Interest Rate Risk in Banking*

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Abstract

We develop a theoretical and empirical framework to estimate bank franchise value. In contrast to regulatory guidance and some existing models, we show that sticky deposits combined with low deposit rate betas do *not* imply a negative duration for franchise value. Operating costs could in principle generate negative duration, but they are more than offset by fixed interest rate spreads that arise largely from banks' lending activity. As a result, bank franchise value declines as interest rates rise, and this decline exacerbates, rather than offsets, losses on banks' security holdings. We also show that in the cross-section, banks with the least responsive deposit rate tend to invest the most in long-term securities, suggesting that they are motivated to hedge cash flows rather than market value. Finally, despite significant losses to both asset *and* franchise values stemming from recent rate hikes, our analysis suggests that most U.S. banks still retain sufficient franchise value to remain solvent as ongoing concerns.

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1 Introduction

Banks are a portfolio of loans with varying maturities, funded primarily by short-term demand deposits. The value of a bank can stem from its ability to discriminate among borrowers and earn a spread on its loan portfolio. The value of a bank can also arise from the money-services that its deposits provide to customers, which allow the bank to earn a convenience yield on issuing deposits. Finally, banks incur operating costs to provide these screening, monitoring, and convenience services, as well as to acquire new borrowers and depositors. Together, these loan and deposit spreads, net of operating costs, determine the bank's "franchise value" — that is, its value in excess of the market value of its portfolio of assets and liabilities.

This paper lays out a framework to estimate the franchise value of a bank, accounting for both the value created on the loan side as well as that on the deposit side, and consider how it interacts with the bank's deposit and lending portfolio. We apply our valuation model to data from the U.S. banking system to address three important questions: what is the magnitude and duration of bank franchise value, how does it vary in the cross-section, and what are the implications for optimal policy.

First, spurred by the failure of interest rate risk management at SVB, there has been academic and policy research on estimating the duration of a bank. While many bank deposits are contractually short-term, they are de-facto longer term because depositors are slow to withdraw deposits from low yielding accounts. A further implication of the sticky deposit behavior is that banks only partially adjust offered deposit rates, which move far less than one-for-one with money market interest rates (the low deposit β in the literature). Bank regulatory guidelines (BCBS, 2016), central bank researchers (Hoffmann et al., 2019; Luck et al., 2023; Greenwald et al., 2023; Paul, 2023), and academic researchers (see e.g. Metrick (2024), Bolton et al. (2023)) have argued that this phenomenon leads to a negative duration for the deposit franchise. If correct, this argument would imply that banks should optimally own long duration assets to hedge the negative duration of its deposits. Instead, in contrast to this existing policy, practitioner, and academic viewpoint, we find that after accounting for the flow of income from both asset- and deposit-side activities, the typical bank franchise has a positive, not negative, duration.

Consistent with other researchers, we find that having a low yielding deposit base on which the bank pays $\beta \times r_t$ with $\beta < 1$, provides the bank with a convenience yield $r_t \times (1 - \beta)$ that rises with interest rates (r_t). However, it is incorrect to conclude from this flow sensitivity that the deposit franchise will have a negative duration. The reason is that the present value of a stream of flow of income of $r_t \times (1 - \beta)$ discounted at the interest rate r_t has a fixed value of $1 - \beta$ which does not depend on interest rates. Flows may be sensitive to interest rates, but the valuation of those flows will not be, and it is the latter which drives the duration of a bank. Regulatory guidelines often create an implied negative duration by suggesting that deposits be treated as having a five to ten year "maturity," at which time this implied value of $1 - \beta$ will be lost. Higher interest rates reduce the present value of this loss, raising the implied franchise value.

In academic research, (Drechsler et al., 2021, 2023a) also model a deposit base that generates a flow of income of $r_t \times (1 - \beta)$. In order to earn this income they model a bank that incurs a fixed stream of operating costs. In their analysis, the income from the deposit base has zero duration, as argued above. Yet they find a negative duration for the bank stemming primarily from the fixed costs of operating the deposit franchise as well as attrition of the deposit base.

We reassess the duration of banks' franchise value by jointly analyzing banks' deposit and lending activity. Importantly, our analysis shows that a key piece of overall bank duration comes from the loan spread banks earn on the asset side. This loan spread flow is long duration and more than offsets the costs of running the deposit franchise for most banks, which explains why our results differ from (Drechsler et al., 2023a). Thus the typical bank is a portfolio of positive duration assets (loans and securities) and a positive duration due to the flow of income coming from spreads in excess of operating costs. On the deposit side, the deposit franchise generates a flow of income in proportion to the interest rate (i.e.,

$r_t \times (1-\beta)$), akin to a floating rate bond with zero duration. Combining all of these pieces, we estimate that the typical bank is positive not negative duration even after accounting for the deposit franchise.

Empirically, we document an inverse relation between the β of a bank and the total duration contributed by the bank's securities portfolio (consistent with Drechsler et al. (2021)). The regulatory guidance banks receive is one rationale for this finding. As noted, regulators suggest that banks treat a low-β deposit as if it is a long duration fixed-rate liability. Thus, a bank with a low β may choose to hold positive duration securities to offset this regulator-prescribed negative duration of the deposit base.

Alternatively, banks may be acting to stabilize their net interest margins (NIM). By purchasing long duration securities, their net, after funding-cost, income from their assets is negatively related to r_t thus acting as a hedge against their deposit income which is positively related to r_t. However, as we have argued, such hedging behavior does not stabilize the market value of a bank, and instead increases duration risk for most banks. In the last two years these actions have led to increased fragility of the banking system. SVB is a manifestation of this hedging mistake. Our result that banks' actions have increased their true interest rate exposure is similar to the findings of Begenau et al. (2015).[1]

Since the failure of SVB, a central issue for investors and bank regulators is to assess how the increases in interest rates from 2021 to 2023 has affected the fragility of the banking system. Jiang et al. (2023) assess the change from 2021Q1 to 2023Q1 in the value of U.S. banks and the entire banking system, computing the change in the value of securities and loans, and asking whether such change leads to a shortfall of the value of a bank relative to its debts. This exercise measures a bank's "liquidation value": liquidate the bank's assets at market values and then ask whether these assets cover the bank's outstanding debts. They estimate a decline of over \$2 trillion in bank asset value, implying that a substantial number

[1]These findings are also consistent with the literature that examines the impact of surprise movements in interest rates due to FOMC announcements on bank stock prices (English et al., 2018)

of U.S. banks are currently insolvent.[2] The exercise assumes that the deposit franchise has zero value. Rather than the liquidation value, Drechsler et al. (2023b) estimates the "going concern value" of banks, which includes the deposit franchise value that would accrue to a bank if it was not liquidated. Given the Drechsler et al. (2023a) result that the deposit franchise has a negative duration, they estimate that the value of the deposit franchise *rises* on the order of $1 to 2 trillion as rates have risen. [3]

We include both assets and liabilities in computing the going concern value of the bank to assess the solvency of the U.S. banking system. We find that despite banks' duration hedging error, the franchise value for the typical bank is substantial. Although this franchise value has declined with the rise in interest rates, enough remains to cushion the losses suffered by most banks. As a result, we estimate a smaller fraction of insolvent banks than Jiang et al. (2023). Nevertheless a robust conclusion of our work is that the franchise value did not rise as interest rates rose. That is, franchise value has not been a hedge against the rise in interest rates in contrast to regulatory guidance as well as the analysis of Drechsler et al. (2023b).

Our finding that banks' franchise value has positive duration is also in sharp contrast to banks' own estimates of the impact of future interest-rate hikes that they reported in their 10k filings. In their 2021 filings, almost all banks in our sample, including those with high exposure to long-duration securities, estimated that upward shifts in the yield curve would *raise* the market value of their equity. These estimates are inconsistent with the actual market value impact of subsequent interest-rate hikes and with the economic logic of our valuation model.

Our valuation exercise takes as inputs a given bank's interest income, interest expense, and franchise costs. We use this data, along with interest rate movements, to estimate the deposit beta, and hence the deposit spread earned by the bank, together with its loan spread

[2]Flannery and Sorescu (2023) perform a related analysis, accounting for the impact of loan and security losses due to the rise in interest rates on Tier 1 equity capital, and concluding that a substantial number of banks are insolvent if these losses are booked.

[3]Drechsler et al. (2023b)'s exercise only considers the cash flows associated with the deposit franchise, while we consider both the loan and deposit side.

income, to determine the bank's total spread income net of operating costs. We assess the interest rate sensitivity of this flow and use our valuation model to estimate the franchise value of a bank. As a check, we compute our model-implied market/book for a set of publicly traded banks and compare this to the stock market's assessed market/book in 2021. We show that our estimates are in line with the market valuation. We also compare our model-implied change in values from 2021 to 2023 to that of the market. The model-implied changes share many of the same qualitative properties as the actual market value changes—losses are higher for banks with high exposure to long-duration securities, for example—but the magnitude of the model-implied changes is larger than the market value changes, although not by as much as the losses estimated by Jiang et al. (2023). Possible reasons for the discrepancy include misvaluation in the stock market or changes in option value components (Kelly et al., 2016) that we do not capture in our calculations.

The paper is organized as follows. The next section presents our valuation framework. Section 3 describe the data. Sections 4 and 5 estimate the components of value and duration for banks, both in the aggregate and cross-section. Section 6 analyzes the model-implied losses to banks from the rise in interest rates from 2021 to 2023, and compares these estimate to other benchmarks. A conclusion and appendix are at the end.

2 Valuation Framework

In this section we develop a basic theoretical model of bank franchise value. There are two potential sources of this franchise value. First, the bank provides transaction services that allow it to pay below market rates on its deposits. Second, the bank may perform screening or monitoring functions that allow it to charge a premium on its loans. These activities are positive NPV as long as the combined deposit and lending spreads exceed the operating cost of the franchise. After laying out the basic model, we then develop the empirical strategy to estimate it.

2.1 Balance Sheet Model

We begin with the following balance sheet model of a bank. The bank raises funds through deposits, external borrowing by issuing bonds or other forms of debt, and issuing equity. These funds are used to make loans or hold tradeable securities. Table 1 illustrates a simple bank balance sheet.

ASSETS	**LIABILITIES**
Loans (L)	Deposits (D)
Tradeable Securities (T)	External Borrowing (B)
	(Book) Equity
Tangible Assets (A)	Liabilities and Equity

Table 1

We assume that the bank's tradeable security purchases (T), along with its external borrowing (B) and equity issuance, are all market-based transactions with zero NPV at the time of trade.

On the other hand, the bank can create value via its deposit-taking (D) and loan-making (L) activities. This value results from the interest rate spread the bank offers on deposits, and charges on loans, relative to the equivalent market rate. These spreads can exist because of the bank's market power, informational advantages, provision of transaction services, etc.

Specifically, we define the interest rate spread on deposits and loans, relative to the short-term funding rate, as follows:

$$\text{Deposit rate spread} \equiv r^* - r^D, \quad \text{Loan rate spread} \equiv r^L - r^* \tag{1}$$

where r^D is the average rate paid on deposits, r^L is the average rate earned on loans, and r^* is the short-term risk-free interest rate.

Letting D be the total amount of deposits, and L the total amount of loans, the total cash flow generated by these rate spreads is given by:

$$S \equiv \underbrace{D(r^* - r^D)}_{S^D} + \underbrace{L(r^L - r^*)}_{S^L} \tag{2}$$

To normalize for bank size, we also define spreads scaled by tangible assets:

$$s^D \equiv \frac{S^D}{A}, \quad s^L = \frac{S^L}{A}. \tag{3}$$

We refer to $s = s^D + s^L$ as the total spread earned by the bank, and s^D and s^L as the deposit and loan spread, respectively, per dollar of assets.

To generate these spreads, the bank incurs operating costs C that includes rent, salaries, trading costs, loan losses, etc. We define the bank's franchise value as the present value of these spreads net of costs:

$$\text{Franchise Value} = PV(S - C). \tag{4}$$

The primary goal of our analysis is to provide an empirical estimation of this franchise value and its sensitivity to changes in market interest rates. Understanding this franchise value is essential to determining the solvency of the bank as an ongoing enterprise.

Long-term Solvency: While we have assumed that security purchases and debt issuances have zero NPV initially, ex post the value of these assets and liabilities will fluctuate with market interest rates. To determine solvency, we must incorporate these mark-to-market gains or losses. Define the notation MTM_p to be the current mark-to-market gains or losses for some portfolio of securities p. Specifically, MTM_{T-B} represents the mark-to-market gains on the bank's tradeable securities net of any increase in value of its external borrowing. Then the bank is solvent as an ongoing enterprise if and only if

$$\text{pretax Market Equity} = \underbrace{\text{Book Equity} + MTM_{T-B}}_{\text{Portfolio Value}} + \underbrace{PV(S-C)}_{\text{Franchise Value}} \geq 0. \tag{5}$$

Note that the present value of the spread includes changes in the value of bank's deposit and lending portfolio. This solvency condition (5) makes clear that to insure against potential insolvency, the bank's position in tradeable securities and borrowings should hedge potential losses to franchise value.

Short-term Solvency: The ongoing solvency condition (4) is distinct from the condition determining the short-term solvency in the event of a potential bank run. Uninsured creditors will suffer losses in the event of liquidation unless

$$\text{Book Equity} + MTM_T - \theta L \geq 0, \tag{6}$$

where θ represents the "haircut" on the bank's loan portfolio if acquired by another lender, encompassing costs associated with illiquidity, asymmetric information, and mark-to-market adjustments. When condition (6) fails, then in the event of liquidation the bank will be unable to pay the face value of its liabilities. Importantly, there is likely to be significant gap between the left-hand side of (5) and (6). The relevant case for regulators is when this gap is positive and the bank remains solvent from an ongoing perspective yet may be subject to short-term illiquidity, in which case forbearance may be warranted.[4]

In our valuation exercise, we measure the continuation value of the bank and assume that the short-term solvency condition is always met. In a stochastic model, it is possible that realizations of shocks push down the market value of a bank so that the long-term solvency condition, (5), is met, but that the short-term solvency condition is violated. In this case,

[4]The existence of multiple equilibria in this case will be relevant when evaluating the market value of equity, and will depend in part on regulators' decision rule regarding when to shut down the bank.

there is the possibility that a bank is liquidated and the ex-ante franchise value of the bank will be affected, as in the analysis of Haddad et al. (2023). As we are interested in the franchise value the bank could achieve if it continues as an ongoing concern, we set aside this possibility in our exercise.

2.2 Franchise Value Estimation

In this section we outline the theory behind our approach for estimating franchise value. We begin with a simple (and standard) model of deposit spreads and evaluate its consequences for deposit franchise valuation and duration. We then extend the model to allow for term deposits and loans, and finally summarize our empirical strategy.

