6: Simulated Monetary Policy Trends

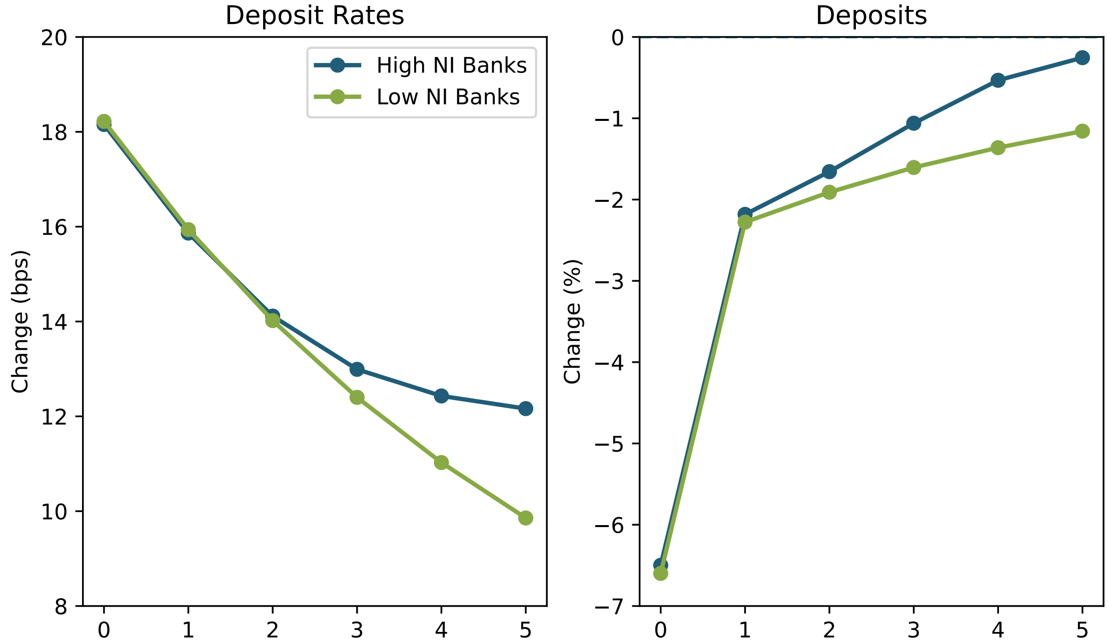


Notes: The left panel shows the deposit spread for high and low non-interest income banks at different levels of the policy rate. The center panel shows the non-interest income share for high and low non-interest income banks at different levels of the policy rate. The right panel shows bank deposits for high and low non-interest income banks at different levels of the policy rate.

Further, when the policy rate is low, banks operate with smaller deposit spreads and, thus, a lower net interest margin. This makes the traditional loan-deposit business model less profitable and increases the relative importance of fee income. Thus, non-interest income is a larger component of total income when the monetary policy rate is low (right panel).

We also simulate the cumulative impact of a one-time unanticipated 100 basis point monetary policy shock to see how equilibrium objects in the model respond. As shown in Figure 7, deposit rates behave similarly to the estimated effects from Section 3.2. For deposit rates, while the model captures the feature that high non-interest income share banks have lower pass-through, the relative difference between the two bank types is more modest. This is not a significant shortcoming of the model as the empirical estimation is based upon more extreme values (i.e. the 10th and 90th percentile of banks according to non-interest income shares) while our calibration is based upon a median threshold.

Figure 7: 100 Basis Point MP Shock (Model)



Notes: Lines reflect model-implied responses of deposit rates and deposits to a 100 basis point increase in the policy rate for low and high non-interest income share banks.

5.3 Counterfactual Analysis

In this section, we perform counterfactual exercises to understand the role of fee income for bank profitability, financial stability, deposit pricing, and credit supply. In the first counterfactual exercise, we measure the effect on banks of eliminating fee income. In the second exercise, we examine how changes in rate uncertainty affect both high and low non-interest income banks. Last, we consider the effect of changing the neutral interest rate and slope of the yield curve. This allows us to examine how policy-invariant non-interest income can affect banks in a high or low interest rate environment.

The Loss of Fee Income. To simulate the effect of no fee income for banks, we set the services elasticity parameter sufficiently high such that $f_i = mc_i^f$ and banks earn zero profit from their financial services. Table 5 records the outcomes for both bank types in levels while Table 6 reports changes, relative to the baseline model.

The loss of fee income acts as a significant decline in bank funding. Banks can respond by either shrinking the size of their balance sheet, increasing deposit funding, or decreasing dividends. In the counterfactual, banks respond with a combination of these options: total lending declines and deposit funding increases. For the latter, this can be seen through banks offering a lower deposit spread to attract more deposit funding. The net result is a more leveraged balance sheet with more risk, as measured by the change in bank z-scores. Thus, the loss of fee income is associated with increased bank risk and lower credit supply.

TABLE 5
Fee Income Versus No Fee Income Model Moments (Levels)

	High Share Banks		**Low Share Banks**	
Object	**Fee Income**	**No Fee Income**	**Fee Income**	**No Fee Income**
Capital Ratio	8.0	5.1	12.4	8.5
Deposit Spread	3.47	3.39	3.33	3.21
Return on Equity	8.3	9.4	6.1	6.7
Z-Score	6.3	4.5	9.4	6.8
Lending	1.0	0.98	1.0	0.97
Non-Int Inc Share	34	0	23	0

Note: This table reports the level of model moments, for both the *high non-interest income share* and *low non-interest income share* banks when banks do not generate fee income. The *Lending* row is normalized to 1 for the baseline scenario with fee income. Reported capital ratios are adjusted to account for non-deposit debt funding.

In addition, a paradoxical result emerges when examining cross-bank differences. Specifically, low non-interest income banks exhibit more sensitivity to the *no fee income* counterfactual. On the surface, this result seems contradictory: high non-interest income banks are the ones losing a larger share of their total income and should be more affected. While this is true, high non-interest income banks also have more deposit market power and are, thus, better insulated from the *no fee income* scenario.

As a result, while high non-interest income banks decrease total lending by 1.9% in the counterfactual, low non-interest income banks decrease lending by 2.8%. Further, the deterioration in financial stability is more pronounced for low non-interest income banks: their z-scores fall by 2.6, as opposed to 1.9.

TABLE 6
FEE INCOME VERSUS NO FEE INCOME MODEL MOMENTS (CHANGES)

	High Share Banks		**Low Share Banks**	
Object	**Fee Income**	**No Fee Income**	**Fee Income**	**No Fee Income**
Capital Ratio	–	-2.9	–	-3.9
Deposit Spread	–	-0.08	–	-0.12
Return on Equity	–	+1.1	–	+0.62
Z-Score	–	-1.8	–	-2.6
Lending	–	-1.9	–	-2.8
Non-Int Inc Share	–	-34	–	-22