A Simple Model of Franchise Value: We start with a standard model of deposit rates and the implications for deposit franchise value. Suppose the deposit rate adjusts linearly to the short-term interest rate:

$$r_t^D = -\alpha^D + \beta_1^D r_t^* \tag{7}$$

Here, β_1^D is referred to as the "deposit beta" and captures the sensitivity of the deposit rate to short rate and is generally estimated to be significantly less than 1. The constant α^D represents an additional fixed discount plus any fee income on deposits.

Consider a bank with assets A , and let d be the fraction funded by deposits such that $D = dA$. Letting c^D be the operating costs per dollar of deposits, the net spread earned by the deposit franchise can be expressed in terms of a return on the bank's assets:

$$S_t^D - c^D D = D(r_t^* - r_t^D) - c^D D = A\left[\underbrace{d(\alpha^d - c^D)}_{\text{Net Fixed Spread}} + \underbrace{d(1-\beta_1^D)r_t^*}_{\text{Floating Spread}}\right] \tag{8}$$

Equation (8) decomposes the deposit franchise earnings into fixed and floating return components. Consider first the floating component of the franchise value. Because the present value of receiving the floating rate r_t^* in perpetuity is simply \$1 (the same cash flow stream can be created by rolling over a \$1 investment in short-term instruments), the floating franchise value is equal to a constant percentage of the bank's deposits:

$$\text{Floating Franchise Value} = PV\left(D(1-\beta_1^D)r_t^*\right) = D(1-\beta_1^D). \tag{9}$$

This floating component arises solely from the fact that the deposit beta is less than 1. A lower deposit beta increases the value of the deposit spread. Note, however, that a low deposit beta does not imply that the value of the deposit franchise increases when interest rates rise. Although the size of the deposit spread in (8) increases when interest rates rise, so does the implied cost of capital, fully offsetting this increase.

Next, the fixed component of the franchise value can be evaluated as a perpetuity using the current long-term interest rate r_t^∞ as,

$$\text{Fixed Franchise Value} = PV\left(D(\alpha^D - c^D)\right) = D\left(\frac{\alpha^D - c^D}{r_t^\infty}\right). \tag{10}$$

Note that this component of the franchise value can be either an asset or a liability depending on the sign of $\alpha^D - c^D$. If $\alpha^D > c^D$, so that the fixed spread or fee income exceeds operating costs, then the value of the deposit franchise declines when interest rates rise.

Negative Franchise Duration: In order for the value of the deposit franchise to have negative duration and thereby increase with interest rates, there are two possible mechanisms: operating costs in excess of fixed spreads, or negative deposit growth (deposit attrition).

First, suppose operating costs exceed fixed spreads ($c^D > \alpha^D$). Then the fixed component in (9) is a perpetual liability. The present value of this liability decreases as interest rates rise. This mechanism is the one emphasized, for example, in Drechsler et al. (2017, 2021).

An alternative way to generate negative duration is to assume deposits have a finite expected "maturity" after which their associated income stream disappears. This deposit attrition is equivalent to assuming a negative expected growth rate of deposits. To see the effect on franchise value, consider a setting with a flat yield curve and a constant risk-neutral expected growth rate $g < 0$ for deposits. The deposit franchise value then becomes a declining perpetuity, with present value given by,

$$PV(S^D - c^D D) = D \underbrace{\left[\frac{\alpha^D - c^D}{r_t^\infty} + (1 - \beta_1^D)\right]}_{\text{dur=sign}(\alpha^D - c^D)} \underbrace{\left(\frac{r_t^\infty}{r_t^\infty - g}\right)}_{\text{dur=sign}(g)}. \tag{11}$$

Again, if g is negative, higher interest rates will reduce the present value of the cost of future attrition, which has a positive effect on franchise value. This approach is the one advocated in bank regulatory guidelines (BCBS, 2016) (which indicates using a long maturity for deposits based on expected runoff rates) as well as by Drechsler et al. (2023a,b) (which assumes an expected deposit "life" of ten years).

While both negative effects on duration can exist in theory, they are not consistent with our empirical findings. First, we show that when both deposit and loan spreads are considered, their fixed component exceeds the total level of operating costs for most banks (i.e., $\alpha^D - c^D > 0$). Second, aggregate deposits appear to grow with GDP, and hence the average bank should anticipate a positive expected deposit growth rate (i.e., $g > 0$).

Term Deposits: The model of deposit rates in (7) ignores term deposits. Term deposits will cause changes in the average deposit rate to lag changes in current short-term rates, which is evident empirically.

To extend the model to allow for term deposits, let y_t^T be the T-period market interest rate on date t. Suppose a fraction λ of total deposits are short-term demand deposits, with the remaining fraction $1 - \lambda$ held as T-period term deposits. These term deposits earn a constant yield equal to a fraction β_T^D of the market yield on the date invested. In this case we can model the average deposit rate as follows:

$$
\begin{aligned}
r_t^D &= -\alpha^D + \lambda\beta_1^D r_t^* + (1-\lambda) \overbrace{\left[\frac{1}{T}\sum_{j=1}^{T} \beta_T^D y_{t-j}^T\right]}^{\text{Avg. rate on term deposits}} \\
&= -\alpha^D + \underbrace{\left[\lambda\beta_1^D + (1-\lambda)\,\beta_T^D\right]}_{\hat{\beta}_1^D = \text{ Avg. deposit beta}} r_t^* + (1-\lambda)\,\beta_T^D \underbrace{\left[\frac{1}{T}\sum_{j=1}^{T} y_{t-j}^T - r_t^*\right]}_{\ell_t^T = \text{ swap ladder payment}} \qquad (12) \\
&= -\alpha^D + \hat{\beta}_1^D r_t^* + (1-\lambda)\,\beta_T^D \ell_t^T.
\end{aligned}
$$

Here, $\hat{\beta}_1^D$ is the average deposit beta across demand and term deposits, and ℓ_t^T represents the average payment on a ladder of $T-$period fixed-for-floating interest rate swaps. We compute the deposit spread as a ratio to assets as s_t^D:[5],

$$
s_t^D \equiv \frac{S_t^D}{A_t} = \left[\underbrace{d\alpha^D}_{\phi_0^D} + \underbrace{d(1-\hat{\beta}_1^D)}_{\phi_1^D}\; r_t^* \; \underbrace{-d(1-\lambda)\beta_T^D}_{\phi_T^D}\; \ell_t^T\right] \qquad (13)
$$

In other words, we can decompose the deposit spread into fixed (ϕ_0^D), floating (ϕ_1^D), and term swap (ϕ_T^D) exposures.

Given these exposures, we can compute the present value of the deposit franchise as in (11) with an additional term capturing the present value arising from the term swap exposure. Because fixed-for-floating swaps have zero value at initiation, their only contribution to the value of the deposit spread comes from the mark-to-market value of the currently held swaps,

[5] For brevity we include only a single swap term T here; we could include multiple terms to represent different term horizons T. We will assess empirically the appropriate horizon to use in the case of both deposits and loans.

which can be approximated as follows,[6]

$$PV(l_t^T) \approx (\overleftarrow{y}_t^T - \overrightarrow{y}_t^T)\left(\frac{T}{2}\right) \tag{14}$$

Here, $\overleftarrow{y}_t^T$ and $\overrightarrow{y}_t^T$ are an average of past and current yields, respectively:

$$\overleftarrow{y}_t^T \equiv \frac{1}{T}\sum_{j=1}^{T} y_{t-j}^T \quad \text{and} \quad \overrightarrow{y}_t^T \equiv \frac{1}{T}\sum_{j=1}^{T} y_t^{T-j}. \tag{15}$$

The first term in (15) represents the difference between past and current average yields, which may be positive of negative. The second term captures the average remaining swap maturity, $T/2$.

In our empirical analysis, the relevant term length T is between two and five years. While this term swap component provides a lagging variable that significantly improves our ability to match the movement in spreads, its impact on bank franchise value is negligible. Given the relatively short term-length, typical changes in interest rates, and measured sensitivities ϕ_T^D well below one, its value contribution is generally less than 1% of bank assets.

Loan Spreads: We have thus far focused on deposit spreads. We can apply a similar decomposition to lending spreads. The average rate charged on floating rate loan may include a fixed spread and a spread that is proportional to the current level of interest rates. The bank may also issue fixed-rate term loans (with spread to longer term yields that also includes both fixed and proportional components). Representing the loan rate similarly to (12),

$$r_t^L = \alpha^L + \lambda^L \beta_1^L r_t^* + (1 - \lambda^L)\beta_T^L \ell_t^T \tag{16}$$

[6]To see this, note that the value on date t of a T-period swap initiated at time $t-j$ can be approximated by

$$PV(y_{t-j}^T - r_{t+s}^* | s = 0 \ldots T-j) = PV(y_{t-j}^T - y_t^{T-j} | s = 0 \ldots T-j) \approx (y_{t-j}^T - y_t^{T-j})(T-j)$$

by first swapping the floating side to the current $(T-j)$-period fixed rate (which is zero NPV) and then ignoring the minor discounting of these payments over the remaining life of the swap. Averaging over the current swaps and ignoring the correlation between j and $(y_{t-j}^T - y_t^{T-j})$ gives (15). Given the relatively short time horizon, these approximations are second order and not consequential for our analysis.

we find a similar ultimate representation to (14) for the bank's loan spread income:

$$s_t^L = \phi_0^L + \phi_1^L r_t^* + \phi_T^L \ell_t^T. \tag{17}$$

Here, for example, $\phi_0^L = \alpha^L L/A$ with a similar mapping to (13) for the other coefficients.

Empirical Implementation: Equations (13) and (17) form the basis of our empirical strategy: we will consider both the deposit and loan spreads for individual banks and evaluate their fixed, floating, and term swap exposures. If we let $\phi = \phi^D + \phi^L$ and $c = C/A$ be total operating costs per dollar of assets, this leads to the following generalization of (11) for the estimation of the bank's franchise value:

$$PV(S-C) = A \underbrace{\left[\frac{\phi_0 - c}{r_t^\infty} + \phi_1 + \phi_T PV(l^T)\right]}_{\text{dur}\approx\text{sign}(\phi_0 - c)} \underbrace{\left(\frac{r_t^\infty}{r_t^\infty - g}\right)}_{\text{dur}=\text{sign}(g)}. \tag{18}$$

3 Data

Our commercial bank data are from the Call Reports of U.S. banks provided by Wharton Research Data Services. We use data from 1984Q1 to 2021Q2.[7] The data contain quarterly observations of the income statements and balance sheets of all U.S. commercial banks. We exclude banks that have the majority of their deposit liabilities in foreign offices. We also exclude banks that obtain more than 30% of their interest income from credit card business. The highly fee-driven credit card business is not represented well by our model of a deposit and lending franchise. For this reason, we exclude this type of bank. Finally, we exclude banks in the bottom percentile by assets. For banks that are publicly traded, we match the Call Report bank data to equity prices obtained from CRSP.

For the subset of publicly traded banks, we obtain bank holding company data from

[7] We process the raw data with a modified version of the program code developed by Drechsler et al. (2021). We thank Philipp Schnabl for providing the code on his website.

WRDS that we merge with market capitalization and returns data from CRSP using a link provided by the Federal Reserve Bank of New York.[8] In the part of our analysis where we compare market valuations with our valuation estimates, we aggregate bank-level data at the bank-holding company level.

Table 2 provides summary statistics. Panel A shows statistics for the full sample from 1984Q1 to 2021Q2 that we use to construct and analyze the time series of aggregate banking sector cash flows. On average, we have about 8,000 banks in each of the 49 quarters. Panel B looks at the single cross-section of banks in 2021Q2 that we use to estimate franchise values. Due to mergers and consolidation during the previous decades, the 3,846 banks in this cross-section are substantially fewer than in the earlier part of the full sample.

In terms of balance sheet composition, the median bank in 2021Q2 looks very similar to the full sample: The loans/assets ratio is around 60% and the deposits/assets ratio slightly above 85%. Only for the securities holdings we see a more substantial change with a decline of securities/assets from a median of around 25% to around 18% in 2021Q2.

3.1 Franchise cost

Franchise costs are the operating costs of the banking business. To calculate the operating costs of the lending and deposit-taking franchise, we begin by computing Tangible Non-Interest Expense ($TNIE$) as the sum of salaries, expenses on premises, and other non-interest expenses (largely technology and marketing expenses). We then subtract deposit service charges (DSC) as this fee income partly offsets the operating costs.

We make two further adjustments to costs, described in more detail in Appendix B. First, some banks have substantial other lines of business outside of deposit-taking and lending that do not fit our valuation model, such as brokerage or investment advising fees, underwriting fees etc. We exclude these sources of other business income from our valuation, and so should exclude an estimate of their corresponding expenses (OBX) from the franchise costs.

[8] See `https://www.newyorkfed.org/research/banking_research/datasets.html`

Table 2
Summary Statistics

The sample in Panel A includes all U.S. commercial banks from 1984Q4 to 2021Q2. In Panel B, the sample is restricted to 2021Q2. All ratios to assets use tangible assets in the denominator.

	Mean	S.d.	p10	Median	p90
Panel A: Full sample 1984Q1 to 2021Q2					
Tangible Assets	830632	21172555	17636	73725	472646
Securities/Assets	0.2652	0.1550	0.0758	0.2472	0.4773
Loans/Assets	0.5738	0.1571	0.3604	0.5906	0.7627
Deposits/Assets	0.8571	0.0795	0.7835	0.8760	0.9162
Other bus. inc./Assets	0.0065	0.0805	0.0007	0.0025	0.0084
Loan losses/Assets	0.0041	0.0089	0.0000	0.0018	0.0095
Franchise cost/Assets	0.0305	0.0671	0.0186	0.0268	0.0403
Deposit spread	0.0085	0.0119	-0.0064	0.0089	0.0238
Lending spread	0.0136	0.0420	0.0005	0.0133	0.0276
Total spread	0.0221	0.0418	0.0092	0.0222	0.0348
#Obs.	1232114				
Panel B: Sample restricted to 2021Q2					
Tangible Assets	4014486	69099614	72836	279711	1860705
Securities/Assets	0.2087	0.1503	0.0347	0.1830	0.4151
Loans/Assets	0.5932	0.1498	0.3901	0.6094	0.7712
Deposits/Assets	0.8525	0.0564	0.7901	0.8649	0.9036
Other bus. inc./Assets	0.0076	0.0272	0.0010	0.0040	0.0128
Loan losses/Assets	0.0012	0.0019	0.0000	0.0008	0.0030
Franchise cost/Assets	0.0198	0.0068	0.0131	0.0194	0.0267
Deposit spread	-0.0028	0.0021	-0.0054	-0.0025	-0.0005
Lending spread	0.0220	0.0083	0.0122	0.0219	0.0318
Total spread	0.0192	0.0079	0.0098	0.0192	0.0285
#Obs.	3846				

Second, even though we have excluded banks with a large share of credit card business, there are still banks in the sample with substantial activity in this line of business. Indeed, business credit cards may be an important component of small business lending (Benetton, 2022). While we include credit card interest in our lending spread, a substantial part of revenue in this line of business is fee income that we do not observe directly. Because our franchise costs measure includes the entire cost of the credit card business, this missing fee income creates a mismatch. We correct by deducting estimated credit card fees (CCF) from the franchise cost.

Together, we therefore have the following definition of franchise costs for the banks deposit and lending business:

$$\text{Franchise Cost} = TNIE - \widehat{OBX} - DSC - \widehat{CCF}. \tag{19}$$

The first two terms capture the total non-interest expenses excluding other businesses, while the second two terms are different types of fee income that offset these expenses. Note that neither $\widehat{OBX}$ nor $\widehat{CCF}$ are directly reported by banks. In the appendix we estimate these components based on the magnitude of the bank's other business income and credit card interest earnings. We also test and show that these franchise costs do not appear to be sensitive to changes in interest rates.

Panel B of Table 2 shows that the mean and median of the franchise cost to tangible assets ratio is close to 2% for the median bank in the 2021Q2 cross section that we use for our franchise valuation calculations and the mean is similar.

In the appendix, we present a robustness check where do these cost adjustments in a simpler fashion. We drop banks with more than 30% of total income from other business income. This screen drops about 7.5% of banks, including some of the largest banks. We then compute Franchise Cost $= TNIE - OBI - DSC$. That is, we do not follow a regression procedure to estimate $\widehat{OBX}$ and $\widehat{CCF}$ as in the main text. We instead include all other business income, which includes credit card fee income, and reduce the franchise costs with such income (note that other business income does not comove with interest rates in a statistically significant fashion). In other words, we are in essence capturing all income and costs, but using our screen to eliminate banks where the magnitude of total income coming from non-deposit and lending activity is large. We then revisit our main result in Table 5 and show that our main conclusions continue to hold up.

3.2 Deposit and lending spread

To understand the interest-rate risk of banks' deposit and lending franchise, we calculate spreads that banks earn from deposit-taking and lending. These spread calculations are based on the assumption that banks earn spreads only in lending, not on securities holdings, and only in deposit-taking, not in other types of funding. As stated in Section 2.1, we assume that other types of funding or investing are zero NPV transactions.

For bank b at time t, we measure the average deposit and lending rate as

$$r^D_{t,b} = \frac{\text{Interest Expense on Deposits}_{t,b}}{D_{t,b}}, \quad \text{and} \quad r^L_{t,b} = \frac{\text{Interest Income on Loans}_{t,b}}{L_{t,b}} - \rho_b. \quad (20)$$

In the expression for the lending rate, ρ_b adjusts for credit losses as follows. We estimate a bank's expected credit loss under the physical measure as the bank's sample average of credit loss provisions as a percentage of loans outstanding. We then convert these expected credit losses into risk-neutral expected credit losses by using the mapping from physical to risk-neutral expected credit losses for corporate bonds in different ratings categories provided in Table III of Berndt et al. (2018). Formally, the expected loss for bank i is,

$$\rho_b = \frac{\text{Historical Credit Loss Provisions}}{L_b} \times \frac{Q(\text{Loss})}{P(\text{Loss})}. \quad (21)$$

We then define the deposit and loan spread income as in Section 2.1 as follows:

$$s^D_{t,b} = \frac{D_{t,b}}{A_{t,b}}(r^*_t - r^D_{t,b}), \quad s^L_{t,b} = \frac{L_{t,b}}{A_{t,b}}(r^L_{t,b} - r^*_t), \quad \text{and} \quad s_{t,b} = s^D_{t,b} + s^L_{t,b}. \quad (22)$$

where $A_{t,b}$ is tangible assets, $D_{t,b}$ is total deposits, and $L_{t,b}$ is total loans and r_t^* is the federal funds rate.

A total spread of zero would arise, for example, for a bank that earns r_t^* on lending and faces r_t^* as a deposit funding cost. If this bank had no other business lines, it would then also earn r_t^* on its equity.

We also highlight a few points of definition in our approach that are useful to keep in mind. We are interested in the variation of the *deposit spread* with respect to r_t^*, a variable we call the bank's "floating exposure" ϕ_1^D. Much of the literature is interested in the variation of the *deposit rate* with respect to r_t^*, which is the "deposit beta" β_1^D in the literature. From equation (13) we have that $\phi_1^D = d(1 - \hat{\beta}_1^D)$. Additionally, we note that these spreads are not in units of interest rates, but rather are expressed in terms of returns on total tangible assets.

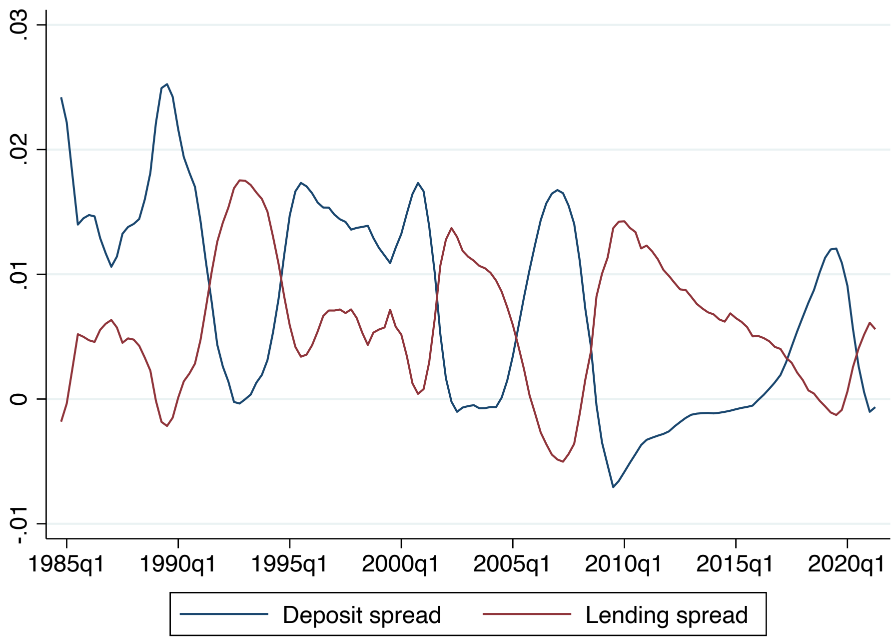
As Panel B of Table 2 shows, with interest rates near zero in 2021Q2, deposit spreads were mostly slightly negative. Nevertheless, the mean and median of total spread is about 1.9% due to a mean and median lending spread of around 2.2%.

4 Aggregate analysis

We start with an analysis based on aggregates. We aggregate balance sheet and income variables across all banks in our data. Based on aggregate data, we then calculate the spreads in (22).

Comparing the deposit and lending spreads in Figure 1a with the fed funds rate shown in Figure 1b, it is evident that deposit and lending spreads move in offsetting directions when the fed funds rate changes. This is related to the observation by Drechsler et al. (2021) that interest income and expenses are strongly positively correlated. As a consequence, the total spread shown in Figure 1b is much more stable than its deposit and lending components. Nevertheless, there is still a clearly visible positive correlation in Figure 1b between the total spread and the federal funds rate.

(A) Aggregate deposit and lending spreads



(B) Total spread and franchise costs

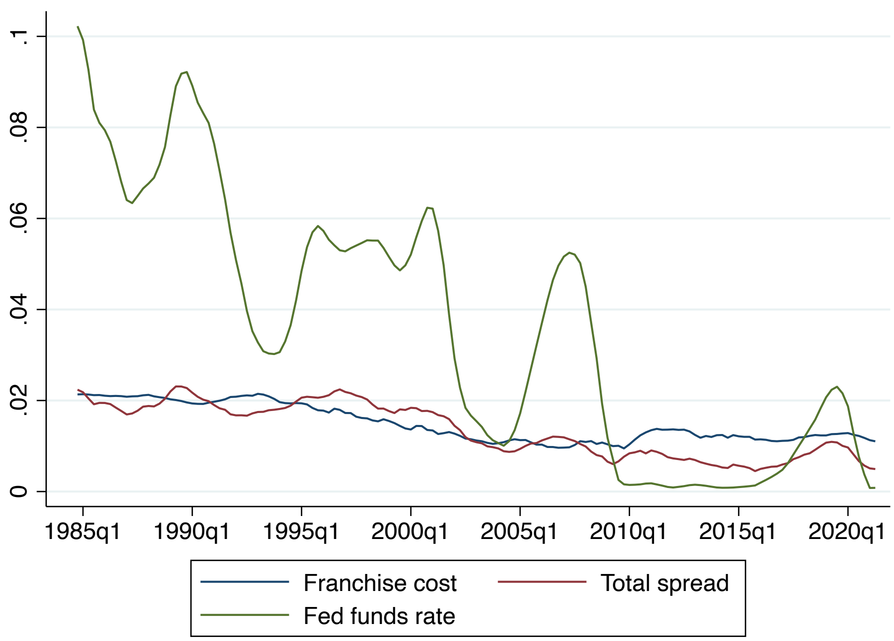


FIGURE 1

Deposit spreads, lending spreads, and franchise costs (4-qtr moving averages)

Figure 1b also shows the time series of the aggregate franchise cost. These costs do not vary with the federal funds rate. The franchise cost is occasionally above the total spread, and after the Great Financial Crisis persistently so. However, as the total spread has a component that floats with the level of interest rates, this does not mean that present value of the franchise cost flow is also above the present value of the total spread flow. To evaluate this, we will need to value the fixed and floating components of the spread separately.

Table 3 examines the dynamics of aggregate spreads with time-series regressions. The first and third column in Panel A show a regression of deposit and lending spreads on the federal funds rate. In line with the impression from Figure 1a, these two spreads load on the federal funds rate with opposite signs. A rise in r_t^* of 100bp is associated with a rise in the deposit spread of 25bp and drop in the lending spread of 7bp. The positive loading of the deposit spread reflects the well-known fact that the deposit beta of deposit interest rates is smaller than one.[9] The negative loading of the lending spread suggests that lending rates adjust less than one-for-one with the federal funds rate.

Note that our estimate for the lending spread differs markedly from a pure "maturity transformation" benchmark model in which the bank uses short-term deposits to fund fixed-rate long-term loans. In that model the lending spread would fall one-for-one with r_t^*. Our estimate for the coefficient ϕ_1^L on r_t^* is far away from -1. Perhaps in part via floating-rate loans and in part by adjusting rates of new loans, banks are able to raise their income from lending when the federal funds rate rises. This finding is broadly consistent with Drechsler et al. (2021).

Deposit rates are known to adjust sluggishly in response to movements in the federal

[9] Existing assessments of the interest-rate risks of cash flows from the deposit business often focus on the loading of deposit yields or deposit rates on the federal funds rate, rather than the loading of the deposit spread on the federal funds rate (ϕ_1^D). Drechsler et al. (2021) measure the deposit yield as the ratio of deposit expense to total assets ($d\beta^D$), and estimate an average of 0.37. We have that $\phi_1^D = d(1-\beta^D)$. In aggregate, banks have $d \approx 0.75$ and we estimate that $\phi_1^D = 0.25$, which yields an implied $d\beta^D$ of 0.50 and β^D of 0.66. Koont et al. (2023) report a β^D for the interest rates on deposit savings accounts of 0.54. Greenwald et al. (2023) examine deposit interest rate betas as reported by banks from the Fed's Senior Financial Officer Survey. Based on the survey of May 2022, we compute an average beta on retail deposit rates of 0.28, on wholesale operational deposits of 0.45, and on wholesale non-operational deposits of 0.57.

Table 3
Dynamics of spreads at the aggregate level

The sample includes U.S. commercial banks from 1984Q1 to 2021Q2. In Panel A, the dependent and explanatory variables are four-quarter moving averages of quarterly aggregates. In Panel B, the dependent variable is the quarterly change in the spread and the slope coefficients shown in this panel are the sum of slope coefficients on the contemporaneous quarterly change in the and three lags of the explanatory variables. The term swap variables are for 2-year and 5-year term swaps. The t-statistics shown in parentheses are based on Newey-West standard errors with 8 lags.

	(1) Deposits	(2) Deposits	(3) Lending	(4) Lending	(5) Total
Panel A: Regression in levels					
r_t^*	0.251	0.239	-0.069	-0.053	0.186
	(11.88)	(17.22)	(-3.03)	(-2.41)	(11.33)
ℓ_t^2		-0.195		0.159	-0.036
		(-3.80)		(2.44)	(-0.60)
ℓ_t^5		-0.069		0.147	0.078
		(-1.73)		(2.61)	(1.40)
Intercept	-0.001	0.002	0.008	0.004	0.006
	(-1.34)	(1.83)	(5.69)	(3.09)	(5.61)
R^2	79.18	95.10	14.86	75.41	83.16
Obs.	147	147	147	147	147
Panel B: Regression in changes					
Δr_t^*	0.386	0.388	-0.299	-0.290	0.098
	(20.53)	(5.24)	(-9.19)	(-2.67)	(1.06)
$\Delta\ell_t^2$		-0.070	.	0.103	0.033
		(-1.42)		(1.72)	(0.51)
$\Delta\ell_t^5$		0.059	.	-0.057	0.001
		(0.73)		(-0.48)	(0.01)
Intercept	0.000	0.000	-0.000	-0.000	-0.000
	(1.63)	(1.37)	(-2.29)	(-1.90)	(-0.57)
R^2	87.07	88.06	50.54	51.79	26.20
Obs.	146	146	146	146	146

funds rate (Diebold and Sharpe, 1990; Hannan and Berger, 1991; Neumark and Sharpe, 1992; Driscoll and Judson, 2013). Likewise, the average income on lending may also adjust slowly because some loans are fixed-rate so that lending income only adjusts once these loans are rolled over or new loans are originated. To allow for slow adjustment of spreads, columns (2) and (4) add the cash flows ℓ_t^2 and ℓ_t^5 from a synthetic long-term swap portfolio. For example, ℓ_t^2 is the average of two-year Treasury bond yields during the past 8 quarters minus the federal funds rate. This is the cash flow from a long-short portfolio that rolls over positions in two-year Treasury bonds acquired at par and held to maturity, financed by borrowing at the federal funds rate. Hence, the portfolio cash flows approximate the cash flows net of funding costs that one gets from medium-duration fixed-rate assets that are rolled over upon maturity. See equation (12).