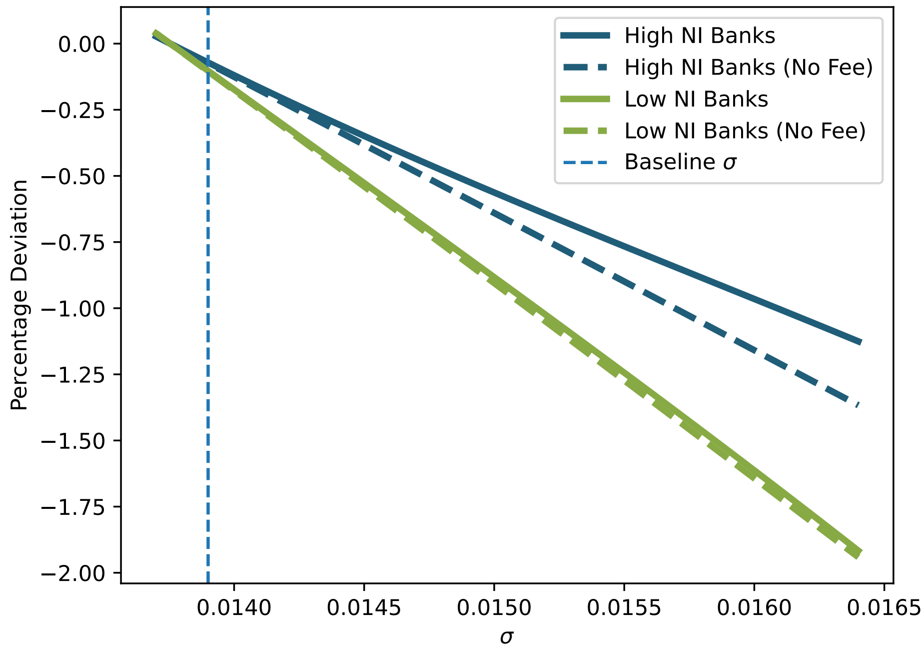
Note: This table reports the change in the level of model moments, for both the *high non-interest income share* and *low non-interest income share* banks when banks do not generate fee income. Change in lending is reported as *percentage change* relative to the baseline fee income scenario.

Elevated Uncertainty. In the second counterfactual exercise, we examine how increased rate uncertainty affects bank credit supply. Specifically, we examine how an increase in the volatility of the aggregate shock process σ_z affects the average quantity of bank loans. Higher σ_z translates into higher volatility in the monetary policy rate, as well as higher volatility in bank loan returns.

Figure 8 plots the average change in lending, relative to the baseline model, for both bank types. In the counterfactual, all banks respond to higher uncertainty by reducing their lending but low non-interest income banks, again, are more sensitive and decrease lending by more. This result can be explained through understanding bank risk tolerance and their dependence on fee income.

Given a convex cost function, bank value functions exhibit concavity and, thus, banks exhibit risk aversion. In the model, fee income acts as risk-free endowment. Given that high non-interest income banks have a larger risk-free endowment, they are less affected by an increase in interest rate risk in the counterfactual. This point is further illustrated when observing the *no fee income* counterfactual scenarios in Figure 8.

Figure 8: Return Uncertainty and Percentage Change Lending, by Bank Type



Note: This figure shows the change in lending as the rate/return uncertainty σ_z increases for different types of banks in a with and without NII environment.

Collectively, the first two counterfactual exercises emphasize that policy invariant fee income can be a stabilizing force for banks, supporting lending and financial stability. For other types of non-interest income that exhibit cyclical variation, such as trading revenue or underwriting fees, this may be less the case. For example, see DeYoung and Roland (2001) and Stiroh (2004).

Changing Interest Rate Environment. In the final exercise, we consider the impact of a change in the neutral interest rate r^* and yield curve slope via Δ^ℓ.[21] Specifically, we examine a *Low* r^* scenario corresponding to a 100 basis point decline in the neutral interest rate, as well as a *Flatter Curve* scenario corresponding to a 50 basis point decline in the loan spread. Table 7 presents the results.

In the *Low* r^* scenario, deposit spreads decrease by 42 to 47 basis points, leading to an inflow of deposit funds. Banks become more restrictive on credit issuance in the *Low* r^* scenario and lending contracts. The overall riskiness of banks, as measured by the z-score, increases and the capital ratio decreases, suggesting greater fragility in the financial system. Similar to the two

[21] For each change in r^* we also change the discount factor β to be consistent with the inverse of the gross rate.

previous counterfactuals, the results are qualitatively similar across banks but more pronounced for low non-interest income banks.

TABLE 7

Low versus High Interest Rate Environment

	High Share Banks		Low Share Banks	
Object	**Low r***	**Flatter Curve**	**Low r***	**Flatter Curve**
Capital Ratio	-9.2	-4.4	-10.8	-3.5
Deposit Spread	-.42	+0.05	-.47	+0.06
Return on Equity	+.64	-0.39	+1.71	+0.2
Z-Score	-5.6	-2.79	-7.1	-2.44
Lending	-1.1	-6.84	-3.5	-6.69
Non-Int Inc Share	+0.3	+1.63	+0.69	+1.27

Note: This table reports the change in the level of model moments, for both the *high non-interest income share* and *low non-interest income share* banks. The *Low r** scenario corresponds to a 100 basis point decrease in the annual neutral interest rate and the *Flatter Curve* scenario corresponds to a 50 basis point drop in bank loan spreads. Change in lending is reported as *percentage change* relative to the baseline scenario. Reported capital ratios are adjusted to account for non-deposit debt funding.

In the *Flatter Curve* scenario, banks exhibit a much larger balance sheet response and this is largely due to differences in deposit demand; banks decrease in does not need corresponding funding through deposits. In both scenarios, banks are negatively affected by thinner net interest margins: low deposit spreads in the *Low* r^* scenario and low loan spreads in the *Flatter Curve* scenario. In the former scenario, though, lower r^* directly increases deposit demand and pushes deposits onto a more inelastic part of the demand curve. This gives banks increased flexibility in managing their balance sheet. The main takeaway is that both — a lower r^* and a flatter curve — increase the volatility of bank aggregates, bank riskiness, and financial instability, the more so the less net interest income a bank holds (as this acts as a cushion and supports a larger share of bank income).

6 Conclusion

We provide novel empirical evidence that the pass-through of monetary policy to bank deposit rates depends upon a bank's use of fee income. Particularly, banks with higher fees and higher non-interest income shares have a lower pass-through to rates. These same banks also have a lower level of deposit rates, suggesting market power in both the deposit and financial services market. We argue that these findings are consistent with product tying: consumers must open a deposit account to access a bank's financial services. We further use a quantitative model of the U.S. banking industry to quantify the importance of non-interest income for credit supply, financial stability, and pricing.

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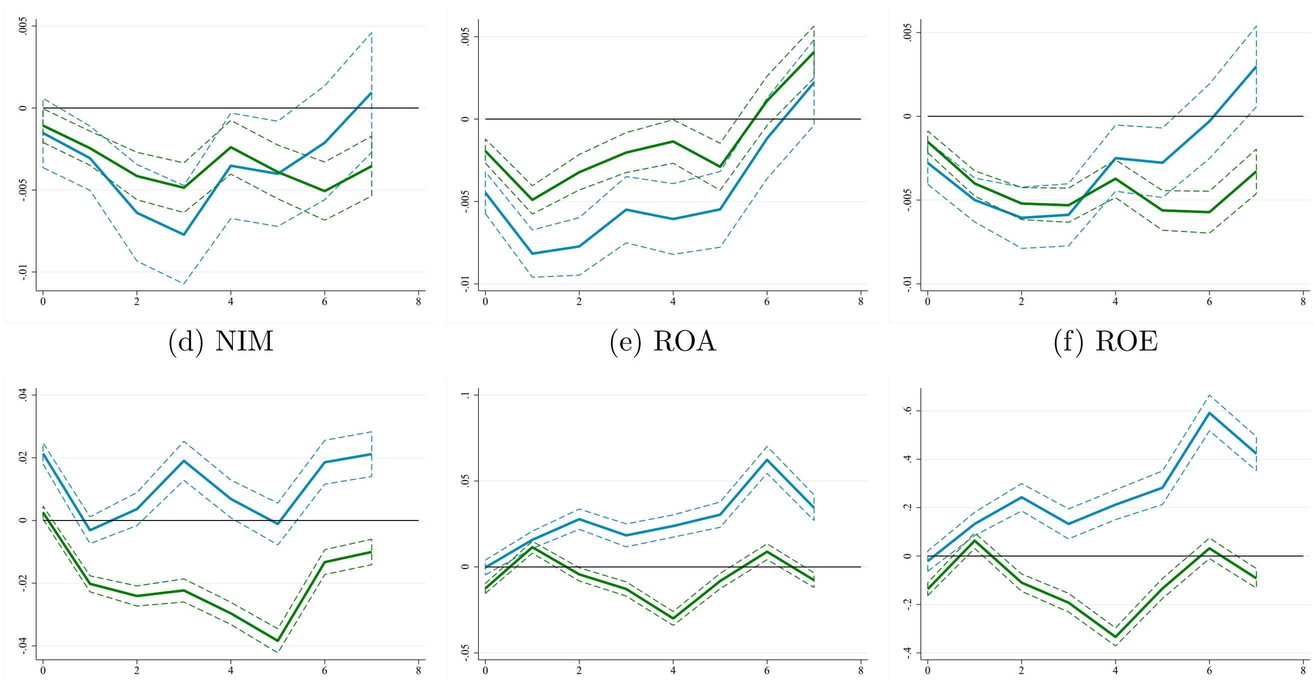
A Figures and Tables

Figure A.1: Bank-level local projections % by non-int. income

(a) Log (deposits) (b) Log (loans) (c) Log (assets)

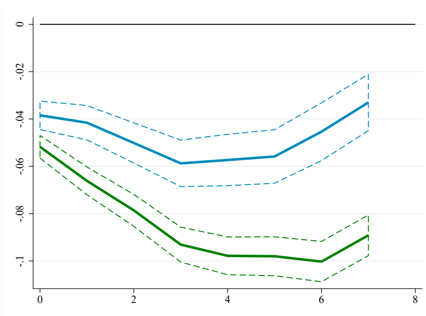


(d) NIM (e) ROA (f) ROE

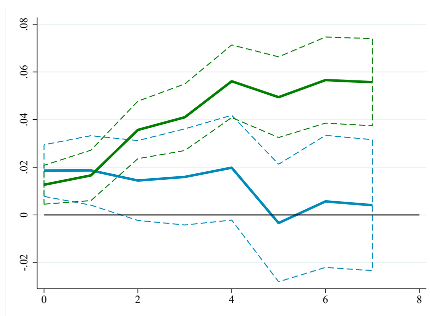
Notes: Impulse responses of deposits, loans, assets, net interest margin (NIM), return on assets (ROA), and return on equity (ROE) to a monetary policy shock at both high (blue) and low (green) shares of non-interest income to interest rate income. Horizon is in quarters. 90% confidence intervals.

Figure A.2: Bank-level local projections % by non-int. income: Add. variables

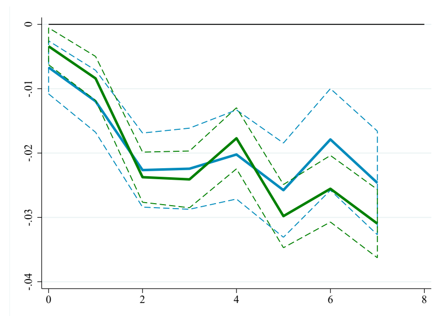
(a) Log (MBS)



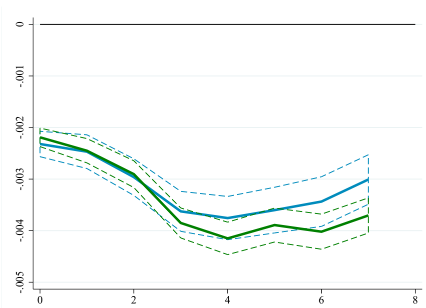
(b) Log (U.S. treasury sec.)



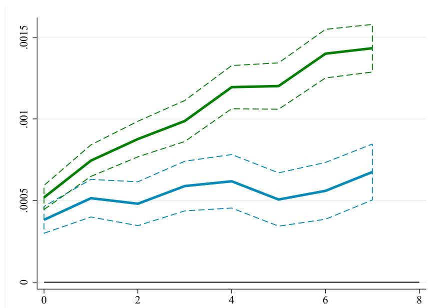
(c) Log (U.S. gov. agency obl.)



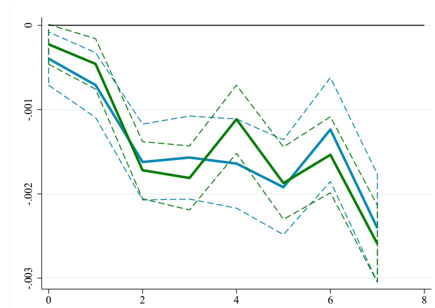
(d) MBS/assets



(e) U.S. treasury sec./assets



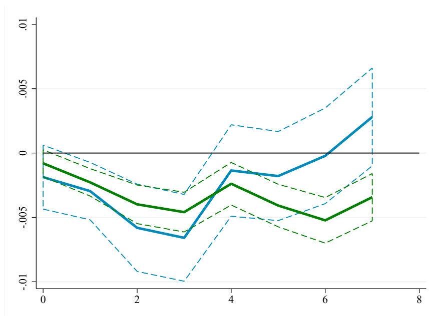
(f) U.S. gov. agency obl./assets



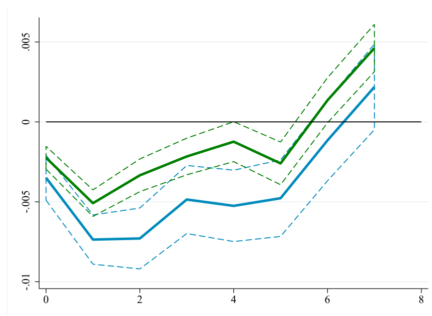
Notes: Impulse responses of mortgage-backed securities, U.S. treasury securities, U.S. government agency obligations in logs and as a ratio over total assets to a monetary policy shock at both high (blue) and low (green) shares of non-interest income to interest rate income. Horizon is in quarters. 90% confidence intervals.

Figure A.3: Bank-level local projections % by non-int. income (with controls)

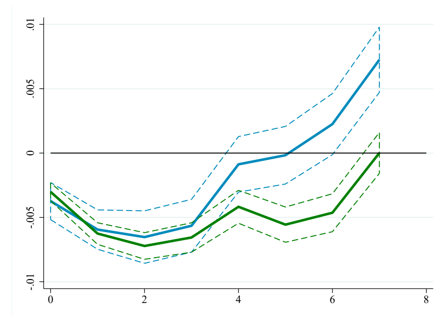
(a) Log (deposits)



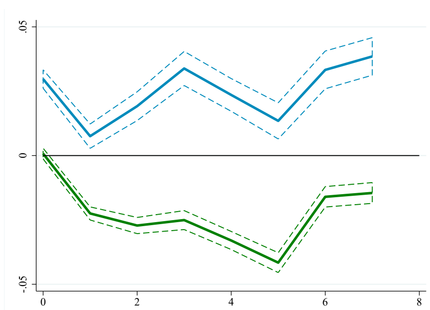
(b) Log (loans)



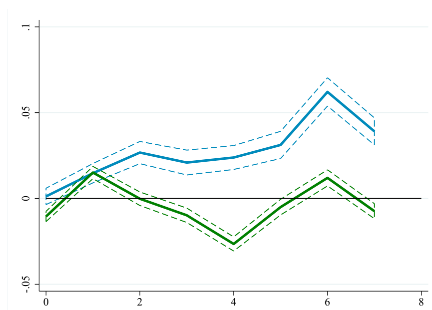
(c) Log (assets)