Deposit spreads load negatively on the cash flows from these portfolios, especially at the two-year horizon, consistent with the literature's finding of slow adjustment of deposit rates. For example, when the federal funds rate has recently fallen but long yields remain high, $\ell_t^2 = \frac{1}{8}\sum_{j=1}^{8} y_{t-j}^2 - r_t^*$ increases and in this situation deposit spreads shrink. The opposite is true for lending spreads, which is consistent with slow adjustment of lending spreads via rolling over of fixed-rate loans. For example, when the federal funds rate has recently fallen but long yields remain high, lending rates are still somewhat anchored to the level of long yields, which results in an increase in lending spreads. Lending spreads load positively on both the two- and five-year portfolios, with the loading on the two-year smaller in magnitude for the lending spread than than that of the deposit spread, while the loading on the five-year is larger in magnitude for the lending spread than that of the deposit spread.

Figure 2 shows the fitted value from the regressions. The figure shows that if the regressions include the federal funds rate only, there is a substantial unexplained component, especially for lending spreads. However, when the two term swap variables at two- and five-year maturity are included, the fit improves markedly, particularly for the deposit spread. The tight fit suggests that there is little room left for further improvements in explanatory power, e.g., by incorporating nonlinearities that are missed in our linear model, as suggested by the evidence for convexity in Greenwald et al. (2023). Begenau and Stafford (2019) presents a similar finding that the loan rates and deposit interest rate are well tracked by the cash flows on a portfolio of US Treasury securities of different maturities.

Column (5) of Table 3 examines the total spread. The high loadings of the deposit spread on r_t^* dominates relative to the negative loading of the lending spread, and hence the total spread has a substantial positive loading on r_t^*. The total spread's positive loading on the federal funds rate suggests that there is a substantial floating-rate component to the franchise value as well. This coefficient ϕ_1 would be an important input to a franchise value calculation. In contrast, the loadings ϕ_2^D ϕ_5^D and ϕ_2^L, ϕ_5^L on the term swap variables roughly offset, which leaves the total spread almost unexposed to these factors. To a first approximation, the fixed rate maturity of the bank loan portfolio matches the slow adjustment of deposit rates, consistent with the findings of Drechsler et al. (2021).

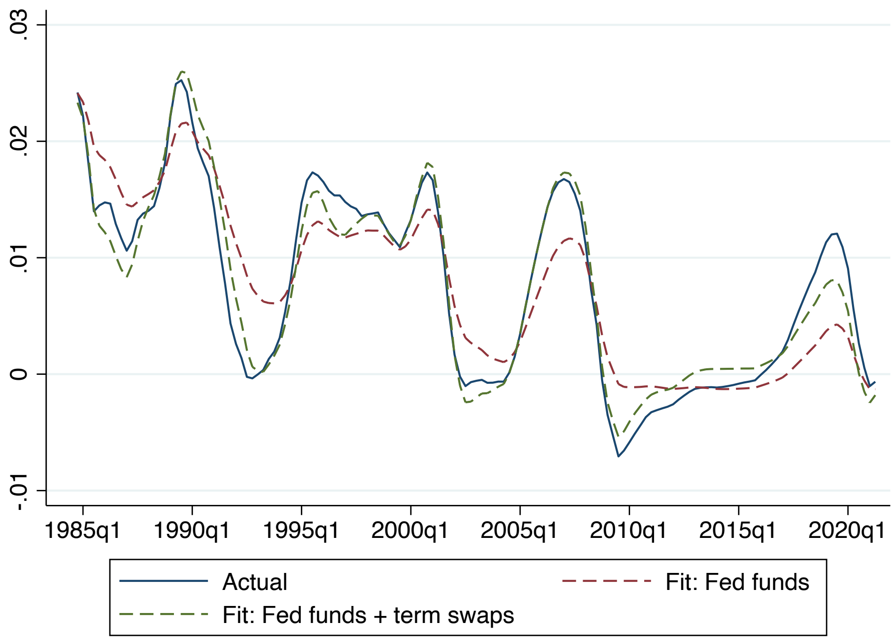
The intercept ϕ_0 in column (5) is important for our analysis. The estimate of 0.006 suggests that banks' aggregate lending spread has a fixed component of 0.6% that accrues irrespective of the level of the federal funds rate. In a franchise valuation of banks in aggregate, this fixed spread component would contribute to the fixed-rate component of the franchise value.

To check whether spurious correlations induced by trends could distort the regression in levels, Panel B runs the same regression in quarterly changes. To allow for slow adjustment of spreads, we follow Drechsler et al. (2021) and include three lags of changes in the explanatory variables:

$$\Delta s_t^x = a + \sum_{\tau=0}^{3} \boldsymbol{b}_\tau' \Delta \boldsymbol{x}_{t-\tau} + \varepsilon_t, \tag{23}$$

where s^x is either s^D, s^L, or s and the vector $\boldsymbol{x}$ collects the explanatory variables. Panel B reports the cumulative effects obtained as $\sum_{\tau=0}^{3} \boldsymbol{b}_\tau$. The fed funds rate coefficient for the deposit spread is substantially higher than in Panel A, but in the total spread this is more than offset by an also much lower coefficient on the fed funds rate in the lending spread

(A) Aggregate deposit spread



(B) Aggregate lending spread

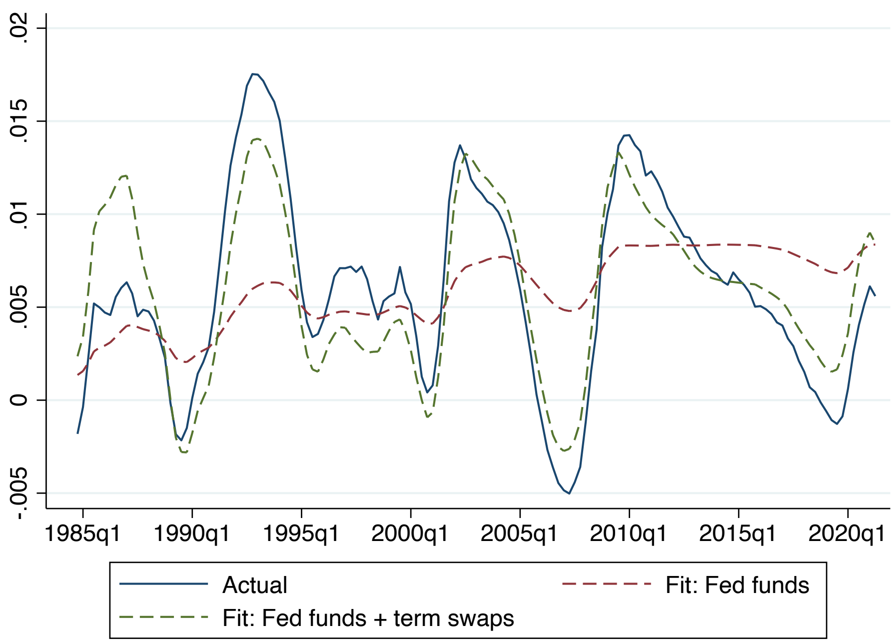


FIGURE 2
Deposit spreads, lending spreads, and fitted values from time-series regressions

regression. The net effect is that the total spread coefficient on the fed funds rate is about half the magnitude of the coefficient in Panel A. That said, the standard error for this coefficient in Panel B is about five times as large as in Panel A, due to the much lower signal-to-noise ratio in differenced regressions, with the consequence that the point estimate in Panel A is still within about one standard error of the point estimate in Panel B. Statistically, there is therefore little evidence that the regressions in changes deliver substantially different results from the levels regressions.

5 Bank-level analysis

We now turn to a bank-level analysis. We estimate the same regressions as in Table 3, but now at the individual bank level, using data from 2001Q1 to 2021Q2. We start in 2001 to capture the properties of banks business after deregulation in the 1990s. That said, our bank-level estimates are broadly consistent with the estimates from aggregate data that used the full 1984Q1 to 2021Q2 sample.

Table 4 presents summary statistics of the bank-level regression results. Focusing on the means of the estimates, we obtain results that are similar to the earlier estimates from aggregate data. In particular, for the total spread in Panel A we find an an average positive loading on the federal funds rate and loadings with opposite signs on the term swap variables. Hence, the bank-level analysis confirms that the typical bank is able to raise lending income when the federal funds rate rises to largely insulate the lending spread from exposure to the federal funds rate. We also note that fit in the bank-level regression is quite good. The regression of the deposit spread on the fed funds rate, the term swap variables, and a bank fixed effect gives an R^2 of 94.2%. As in the aggregate data, the term swap variables are important to capture the slow adjustment of the deposit spread to changes in the level of interest rates, and once this accounted for, there is little further room to improve the fit beyond our linear model.

We find a substantially positive intercept. The mean of the bank-level intercept is 2.0%,

Table 4
Summary Statistics of Bank-level Spread ϕ Estimates

The sample includes U.S. commercial banks from 2001Q1 to 2021Q2. The loadings shown in Panel A are estimated in regressions where the dependent and explanatory variables are four-quarter moving averages. In Panel B, the dependent variable is the quarterly change in the spread and the slope coefficients shown in this panel are the sum of slope coefficients on the contemporaneous quarterly change in the and three lags of the explanatory variables. The term swap variables are for 2-year and 5-year term swaps.

	(1) Intercept ϕ_0	(2) Fed Funds ϕ_1	(3) Term Swap ϕ_2	(4) Term Swap ϕ_5
		Panel A: Regression in levels		
		Deposit spread		
mean	0.0019	0.25	-0.23	-0.22
p50	0.0023	0.25	-0.23	-0.22
s.d.	0.0029	0.13	0.096	0.13
		Loan spread		
mean	0.018	-0.10	0.090	0.28
p50	0.018	-0.098	0.093	0.29
s.d.	0.0089	0.18	0.20	0.22
		Total spread		
mean	0.020	0.15	-0.14	0.068
p50	0.020	0.15	-0.13	0.070
s.d.	0.0089	0.22	0.20	0.22
		Panel B: Regression in changes		
		Deposit spread		
mean		0.30	-0.16	-0.13
p50		0.31	-0.15	-0.12
s.d.		0.16	0.14	0.17
		Loan spread		
mean		-0.15	0.13	0.18
p50		-0.14	0.13	0.20
s.d.		0.37	0.42	0.42
		Total spread		
mean		0.15	-0.031	0.054
p50		0.17	-0.018	0.067
s.d.		0.39	0.42	0.42

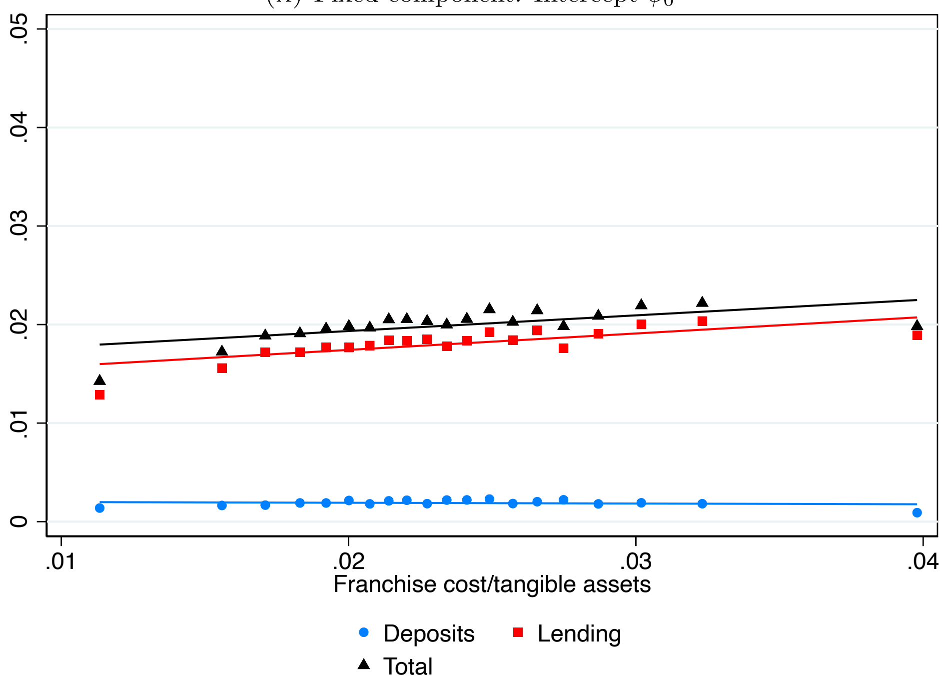
which is higher than the 0.6% estimate from the aggregate analysis. This indicates that smaller banks (which obtain a higher weight in the average of bank-level estimates than in the aggregate analysis) appear to have a higher fixed spread component. The higher fixed spread for the median bank comes predominantly from the loan side.

Panel B presents results for regression specifications in changes similar to (23). At the bank level, the differences between the level and changes regressions are minor.

Regressions in levels are possibly subject to contamination by trends in dependent and explanatory variables unrelated to the mechanisms that we are trying to capture. However, regressions in changes are more sensitive to bias due to inertia effects and noise. Moreover, at the bank-level, the analysis of changes can be distorted by mergers and other corporate actions. For the remainder of the analysis, we focus on the regression in levels. We winsorize betas at the 5% level and we recalculate intercepts based on these winsorized betas. In Appendix C.2, we report a robustness check where we perform the franchise valuation based on the estimates from the regressions in changes.