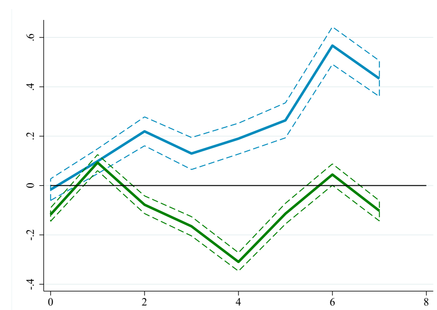
(d) NIM



(e) ROA



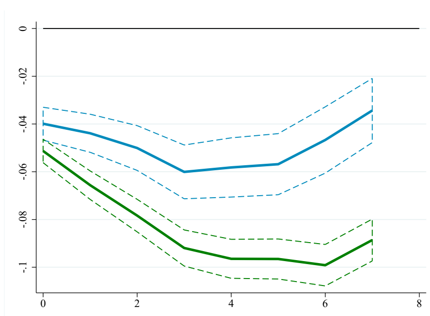
(f) ROE



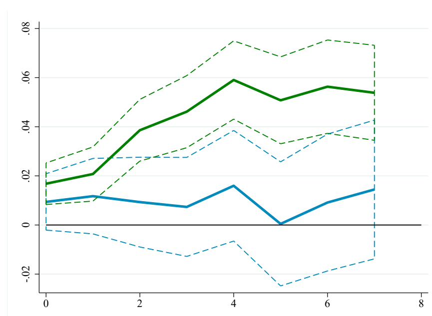
Notes: Impulse responses of deposits, loans, assets, net interest margin (NIM), return on assets (ROA), and return on equity (ROE) to a monetary policy shock at both high (blue) and low (green) shares of non-interest income to interest rate income. Horizon is in quarters. 90% confidence intervals.

Figure A.4: Bank-level local projections % by non-int. income (with controls): Add. variables

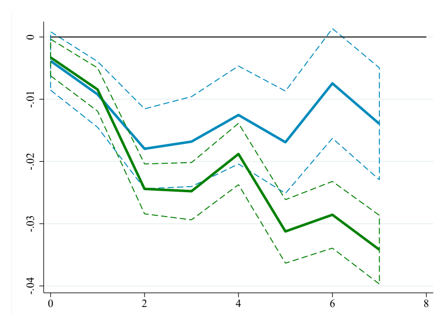
(a) Log (MBS)



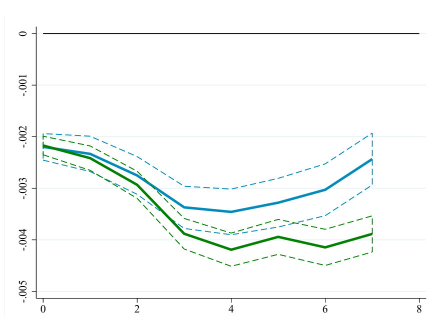
(b) Log (U.S. treasury sec.)



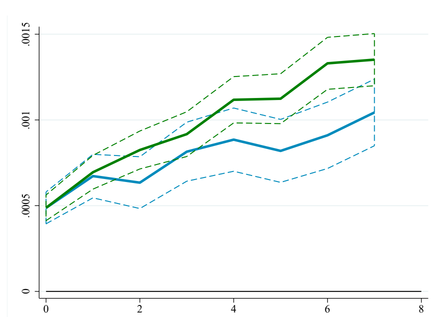
(c) Log (U.S. gov. agency obl.)



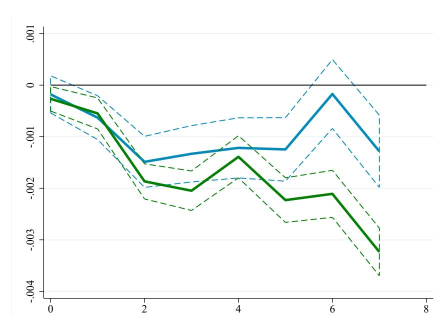
(d) MBS/assets



(e) U.S. treasury sec./assets

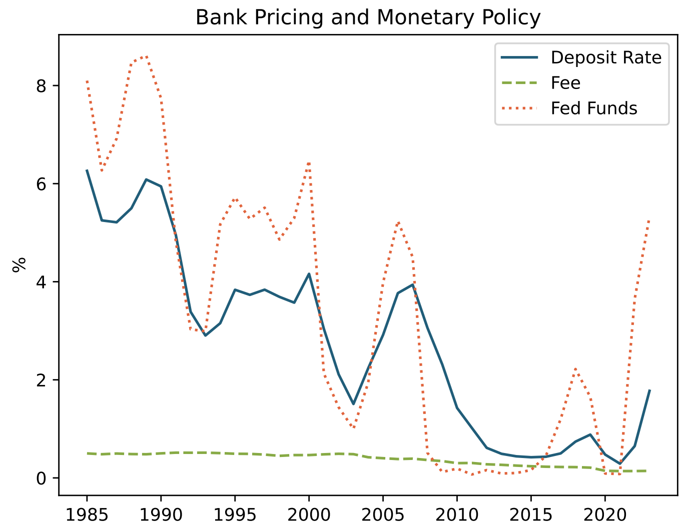


(f) U.S. gov. agency obl./assets



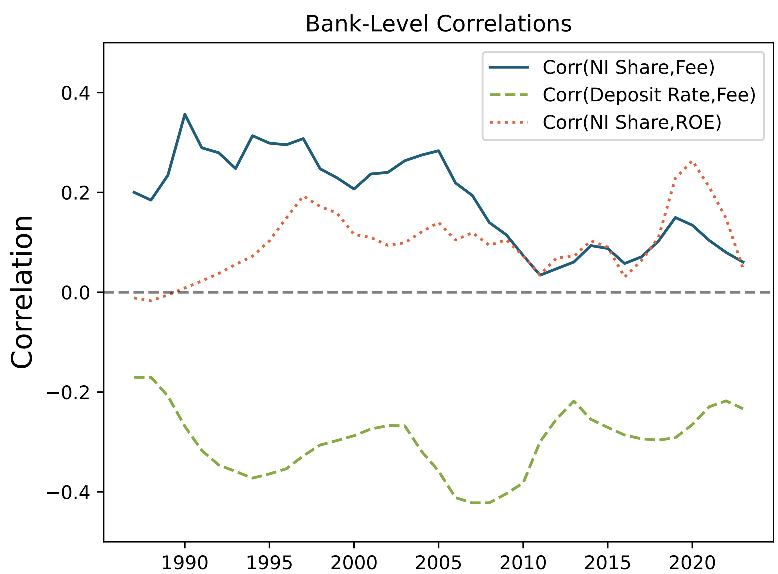
Notes: Impulse responses of mortgage-backed securities, U.S. treasury securities, U.S. government agency obligations in logs and as a ratio over total assets to a monetary policy shock at both high (blue) and low (green) shares of non-interest income to interest rate income. Horizon is in quarters. 90% confidence intervals.

Figure A.5: Deposit rates and fees over time



Notes: Deposit rate computed as the ratio of total deposit interest expense to total deposits. Fee rate computed as the ratio of service charge income on deposit accounts to total deposits. Numbers are annualized by using comprehensive Q4 expense and income for each fiscal year. Source: FDIC.

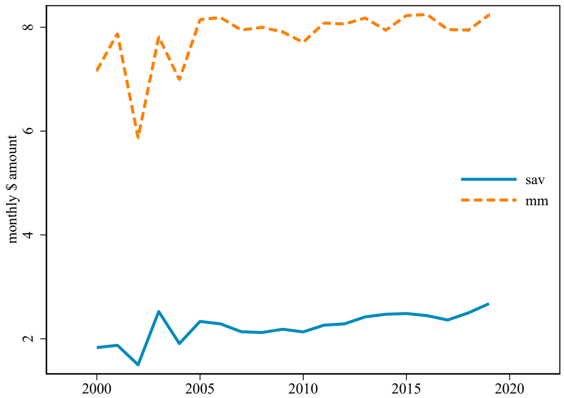
Figure A.6: Correlation of Deposit rates, Fees and Non-Interest Income at the Bank Level



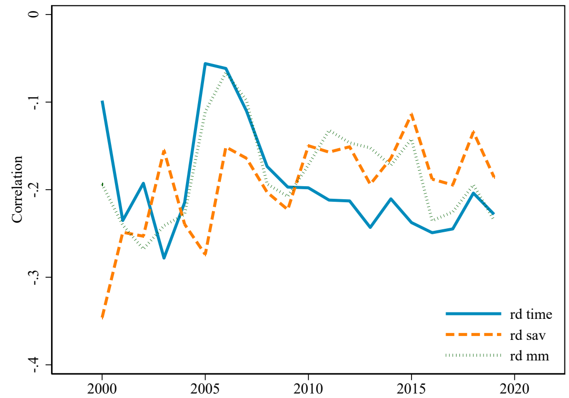
Notes: Deposit rate computed as the ratio of total deposit interest expense to total deposits. Fee rate is computed as the ratio of service charge income on deposit accounts to total deposits. Numbers are annualized by using comprehensive Q4 expenses and income for each fiscal year. For each quarter, compute the cross-sectional correlation and apply a rolling three-year average to smooth out the time series. Source: FDIC.

Figure A.7: Branch-level evidence

(a) Average monthly charges



(b) Correlation monthly charges and rates



Notes: Average monthly charges for savings and money market accounts. The correlation coefficient of monthly charges and deposit rates. Converted to yearly frequency (average). Correlation for each point in time. Source: RateWatch.

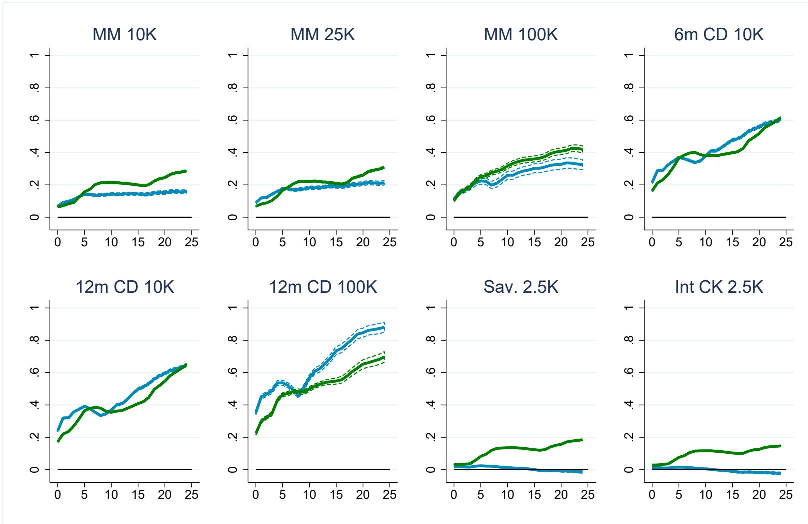
TABLE A.1

Bank balance sheet characteristics by non-interest income share %

	1	2	3	4	Average
% Non-int Income Share	.05	.09	.12	.21	.12
Assets ($,mil)	464	401	603	6,398	1,966
% Deposits	.82	.83	.84	.83	.83
% Insured deposits	.84	.83	.81	.79	.81
Maturity Gap	4.40	4.34	4.41	4.40	4.39
eqv	11.86	10.87	10.53	10.38	10.91
Total Risk-Based CR	19.83	17.47	16.67	16.06	17.50
Tier 1 Risk-Based CR	18.73	16.35	15.54	14.92	16.38
Liquidity Ratio	3.46	3.01	2.68	2.38	2.88
Loan Markups	4.86	2.51	2.71	3.26	3.23
Deposit Markups	.67	.67	.68	.68	.68
Service Charge as % NII	.50	.50	.48	.40	.47
Fiduciary as % NII	.11	.11	.15	.20	.16
Other as % NII	.58	.52	.52	.56	.54
Loan Sales as % Assets	.63	.63	.63	.63	.62
RE Loan Sales % Assets	.47	.44	.45	.44	.45
Securities as % Assets	.23	.23	.22	.22	.23
Wholesale Funding % Assets	.13	.15	.16	.17	.15
Int-Bearing Deposits % Assets	.71	.74	.74	.74	.73
Deposit Rates	1.45	1.17	.93	.90	1.06
Loan Rates	5.63	5.57	5.28	5.19	5.37
ROA	.86	.934	.98	1.02	.95
ROE	7.92	9.16	9.85	10.51	9.36
Bank HHI	0.21	0.23	0.23	0.21	0.22
# of branches	14.83	13.04	18.70	76.09	32.36

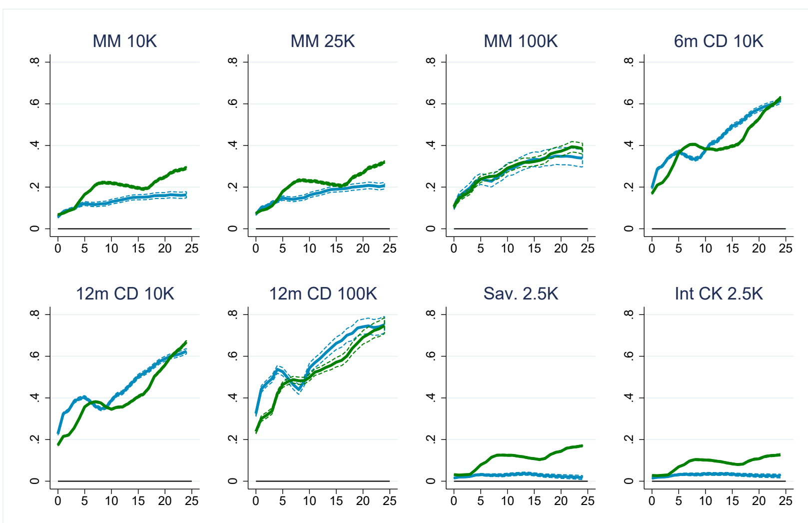
Notes: Summary statistics grouped by share of non-interest income. We differ between four groups and calculate the average for the period of 2000-2022. Non-interest income share is the 20-quarter average by bank institutions.[22]

Figure A.8: Local projections of deposit rates to monetary shock by 5-year avg. non.-int inc. share



Notes: Impulse responses of different deposit rates to a monetary policy shock at both high (green) and low (blue) shares of non-interest income to interest rate income. Horizon is in months. (90% confidence intervals).

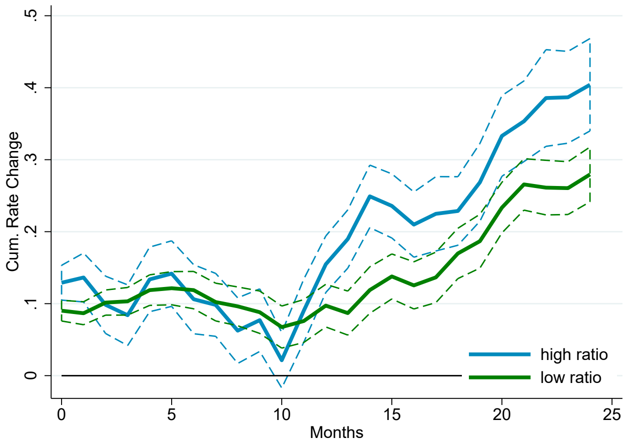
Figure A.9: Local projections of deposit rates to monetary shock by 5-year avg. non.-int inc. share (with bank-level controls)



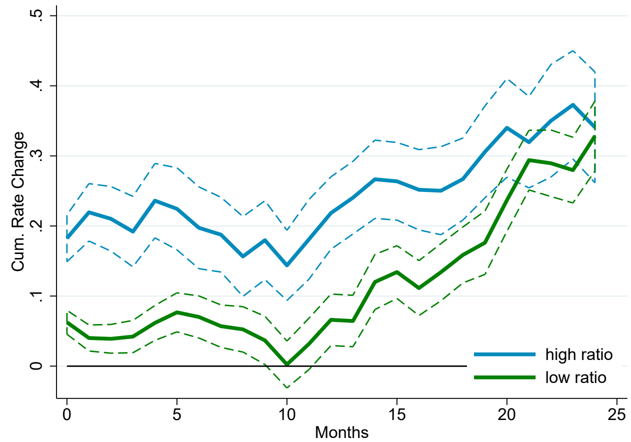
Notes: Impulse responses of different deposit rates to a monetary policy shock at both high (blue) and low (green) shares of non-interest income to interest rate income. Horizon is in months. (90% confidence intervals).