The estimates in Table 4 show that there is substantial variation in the estimated loadings around their means. In our analysis of franchise values, we explore this cross-sectional variation. Figure 3 shows the intercept ϕ_0 (top panel) and the floating sensitivity ϕ_1 (bottom panel) binned by the average ratio of franchise cost to tangible assets during the sample used for estimation. The top panel shows that banks with higher franchise cost earn higher fixed spreads from their lending activity, but not from deposits. Considering the total, we see that a one percentage point higher franchise cost roughly correlates with a 0.2 percentage points higher fixed spread, so the fixed spread component only partly covers the higher franchise costs. The floating spread component is a potential alternative source of income to cover costs. In the model of Drechsler et al. (2021), banks with higher franchise costs have lower deposit betas, which would translate into a higher deposit ϕ_1^D in our regressions. As the bottom panel shows, while the ϕ_1^D for deposit spreads is increasing in franchise costs, the ϕ_1 coefficient for total spreads is roughly constant across franchise cost bins. The latter is the

(A) Fixed component: Intercept ϕ_0



(B) Floating component: fed funds sensitivity ϕ_1

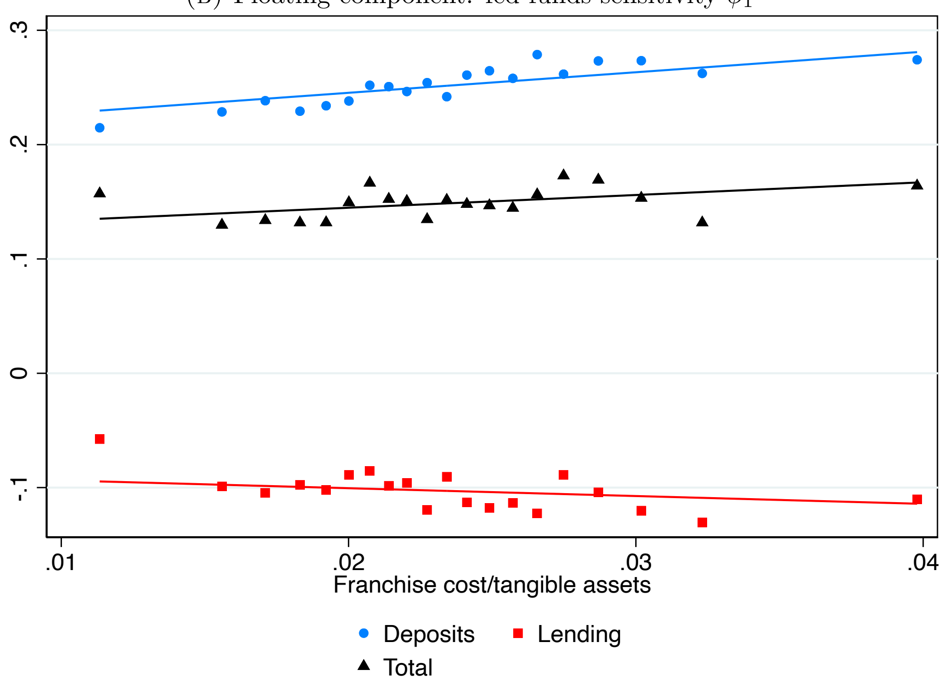


FIGURE 3

Fixed and Floating Spread Sensitivities, by Franchise Cost

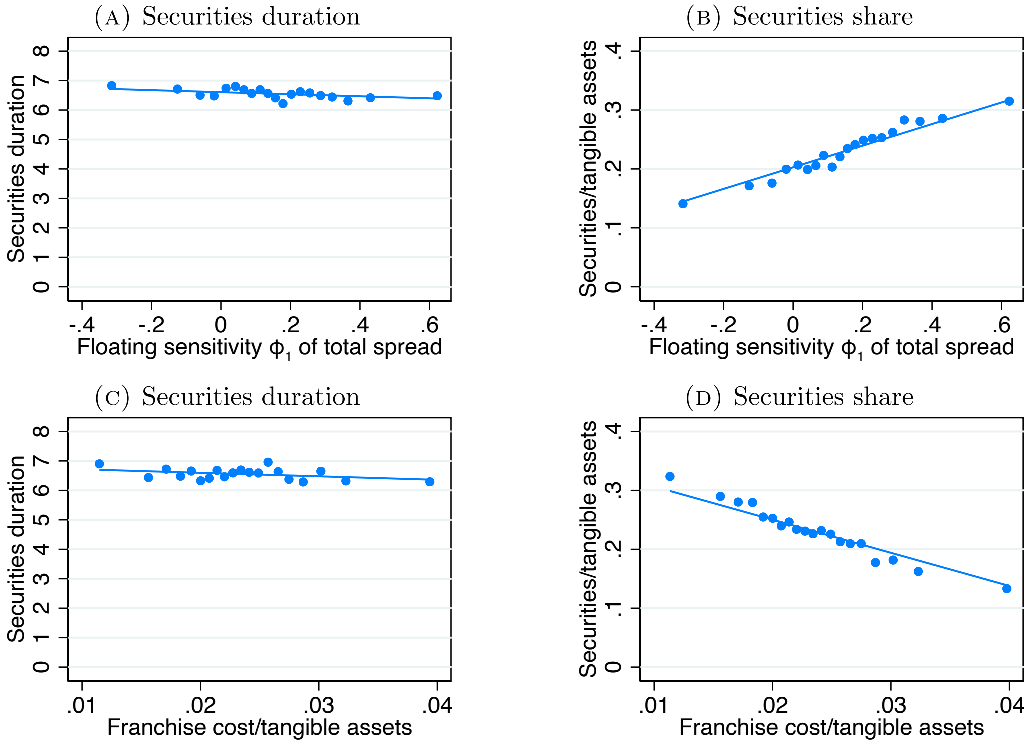


FIGURE 4
Securities Holdings in 2021Q2, Floating Sensitivity ϕ_1, and Franchise Cost

object that should matter in the free-entry model of Drechsler et al. (2021).

5.1 Securities holdings as hedges?

We next examine the possible drivers of banks' holdings of long-term fixed rate securities. Figure 4, upper panels, plots the duration of banks' securities portfolio (panel A) as well as the ratio of securities to tangible assets (panel B) against the floating sensitivity ϕ_1. We measure the security holdings in 2021Q2. From the top left, we see that banks hold a duration of roughly 7 years, independent of the ϕ_1. On the top right, we see that there is a systematic relation between the share of these 7-year securities in total assets and the ϕ_1 estimates.

The regulatory guidance banks receive is one rationale for this finding. Regulators suggest that banks treat a low-β deposit as if it is a long duration fixed rate liability. Table 2 in BCBS (2016) guides banks to slot the cash flow on core deposits, depending on type of deposit, into

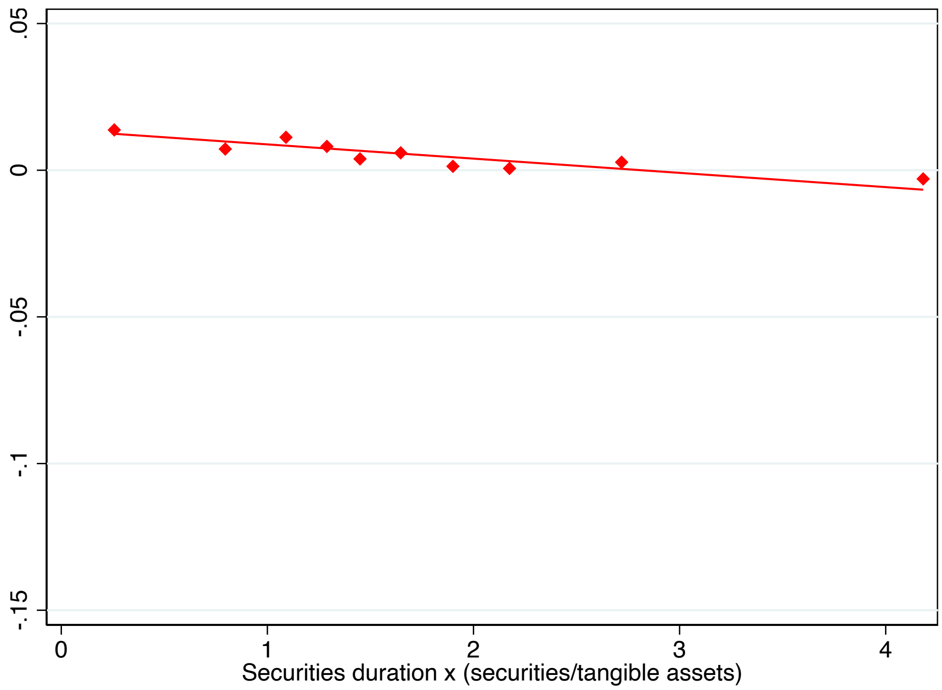


FIGURE 5
Banks' 10-K estimates in 2021 of potential losses, in units of change in market-to-book, for +100bp yield curve shift

maturity buckets of up to 5 years. Thus, a bank with a low β (high ϕ_1) may slot many deposits as long-duration liabilities, and then choose to hold positive duration securities to offset this regulator-prescribed negative duration of the deposit base.

Another possible regulatory rationale for this relation is that banks aim to stabilize their net interest margins. Take a bank with a high ϕ_1 so that the banks' total lending-deposit spread is increasing in the level of the federal funds rate. The cash flow from a long-term security that is funded with short-term debt at r_t^* is decreasing in the level of the federal funds rate. Thus, by holding long-term securities, this bank is effectively stabilizing the sum of lending-deposit income and the securities-funding cost income. We would then expect banks with a higher ϕ_1 to have a higher securities share, as indicated by the figure.

In their annual 10-K filings, many banks report measures of interest rate risk exposure of their net interest income and equity market value. Most banks report their estimates of how shifts in the yield curve of various magnitudes (e.g., 100bp, 200bp, and 400bp parallel shifts) would affect their net interest income, and some, but not all, report the estimated effect on the market value of equity. When available, we collect this information from the 2021 10-K filings of all publicly traded bank holding companies in the U.S. Figure 5 shows banks' estimates for the effect of a 100bp parallel upward shift in the yield curve, expressed as the implied change in the market-to-book assets ratio, binned by the duration contribution of securities holdings. We see that the banks' assessment of the impact of the interest rate shock is independent of securities duration. This suggests that the banks are choosing the securities duration to hedge their assessment of interest rate risk, so that variation in duration does not generate interest rate risk exposure.

An alternative rationale focuses on hedging the costs associated with running the deposit franchise. Drechsler et al. (2021) suggests that banks have a motive for holding long-term fixed rate securities in order to hedge the present value of interest-insensitive operating costs of the banking franchise. To examine this, the lower panels in Figure 4 look at the duration of banks' securities portfolio (C) as well as the ratio of securities to tangible assets (D) as a function of franchise costs. As the figure shows, banks with high franchise costs hold securities of about the same duration as banks with low franchise costs, but high-cost banks hold a much lower share of securities on their balance sheet. Taken together, these results are not consistent with the idea that banks hold long-duration securities as a hedge of the interest-rate risk of the present value of franchise costs.

5.2 Franchise value in 2021

We now calculate banks' franchise value in 2021Q2 following the valuation framework in (18). We set $g = 0$ in our computations. Note that some approaches to valuation set $g < 0$ based on the assumption of deposit attrition. Since banks on average grow, a negative g is inconsistent with the data. On the other hand, g in our valuation framework is a risk-neutral growth rate. We opt to set $g = 0$ which assumes that the positive growth is equal to the negative risk adjustment required.

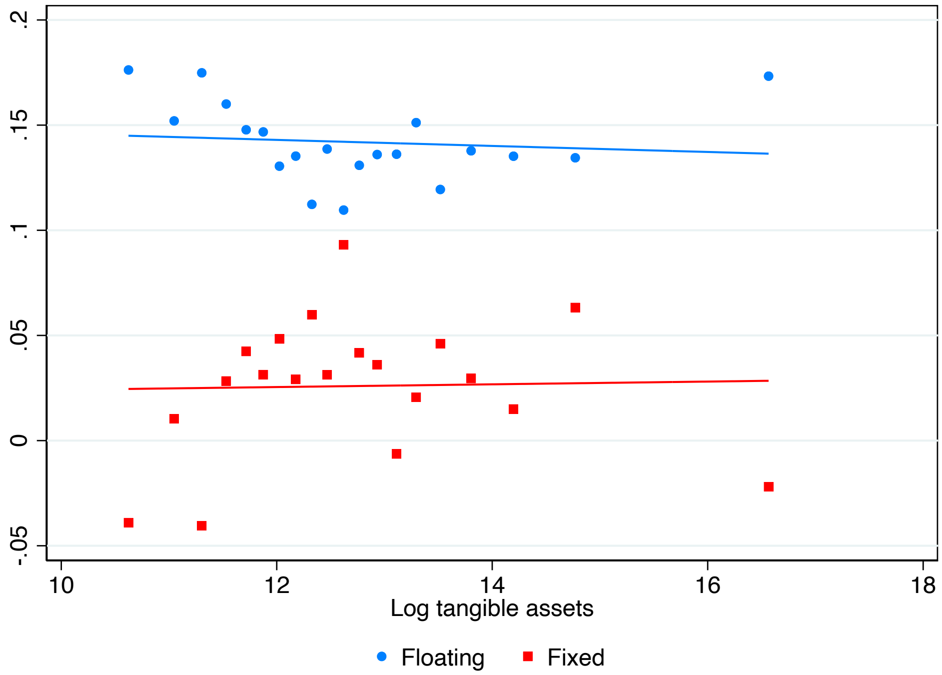
The source of the franchise value is the total spread that we analyzed in the regressions reported in Table 4. The total spread represents the cash flow (as a proportion of tangible assets) that the bank earns from lending and deposit taking. Based on the regression estimates, these cash flows, and their associated present value (PV), can be decomposed into the following three components:

- Fixed component: The PV of the constant cash flow component represented by the intercept ϕ_0 net of franchise costs c, valued as a perpetuity.
- Floating component: The PV of the cash flow component represented by floating exposure, which is given by ϕ_1 (that is, the sensitivity and PV are the same, since a floating exposure trades at par).
- Term inertia component: The PV of the cash flow component represented by the exposures ϕ_2 and ϕ_5 to the synthetic term swaps ℓ_t^2 and ℓ_t^5, as approximated by (14)

The first component is akin to a perpetual bond. We take the intercept, after subtracting franchise costs, as an annual cash flow that we discount as a perpetuity. As an approximation for a perpetual bond yield we use the 30-year forward rate extracted from Treasury yields at the end of 2021Q2. The second component is a floating rate bond whose value is ϕ_1. The PV of the third component should be relatively small. It may deviate from zero depending on recent changes in the slope of the yield curve, but its unconditional PV is zero.