Figure A.10: Local projections of loan rates to monetary shock by 5-year avg. non.-int inc. share

(a) Baseline



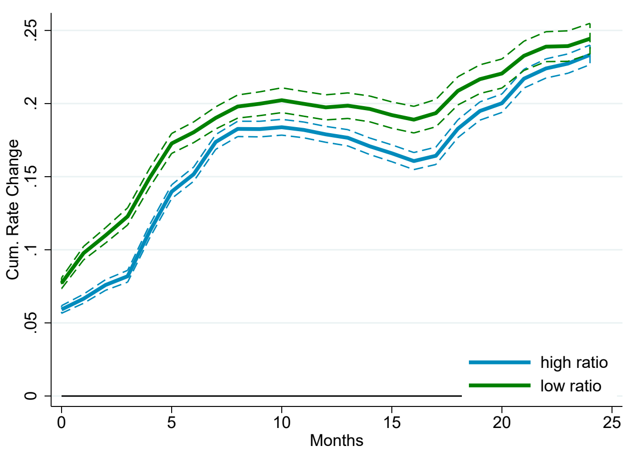
(b) With bank-level controls



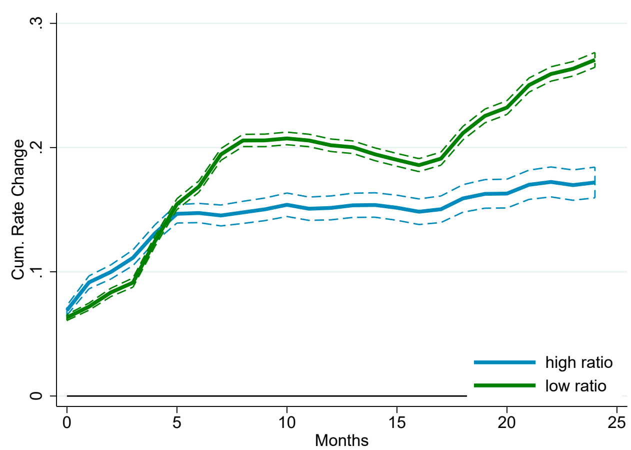
Notes: Impulse responses of the 1-year adjustable mortgage rate to a monetary policy shock at both high (blue) and low (green) shares of non-interest income to interest rate income. Horizon is in months. (90% confidence intervals).

Figure A.11: Narrower categories of non-interest income

(a) Service charges on deposit accounts over total non-interest income



(b) Additional non-interest income over total non-interest income

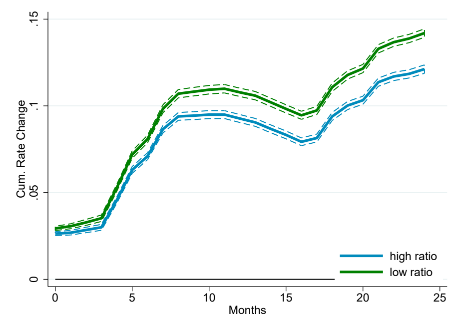


Notes: Impulse responses of the MM rate 10K to a monetary policy shock at both high (blue) and low (green) shares of 5-year avg. of service charges on deposit accounts over total non-interest income and 5-year avg. of additional non-interest income over total non-interest income, respectively. Horizon is in months. (90% confidence intervals).

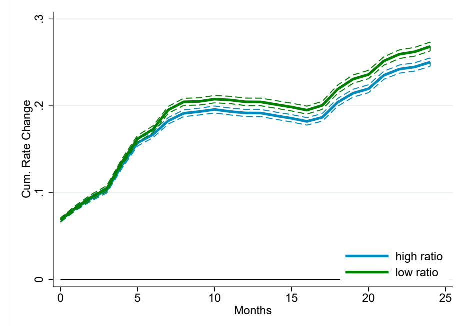
Figure A.12: Number of Branches as a proxy for payment services quality

Without controls

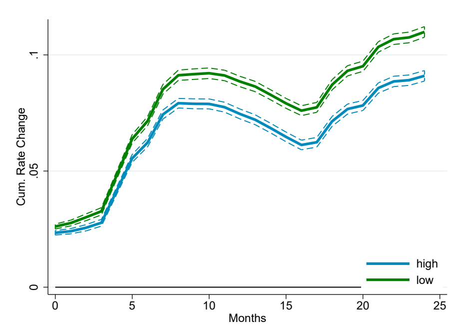
(a) Savings (2.5K)



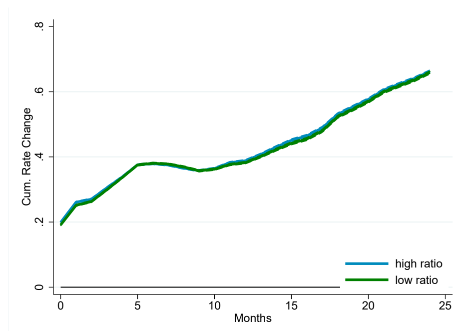
(b) Money Market (10K)



(c) Checking (2.5K)

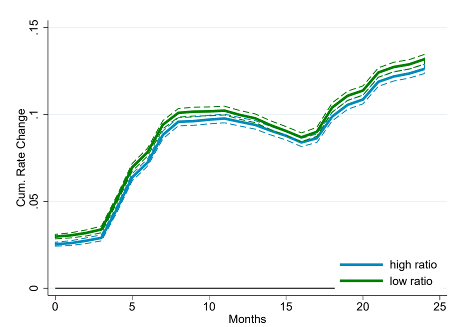


(d) Certificate of deposit (10K)

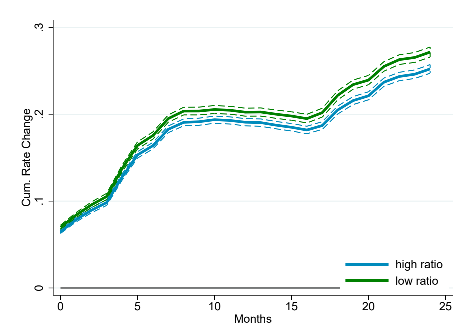


With controls

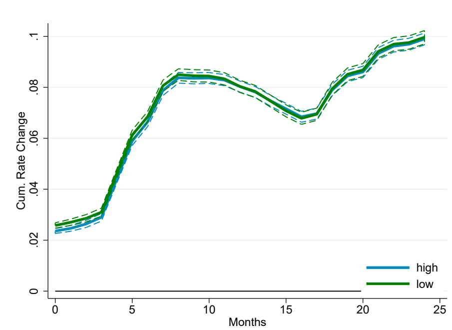
(e) Savings (2.5K)



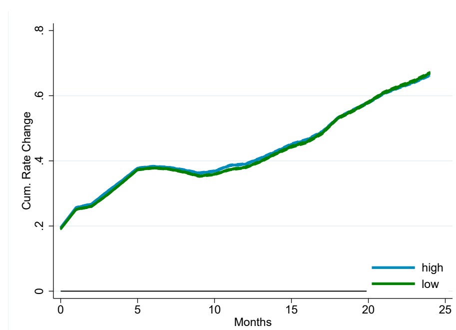
(f) Money Market (10K)



(g) Checking (2.5K)



(h) Certificate of deposit (10K)

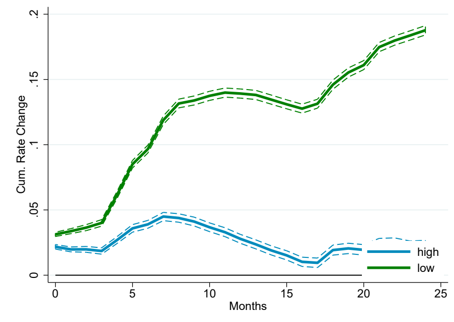


Notes: Impulse responses of deposit rates (savings accounts, money market accounts, checking accounts, and certificates of deposit) to a monetary policy shock at both high (blue) and low (green) number of branches. Horizon is in months. 90% confidence intervals.

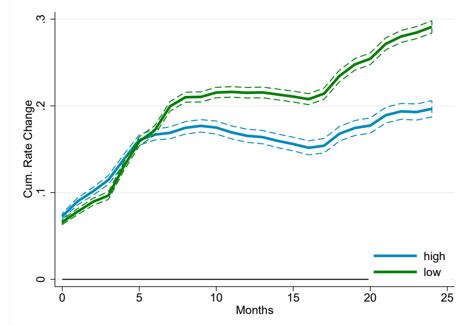
Figure A.13: Log Number of Branches as a proxy for payment services quality

Without controls

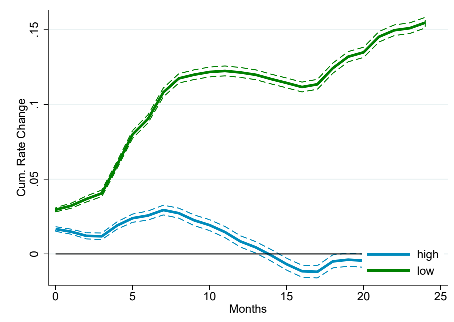
(a) Savings (2.5K)



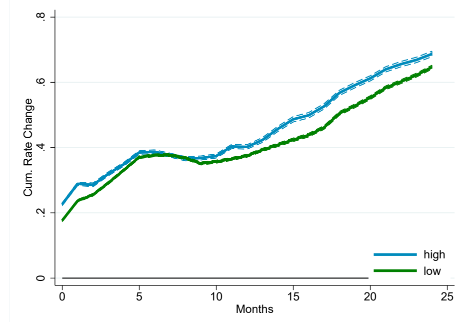
(b) Money Market (10K)



(c) Checking (2.5K)

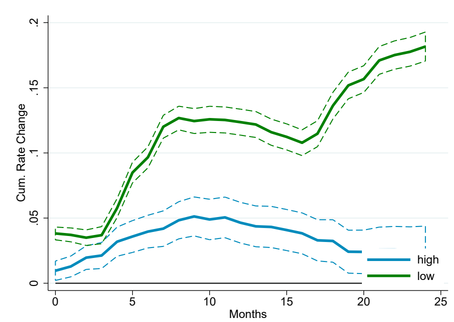


(d) Certificate of deposit (10K)

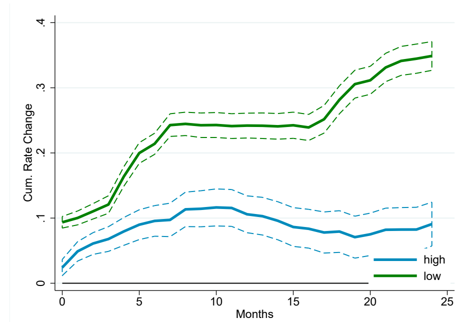


With controls

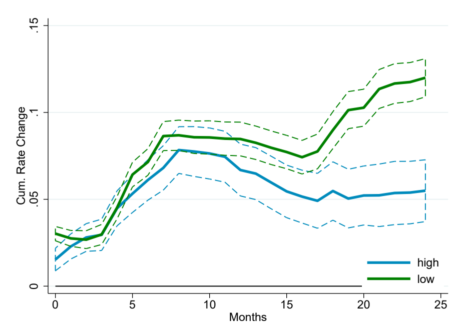
(e) Savings (2.5K)



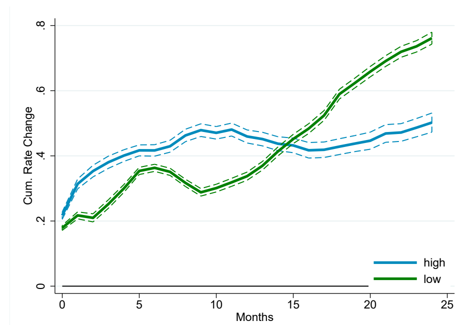
(f) Money Market (10K)



(g) Checking (2.5K)



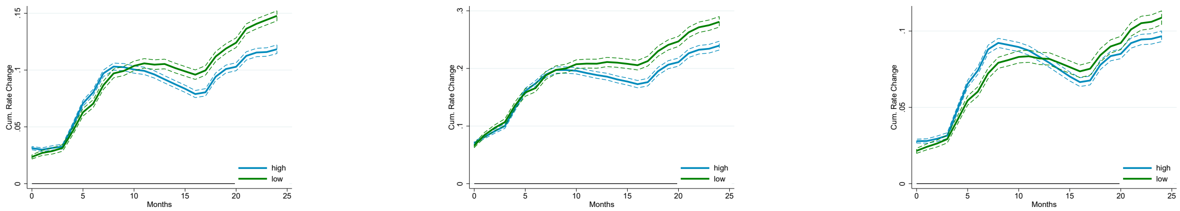
(h) Certificate of deposit (10K)



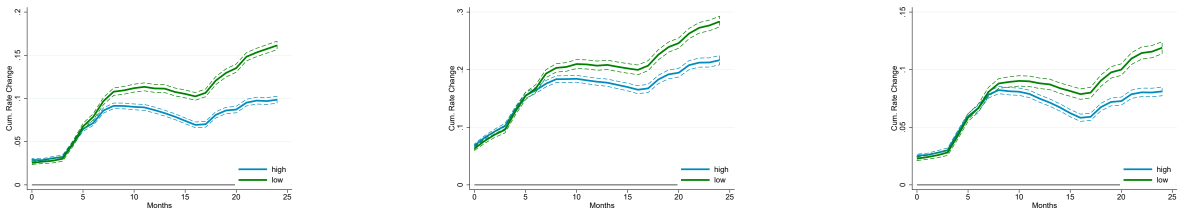
Notes: Impulse responses of deposit rates (savings accounts, money market accounts, checking accounts, and certificates of deposit) to a monetary policy shock at both high (blue) and low (green) log number of branches. Horizon is in months. 90% confidence intervals.

Figure A.14: Fee price as a proxy for payment services quality

(a) Savings (2.5K) (b) Money Market (10K) (c) Checking (2.5K)



(d) Savings (2.5K) - 5yr avg (e) Money Market (10K) - 5yr avg (f) Checking (2.5K) - 5yr avg



Notes: Impulse responses of deposit rates (savings accounts, money market accounts, checking accounts, and certificates of deposit) to a monetary policy shock at both high (blue) and low (green) fee prices (calculated as service charges on deposit accounts over deposits: iserchg/dep). Horizon is in months. 90% confidence intervals.