Figure 6a presents the fixed and floating components of franchise value for banks that are binned by size. For the median bank, the franchise value of the bank is attributable more to the floating component (which mostly represents the present value of future deposit spreads) than the fixed component (which is mostly arising from the present value of future loan spreads). Egan et al. (2022) using a different methodology estimate that the median bank earns 60-70% of value from the deposit side while the loan side contributes 30-40%. We cannot directly compare our numbers to theirs, as we do not attempt a split franchise costs

(A) Binned by size



(B) Binned by franchise value cost

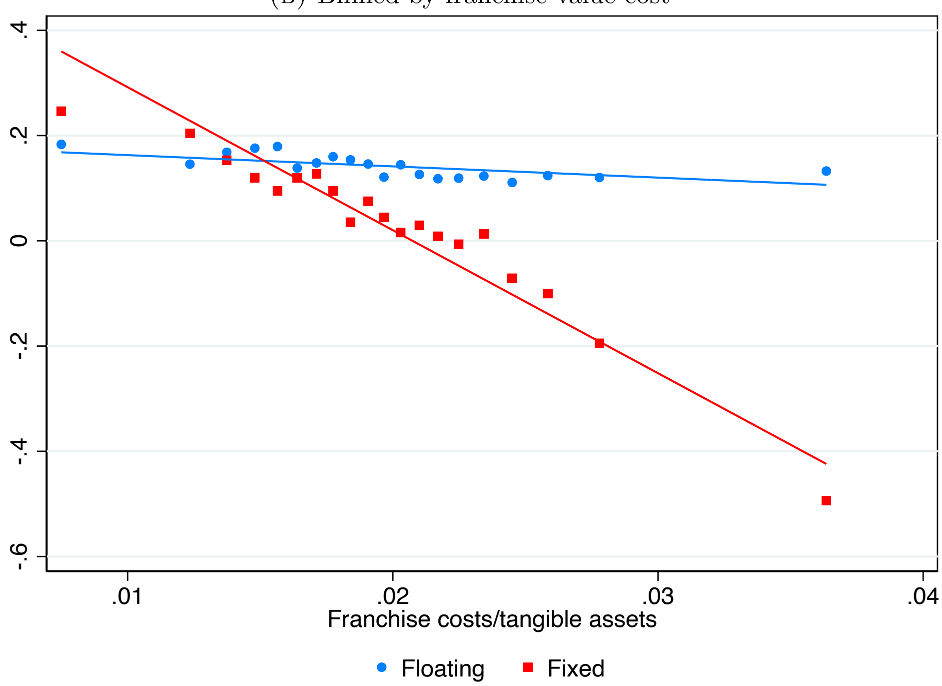


Figure 6
Fixed and floating components of franchise value

into deposit business and lending business components, but the substantial value contribution of the floating component in our analysis is broadly consistent with their estimates. The high value of the floating component is also consistent with data from the sale prices of bank branches that show higher prices for banks with a larger core deposit business (Sheehan, 2013; Cyree, 2010). For smaller banks, the floating component plays a particularly significant role. That is, small banks have a deposit base on which they are able to pay a deposit rate that is substantially below market rates. There is evidence that larger banks have a higher deposit beta than smaller banks (Drechsler et al., 2021) and evidence that digital banks, which likely have a more sophisticated depositor base, have a higher beta than non-digital banks (Koont et al., 2023). Interestingly, the banks in the very largest size bin look similar to the small banks in that the franchise value originates entirely from the floating component. This could be a consequence of the perceived too-big-to-fail status of these banking giants that gives them an advantage in the deposit market. These very large banks in the highest size bin also drive the results in our earlier aggregate analysis.

Figure 6b shows the fixed and floating components, binned by franchise costs. High cost banks have a negative fixed component of the franchise value, which means that the duration of the franchise value is negative. This provides a motive for holding long-duration securities to hedge the negative duration of the franchise value. However, as Figure 4d showed earlier, these banks actually have lower long-duration securities holdings, inconsistent with the hedging motive.

We draw two main conclusions from this analysis. First, most banks' franchise value in 2021 is exposed to risk from a rise in interest rates. For the typical bank, the fixed spread component of the total spread exceeds fixed franchise costs, which renders the duration of the franchise value positive. Panel B in Table 5 shows that the mean fixed component of the franchise value is close to 2.6% of tangible assets.

Panel B also reports a standard error for this mean of the fixed franchise value component, as well as for floating component, and, in Panel A, the key inputs to the franchise value

Table 5
Franchise Value Statistics

	(1) Mean	(2) Median	(3) S.E. of Mean
Panel A: Franchise value inputs			
ϕ_0	0.0205	0.0206	0.0001
ϕ_1	0.1419	0.1396	0.0028
Franchise cost/Assets	0.0198	0.0194	0.0001
Panel B: Franchise value components			
Floating FV	0.1419	0.1396	0.0028
Fixed FV	0.0259	0.0405	0.0055

calculations. To calculate these standard errors, we make two assumptions. First, all between-bank heterogeneity in the estimated regression coefficients ϕ_0, ϕ_1, and the other inputs of the franchise value calculation, is due to estimation error. This assumption likely substantially overstates the standard error, as there is presumably some between-bank heterogeneity in the true values of these inputs. Second, we assume that the residuals in the bank-level regressions are uncorrelated across banks. This likely understates the standard error to some extent, as there may be some commonality in residuals. Based on these assumptions, we can estimate the standard error consistently as $1/\sqrt{N}$ times the cross-sectional standard deviation of the franchise valuation calculation inputs.[10] Given the likely large upward bias in the standard error from ignoring true heterogeneity in these input variables, we regard these standard error estimates as an upper bound. Based on the standard error estimate for the mean fixed franchise value component, the estimated mean is more than five standard errors above zero. Hence, the inference that the typical bank has a franchise value with positive duration can be made with a high degree of statistical confidence.

We next revisit the analysis of the security duration chosen by banks, examining the extent

[10]This approach is in analogy to Fama-MacBeth regressions in asset pricing research where $1/\sqrt{T}$ times the time-series standard deviation of date-by-date cross-sectional regression coefficients consistently estimates the standard error if errors are uncorrelated across time and the true regression coefficients are time-invariant.

to which such holdings hedge bank value. Table 6 regresses the fixed FV and floating FV on the total duration of bank's securities holdings (securities share $\times$ duration of securities). Column (1) shows that banks with a low fixed FV hold more duration. This is consistent with hedging a motive for banks. Note that a low fixed FV could arise because of either low fixed spreads on loans/deposits or a high franchise cost. In figure 4d we showed that there is no relation between franchise costs and the security duration, indicating that the relation is driven by low spreads. A possible explanation for the correlation is variation in business models. Hanson et al. (2024) document that banks vary in business models, with some banks specializing in making informationally insensitive loans financed by deposits, with others specializing in providing liquidity services, in the form of deposits, credit lines, and owning securities. Such a variation in business models would generate the relation we see in the data, although in this case securities holdings are a proxy for business model and not a hedge (e.g., the liquidity-providing banks could have chosen to only hold short-duration securities).

In column (2) we included both fixed and floating FV as independent variables. Now we see that the R^2 rises substantially and the explanatory power of the fixed FV falls considerably. As we noted in Figure 4b, high ϕ_1 banks (low β banks) hold more long duration securities. As the floating FV is proportional to ϕ_1, the table reproduces the finding of the earlier figure. In column (3) we add log tangible assets as a control for size, and doing so has no appreciable effect on the results.

Figure 7 presents the result graphically. We sort the banks into 25 equally sized bins on the basis of 5 bins of each of fixed and floating FV. We then plot the average securities duration in each bin. We see that securities duration is largely driven by variation in floating FV, with the highest duration in the highest floating FV bin. The variation across the fixed FV bins is far smaller in magnitude.

Table 6
Determinants of Long-Duration Securities Exposure

The sample includes all U.S. commercial banks in 2021Q2. The dependent variable is the duration of securities held by each bank times the ratio of securities holdings to tangible assets. t-statistics are reported in parentheses.

	(1)	(2)	(3)
Fixed FV component	-0.636	-0.139	-0.141
	(-6.12)	(-1.55)	(-1.56)
Floating FV component		3.151	3.144
		(15.99)	(15.95)
Log tangible assets			-0.052
			(-2.74)
Intercept	2.177	1.713	2.373
	(70.23)	(51.93)	(9.64)
R^2	0.01	0.09	0.09
Obs.	3772	3772	3772

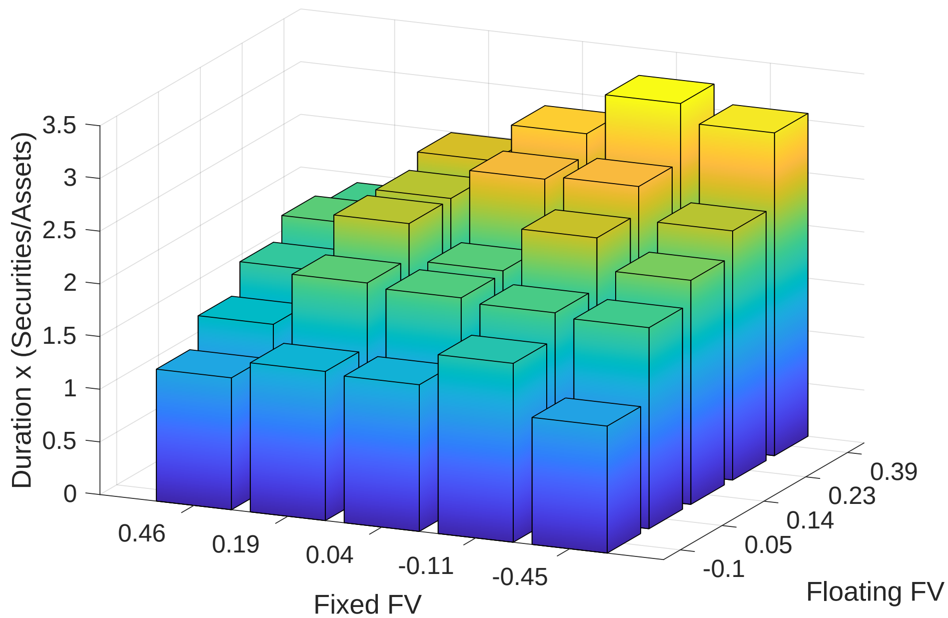


FIGURE 7
Long-Duration Securities Exposure as Function of Fixed and Floating Components of Franchise value

5.3 Implied and actual market-to-book ratio in 2021

As a check of our valuation framework and the franchise value estimates, we compare the market-to-book ratio implied by these calculations to the actual market-to-book for banks with publicly traded equity. For these comparisons, we look at the banking subsidiaries aggregated at the bank holding company level for publicly traded bank holding companies. We measure the actual market-to-book ratio at the end of 2021Q2 using market equity, plus book assets minus common equity, divided by tangible assets.

To map to available market data, we can use our valuation model to estimate the market value of the firm's equity (conditional on its long-run survival). Because returns to equity holders are subject to taxes, given tax rate τ, we must adjust the pretax market equity by the factor $(1-\tau)$ to determine the post-tax market equity value:

$$\begin{aligned} \text{Market Equity} &= (1-\tau)\text{Pre-tax Market Equity} \\ &= (1-\tau)\left(\text{Book Equity} + \text{MTM}_{T-B} + PV(S-C)\right) \end{aligned} \tag{24}$$

Finally, to abstract from differences in leverage, it will be useful to assess and compare banks based on the market value of their assets (relative to their book value). For this computation we adjust for the difference between the market and book value of equity:

$$\text{Asset } M/B = 1 + \frac{\overbrace{(1-\tau)\left(\text{MTM}_{T-B} + PV(S-C)\right) - \tau \text{ Book Equity}}^{\text{Market Equity - Book Equity}}}{\text{Book Assets}} \tag{25}$$

Equation (25) highlights the tax disadvantage associated with bank equity; for banks to add value to their investors, the franchise value associated with deposit and lending activity must overcome this additional cost. We set $\tau = 0.25$ in our computations.

If q_i is the true market-to-book ratio of bank i and our estimates of the franchise value are noisy but unbiased, then $\hat{q}_i = q_i + e_i$ where e_i is mean-zero noise uncorrelated with q_i. In this case, averaging $\hat{q}_i$ of many banks in a neighborhood of q_i should yield a value approximately equal to q_i. Figure 8 shows that our model estimates, $\hat{q}_i$ are in line with the market estimate q_i. In this figure observations are binned by the equity market measure of M/B and we can see that the the average model-estimated M/B in each bin is quite close to the equity market's M/B. It is also noteworthy that the actual M/B of banks in 2021Q2 are generally greater than unity. This is not consistent with models of bank franchise values that predict negative franchise values and hence $M/B < 1$ in times of very low short-term interest rates, as, for example, in Begenau and Stafford (2019).

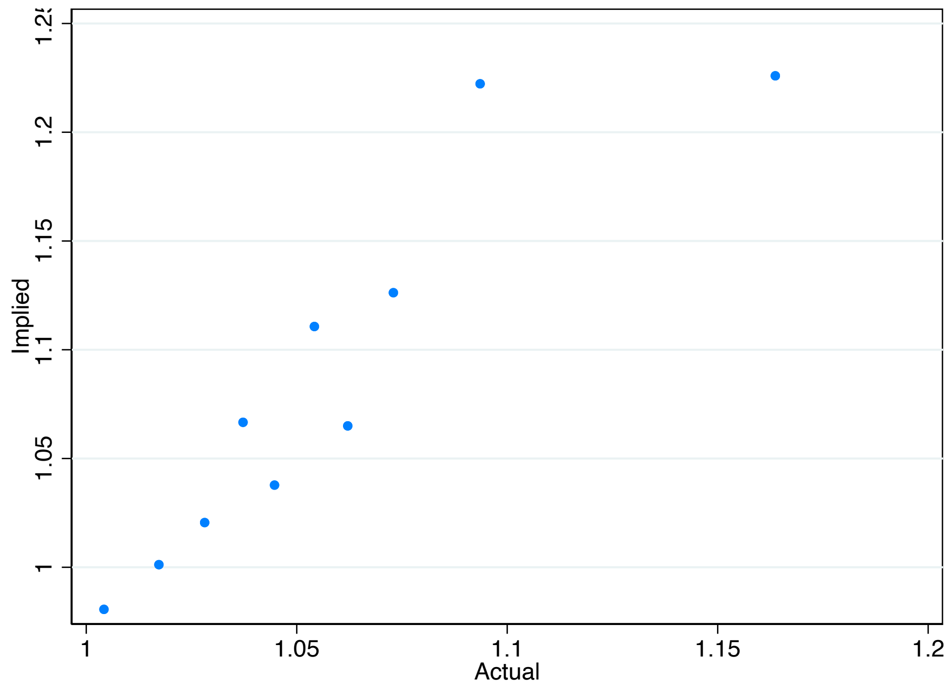


FIGURE 8
Actual and model-implied market-to-book in 2021Q2

6 Banks' Losses in 2023

In our framework, the interest-rate hikes between 2021Q2 and 2023Q1 affect the value of bank equity through two channels. First, higher rates lead to higher discounting of the fixed-rate component of the spread that banks earn from combined lending and deposit business. This reduces the present value of the fixed component. We estimate this valuation change by keeping costs and the other inputs of the franchise value calculation as in 2021Q2, but now with the discount rate for the fixed component based on the 30-year forward rate from 2023Q1, and with the term swap valuation based on the yield history up to 2023Q1.

Second, banks can have losses outside of the lending and deposit-taking business that we have not captured in our analysis of spread dynamics. In particular, losses on securities holdings can lead to losses that could potentially push market-to-book below unity and the bank into insolvency. Jiang et al. (2023) calculate valuation losses due to higher rates on securities holdings of banks and loans. In interpreting these losses as the total losses on banks' equity, they implicitly hold as fixed the rest of the bank business model. Drechsler et al. (2023a) have argued that the rest of the bank business model rises in value as interest rates rise. We assess the total effects using our framework and estimates. We add the Jiang et al. (2023) estimates of losses on securities holdings to our estimates of changes in franchise values to obtain an estimate of the loss in banks' market value of equity. For comparison, we also look at the Jiang et al. (2023) total loss estimates which ignore the contribution of changes in banks' franchise value.

6.1 All banks

We start by examining loss estimates for all banks, including those without publicly traded equity. Figure 9a shows the loss estimates binned by size. For the average bank, the loss on franchise value and securities combined is about 5% of tangible assets. These loss estimates are much smaller than the total loss estimated by Jiang et al. (2023), which are also shown in the figure. Banks' equity has positive duration, but the duration is smaller than what it would be just based on securities and loan duration in isolation, without considering offsetting effects due to the properties of costs and spreads in the banking franchise. Across the size spectrum, medium-sized banks are particularly strongly exposed to losses.

Our earlier analysis suggested that banks most at risk from interest-rate hikes in 2021 were those with large exposure to long-duration securities. Figure 9b provides confirmation. The observations are binned by the contribution to asset duration from securities holdings, calculated as product of the duration of the securities portfolio with the securities/assets ratio. Banks with the highest exposure to long-duration securities have losses that are about twice as big as those of banks with the lowest long-duration securities exposure.

The important message coming from our analysis is that for the typical bank there was a limited hedging motivation for holding long-duration securities because the combined lending and deposit-taking business already has positive duration. That is, the bank's ownership of

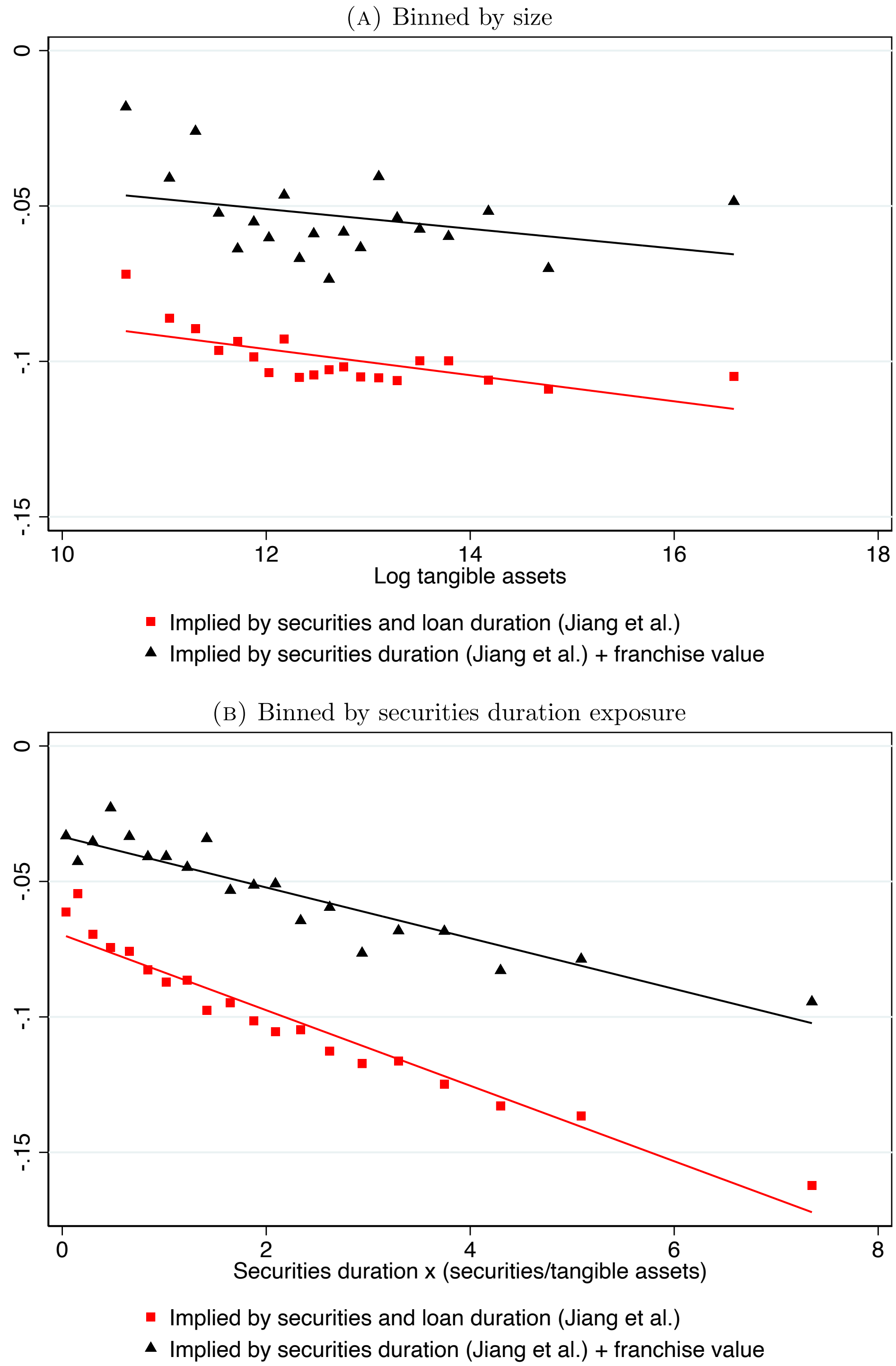


FIGURE 9
Estimates of Present Value Loss from 2021Q2 to 2023Q1

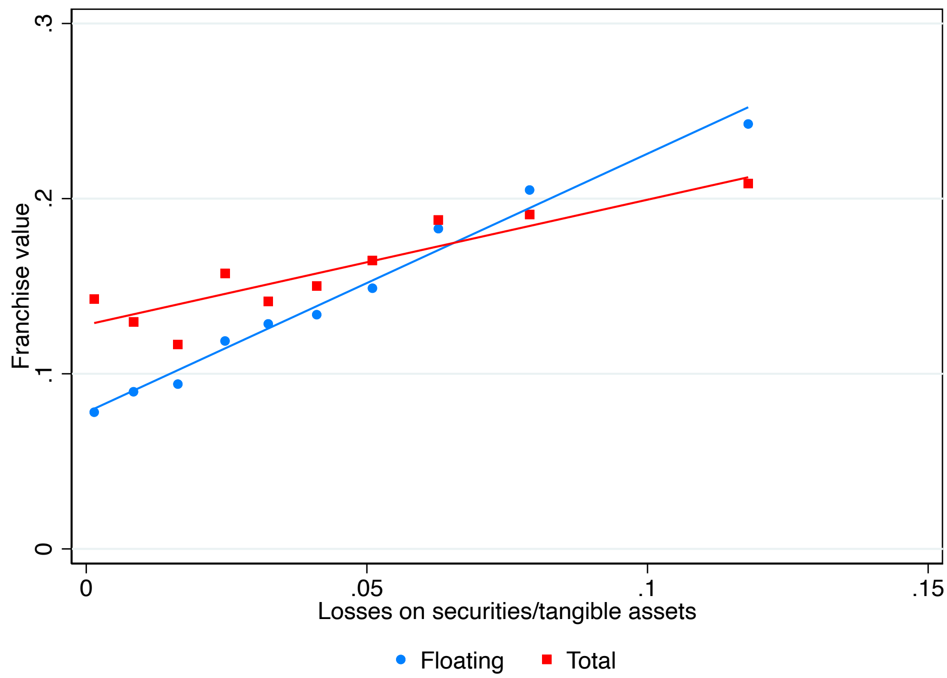


FIGURE 10
Comparison of franchise value in 2023 with losses on securities holdings

long-duration securities adds risks rather than hedges risk, echoing a finding in Begenau et al. (2015).

In Figure 10 we examine whether franchise value in 2023Q1 is sufficiently positive to offset the securities losses that banks experienced. According to our estimates, even banks in the highest bin of securities losses (more than 10% of tangible assets) still have sufficient franchise value to yield a positive residual value under the assumption that the bank survives as a going concern. In the appendix, we present this result in the form of a histogram of losses along the lines of Jiang et al. (2023).

6.2 Publicly traded banks

We now turn to publicly traded banks. For this subset of banks, we can express our loss estimates in terms of the implied change in M/B. We can then compare this implied change in M/B with the actual M/B based on observed stock prices.

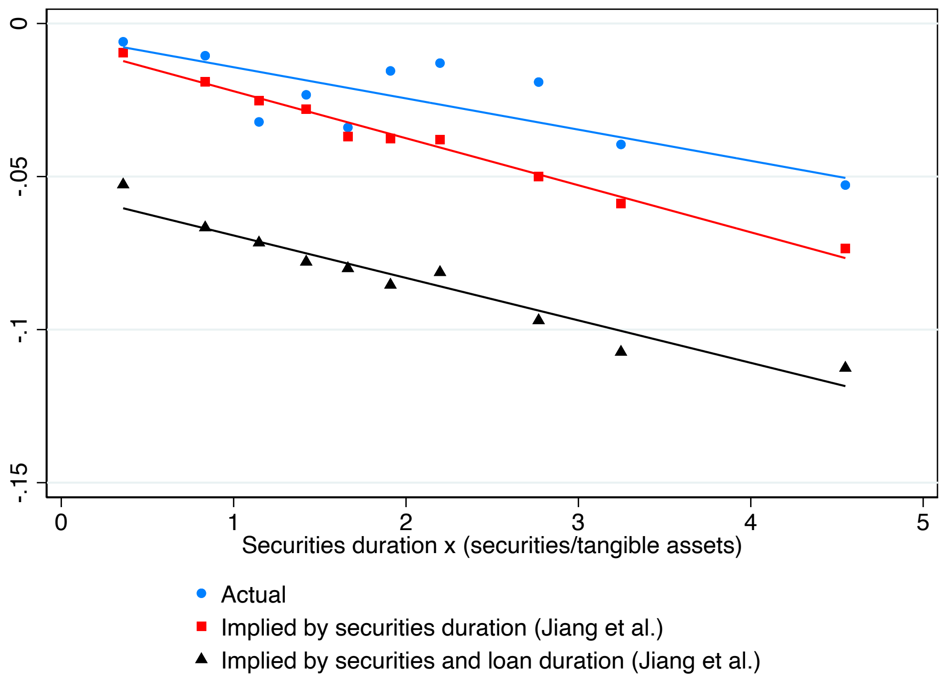


FIGURE 11

Changes in market-to-book assets ratio from 2021Q2 to 2023Q1: Actuals and Jiang et al. (2023) loss estimates

Figure 11 shows the change in the market measured M/B from end of 2021Q2 to end of 2023Q1 for banks binned by their long-duration securities exposure. For comparison, we also show the change in M/B implied by only the losses on securities from Jiang et al. (2023)'s calculations, and the change in M/B implied by only the losses on loans from Jiang et al. (2023)'s calculations. As the figure shows, the losses on securities alone roughly match the actual change in M/B. Including the losses on loans, but without considering franchise value, gives a fall in value far greater than that measured by the equity market.

We next include the change in the franchise value in the implied M/B. Figure 12 shows the result. The figure shows that the change in the valuation of the fixed franchise value component only makes a minor contribution for banks with high exposure to long-duration securities. That is most of the losses for these banks still come from the securities losses. In contrast, for banks with little exposure to long-duration securities, the estimated losses are

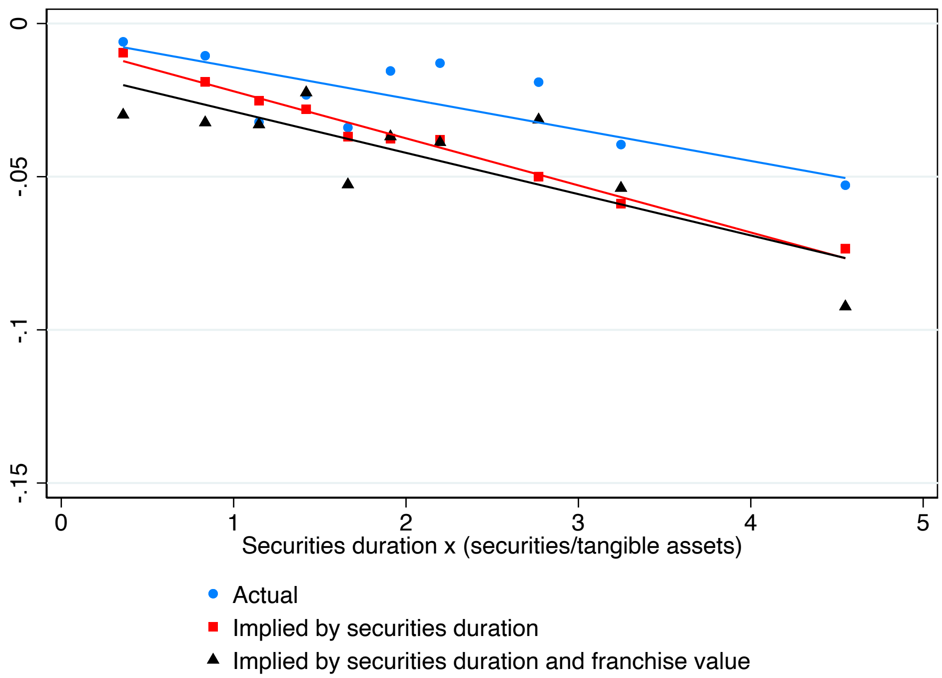


FIGURE 12
Changes in market-to-book assets ratio from 2021Q2 to 2023Q1: Estimates based on franchise values

smaller, and mostly due to the franchise value changes.

The change in implied M/B based on securities losses and franchise value changes combined is larger than the actual M/B changes in market data. It is possible that the actual M/B may also reflect a misvaluation in the stock market or option value components (Kelly et al., 2016) that we do not capture in our calculations.

6.3 Banks' own loss estimates

As we describe in Section 5.1, in their annual 10-K filings, many banks report measures of interest rate risk exposure of their net interest income and equity market value. We collect this information from the 2021 10-K filings of all publicly traded bank holding companies in the U.S and compare the estimates to the calculations we have done.