Figure A.15: Local projections of MM 10K rate to monetary policy

(a) Commercial bank (b) Credit union (c) Savings & loan assoc (d) Internet bank

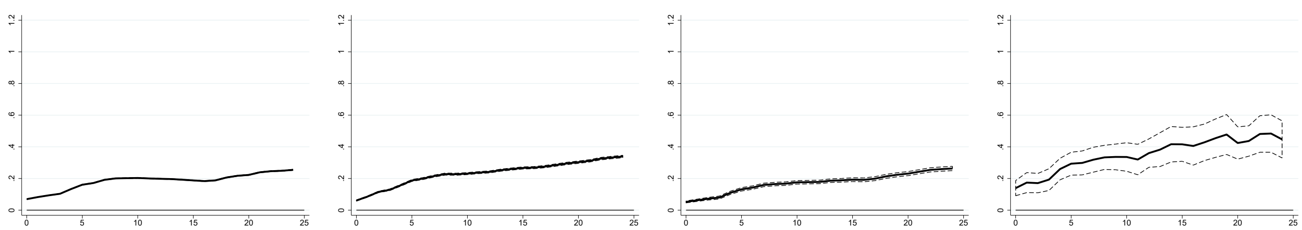


Figure A.16: Local projections of Sav 2.5K rate to monetary policy

(a) Commercial bank (b) Credit union (c) Savings & loan assoc (d) Internet bank

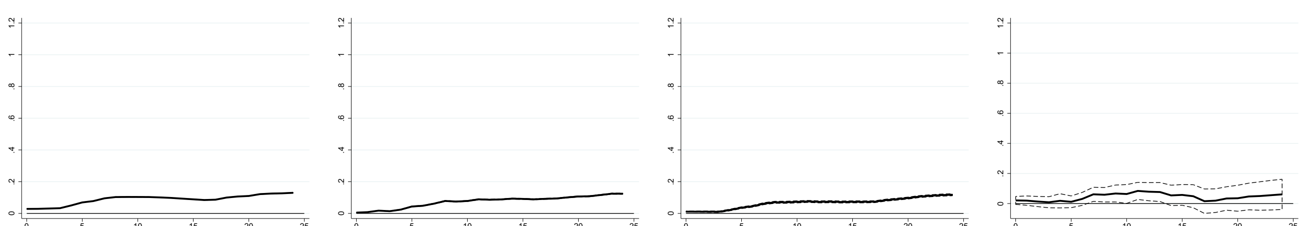


Figure A.17: Local projections of 12M CD 10K rate to monetary policy

(a) Commercial bank (b) Credit union (c) Savings & loan assoc (d) Internet bank

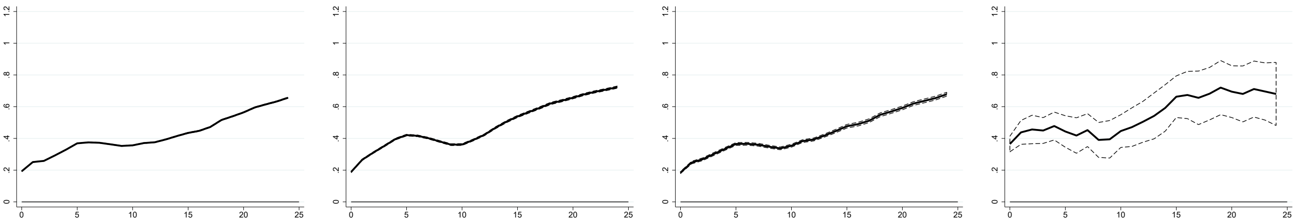
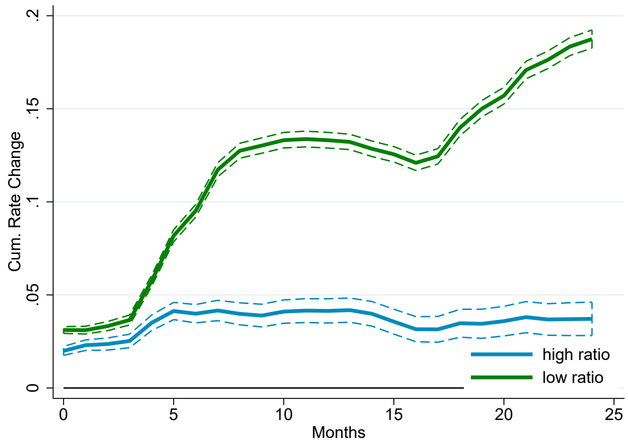
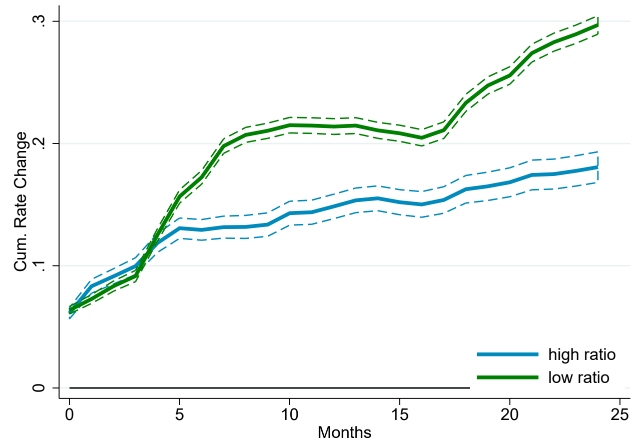


Figure A.18: Estimation at the headquarter level

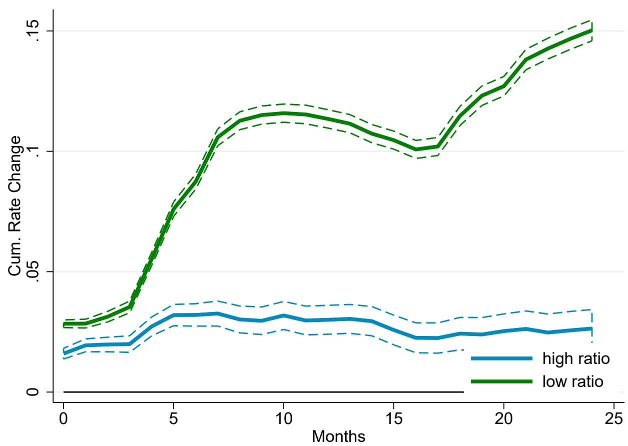
(a) Savings (2.5K)



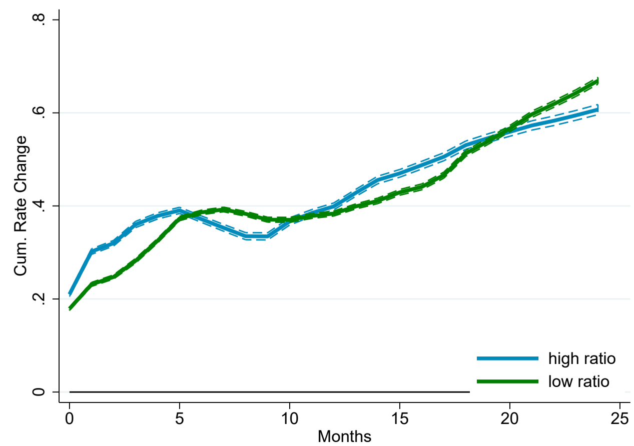
(b) Money Market (10K)



(c) Checking (2.5K)



(d) Certificate of deposit (10K)



Notes: Impulse responses of deposit rates (savings accounts, money market accounts, checking accounts, and certificates of deposit) to a monetary policy shock at both high (blue) and low (green) shares of non-interest income to interest rate income. Horizon is in months. 90% confidence intervals.