Figure 13 shows banks' estimates for the effect of a 100bp parallel upward shift in the

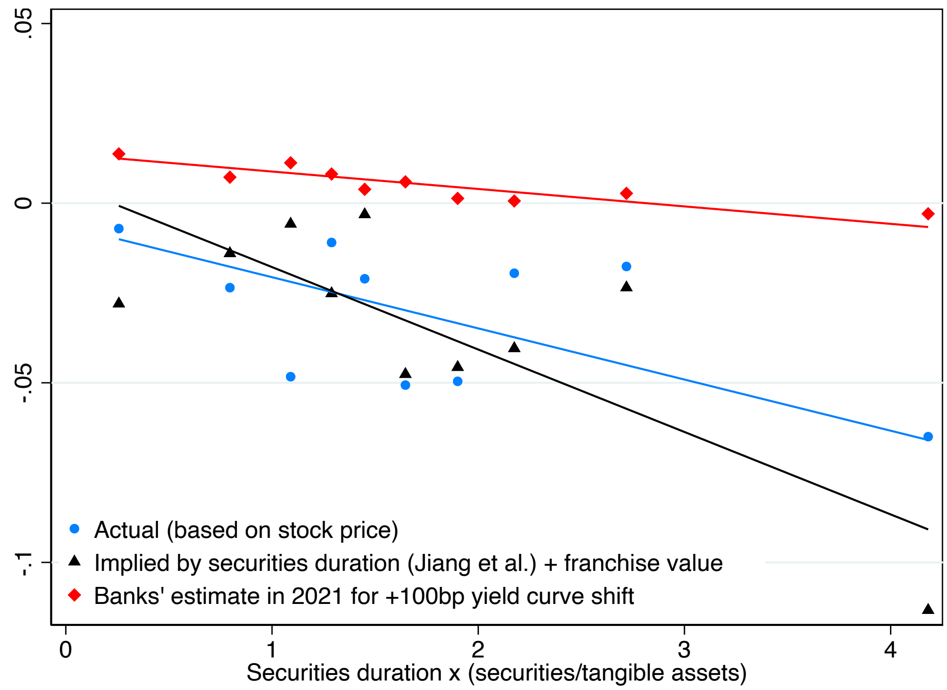


FIGURE 13
Comparison of losses in 2023 with banks' estimates in 2021 of potential losses

yield curve, expressed as the implied change in the market-to-book assets ratio, binned by the duration contribution of securities holdings. Virtually all banks, except those with the highest securities duration contribution, had expected that a rise in interest rates would *raise* their market value of equity! This is in stark contrast to what actually happened, as shown in the plot by the changes in actual market-to-book asset ratios. The figure also shows the loss estimate based on franchise value changes and securities losses from 12, but here only for the subset of bank holding companies for which the loss estimates from 10k filings are available.[11]

[11]These estimates from 10k filings are available for 56 of 150 bank holding companies.

7 Conclusion

- For the median bank, the lending business hedges floating exposure of deposit taking. The spread earned from the deposit and lending business together has a positive loading on federal funds rate.

- Taking into account the fixed component of spread and franchise cost and risk-neutral expected credit losses, the resulting net fixed spread component is positive. Hence, the franchise value of the median bank has positive duration. But it is a relatively small positive duration (compared to a bank that lends entirely at fixed rates and borrows floating). As a result, the interest-rate risk from this positive duration is limited, as higher discounting of the fixed cash flow stream cannot push market-to-book below unity.

- Therefore, interest-rate risk is primarily in the securities holdings, not in the lending and deposit franchise

- Empirically, banks with a high floating component of franchise value own more long-duration securities holdings even though the floating component has zero duration. They seem to behave as if a high floating component of the franchise value (which reflects a low deposit beta) required hedging by long-duration securities holdings.

- Consistent with this, losses from securities holdings in 2023 are concentrated among banks with high exposure to long-duration securities. For these banks at the end of 2023Q1 the franchise value is still large enough to offset these securities losses (under the assumption that the banks can continue as a going concern).

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Online Appendix

A Proofs

B Franchise cost adjustments

The fees earned from credit cards (CCF) are included in other business income (OBI). To estimate them, we assume the magnitude of these fees are related to the bank's credit card interest income ($CCII$). We therefore use data for all banks to regress OBI/A on the credit card interest income to tangible assets ratio ($CCII/A$),

$$OBI_i/A_i = \eta_0 + \eta_1 CCII_i/A_i + \varepsilon_i, \tag{B.1}$$

The fitted value from this regression provides an estimate of CCF:

$$\widehat{CCF}_i = \eta_1 CCII_i \tag{B.2}$$

Next we estimate the average profit margins from lines of business that generate other business income by regressing the ratio of total non-interest expenses ($TNIE$) to tangible assets on other business income (OBI) to tangible assets using data for all banks:

$$TNIE_i/A_i = \gamma_0 + \gamma_1 OBI_i/A_i + \varepsilon_i. \tag{B.3}$$

The fitted value from this regression provides an estimate of other business expenses (OBX) that come from non-credit card activities:

$$\widehat{OBX}_i = \gamma_1(OBI_i - \widehat{CCF}_i) \tag{B.4}$$

We then adjust the franchise cost computation for a given bank i downwards by subtracting the estimated OBX_i:

$$\begin{aligned} \text{Franchise Cost}_i &= TNIE_i - DSC_i - \widehat{OBX}_i - \widehat{CCF}_i && \text{(B.5)} \\ &= TNIE_i - DSC_i - \gamma_1 OBI_i - (1-\gamma_1)\eta_1 CCII_i. && \text{(B.6)} \end{aligned}$$

In our estimation, we find $\gamma_1 \approx 0.7$, consistent with a 30% profit margin on other business activities. We also estimate $\eta_1 \approx 2.1$, suggesting that credit card fee income is roughly double the income earned from credit card interest.

Table B.1 shows the magnitudes of the adjustments of franchise costs at the bank level for ordinary business expenses (OBX) and credit card fees as a fraction of the dollar amount of costs before these adjustments. The OBX adjustment is substantial, especially for some banks in the tails of the distribution with large non-interest business. In contrast, the CCF adjustment is minor for all banks in the sample.

Table B.1
Franchise Cost Adjustments As Fraction of Unadjusted Costs

	(1) Mean	(2) S.D.	(3) 1st Pctile	(4) 10th Pctile	(5) Median	(6) 90th Pctile	(7) 99th Pctile
OBX	0.1422	0.2008	-0.0059	0.0296	0.1079	0.2956	0.7247
CCF	0.0015	0.0081	0.0000	0.0000	0.0000	0.0035	0.0215

C Robustness checks

C.1 Dynamics of costs

Table C.1 checks the interest rate sensitivity of franchise costs by regressing aggregate franchise costs on the three interest rate factors. In levels, the franchise cost series shares a common downward trend with the federal funds rate. This leads to a positive coefficient on the federal funds rate in Panel A. However, as Panel B shows, this positive coefficient largely goes away in the differenced regression. None of the factor loadings in the differences regression are statistically significant and they are all quite small. So overall there is little evidence of interest rate sensitivity of franchise costs.

C.2 Franchise value calculations based on slope coefficients from regressions in changes

The intercept and slope coefficients that go into the calculations of fixed and floating franchise values are from a regression of the level of total spreads on the level of the federal funds rate and the synthetic lending portfolio factor. Summary statistics of the estimated regression coefficients are shown in Panel A of Table 4. Regressions in levels are potentially contaminated with spurious correlations arising from the presence of trends in dependent and explanatory variables. For this reason, we check robustness by doing the franchise valuation with the coefficients from regressions in changes shown in Panel B of Table 4. To get the fixed spread component, we then take the two slope coefficients ϕ_1, ϕ_2, and ϕ_5 for each bank from the regression in changes and calculate an implied intercept as

$$\text{Mean(total spread)} - \phi_1 \times \text{Mean}(r^*) - \phi_2 \times \text{Mean}(\ell^2) - \phi_5 \times \text{Mean}(\ell^5) \qquad \text{(C.1)}$$

We then recalculate the fixed component of the franchise value in 2021Q2 based on this implied intercept.

Figure C.1 shows the result in the cross-section of banks binned by the ratio of franchise cost to tangible assets, which, as we show in the main part of the paper, is strongly associated with cross-sectional variation in the value of the fixed spread component. As the figure shows, switching to the alternative calculation only has a minor effect on the fixed spread component of the franchise value.

Table C.1

Dynamics of costs at the aggregate level

The sample includes U.S. commercial banks from 1984Q1 to 2021Q2. In Panel A, the dependent and explanatory variables are four-quarter moving averages of quarterly aggregates of franchise costs/tangible assets. In Panel B, the dependent variable is the quarterly change and the slope coefficients shown in this panel are the sum of slope coefficients on the contemporaneous quarterly change in the and three lags of the explanatory variables. The term swap variables are for 2-year and 5-year term swaps. The t-statistics shown in parentheses are based on Newey-West standard errors with 8 lags.

	(1) Costs	(2) Costs
Panel A: Regression in levels		
r_t^*	0.102	0.111
	(8.97)	(10.11)
ℓ_t^2		-0.039
		(-0.61)
ℓ_t^5		0.138
		(3.16)
Intercept	0.011	0.009
	(17.88)	(10.46)
R^2	53.07	74.35
Obs.	147	147
Panel B: Regression in changes		
Δr_t^*	-0.006	0.041
	(-0.66)	(0.89)
$\Delta \ell_t^2$		-0.017
		(-0.78)
$\Delta \ell_t^5$		0.076
		(1.67)
Intercept	-0.000	-0.000
	(-1.71)	(-0.65)
R^2	1.43	8.54
Obs.	146	146

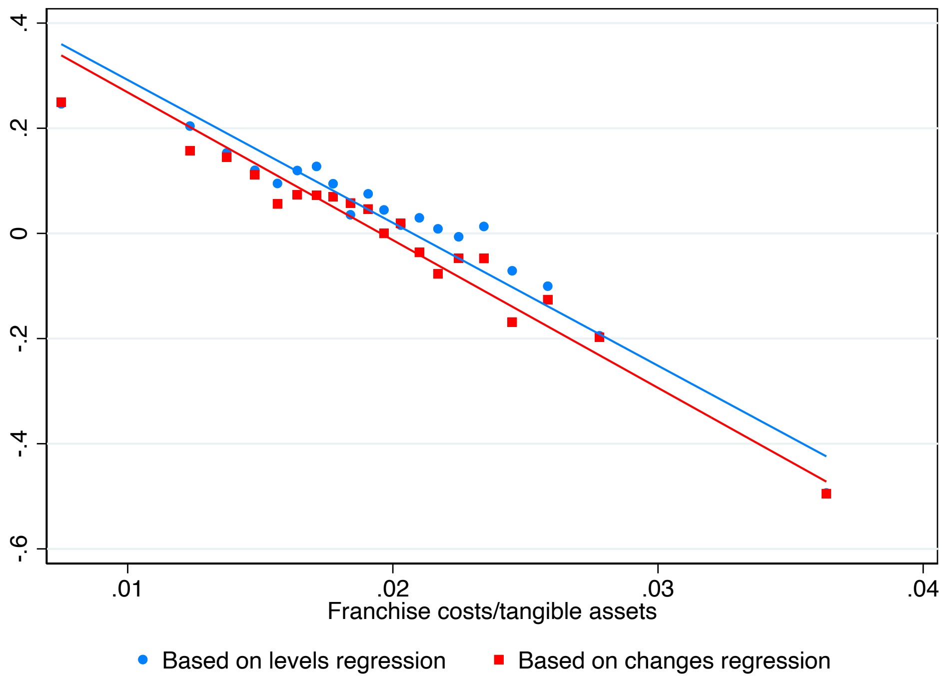

FIGURE C.1
Fixed components of franchise value based on intercept from levels regression and implied intercept from changes regression

Table C.2
Summary statistics of bank-level spread beta and deposit beta estimates

The sample includes U.S. commercial banks from 2001Q1 to 2021Q2. The fed funds rate is the only explanatory variable. The dependent variable in columns (1) and (2) is the deposit spread, as in our main analysis. The dependent variable in columns (3) and (4) is deposit interest expense divided by total deposits. The regressions in columns (1) and (3) are run in levels, those in columns (2) are run in changes, and the coefficients shown in the table are the sum of the slope coefficient on the contemporaneous quarterly change of the federal funds rate and three lags.

	(1) Deposit spread	(2) Δ Deposit spread	(3) Int.exp./Deposits	(4) Δ Int.exp./Deposits
mean	0.42	0.55	0.49	0.34
p50	0.42	0.55	0.50	0.34
s.d.	0.088	0.084	0.099	0.087

C.3 Deposit betas based on interest expense to deposit ratios

The deposit spread that we use in our regressions and franchise value calculations is expressed as a share of tangible assets. The variation in this spread can therefore be decomposed into variation coming from interest expenses/deposits and the ratio of deposits/tangible assets. In principle, therefore, the slope coefficient on the federal funds rate in our regression could capture some comovement between the federal funds rate and deposit in- or outflows rather than a relation with the pricing of deposits. Are these quantity movements contributing significantly to the estimated loading of deposit spreads on the federal funds rate? If not, then we should be able to run the regressions with interest expenses/deposits as dependent variable and get back from these estimates to our estimates based on deposit spreads scaled by tangible assets by appropriate rescaling with the average deposit/tangible assets ratio (which is 0.84 on average across banks in the sample from 2001 to 2021 that we use for bank-level regressions).

Column (1) shows that in a regression just on the federal funds rate (without the synthetic lending portfolio factor), we get a mean coefficient of 0.42. Using eq. 13, and $d = 0.84$, this implies that deposit beta in a regression of interest expenses on deposits is $1 - 0.42/0.84 \approx 0.5$. (The deposit beta when interest expenses are scaled instead by tangible assets would be $0.5(0.84) = 0.42$.) For comparison, running this regression in the data, as shown in column (3), yields a mean deposit beta estimate of 0.49, i.e., a value exactly the same as the one implied by this calculation. A calculation based on the coefficients from regressions in changes in columns (2) and (4) produces similar results: $1 - 0.55/0.84 \approx 0.35$ which is exactly the same as the estimated coefficient 0.35 in column (4).

So variation in the deposits to tangible assets ratio contributes to some extent to lowering the slope coefficient in the spread beta regression in column (1). When the federal funds rate is high, deposits are lower relative to tangible assets, which lowers the share of cheap deposit funding, which lowers the spread earned on deposits as a fraction of tangible assets.

Table C.3
Franchise Value Statistics

	(1) Mean	(2) Median	(3) S.E. of Mean
Panel A: Franchise value inputs			
ϕ_0	0.0208	0.0209	0.0001
ϕ_1	0.1401	0.1365	0.0029
Franchise cost/Assets	0.0182	0.0177	0.0001
Panel B: Franchise value components			
Floating FV	0.1401	0.1365	0.0029
Fixed FV	0.0981	0.1074	0.0054

C.4 Alternative franchise cost measurement

We drop banks with more than 30% of total income from other business income. This screen drops about 7.5% of banks, including some of the largest banks. We then compute Franchise Cost $= TNIE - OBI - DSC$. That is, we do not follow a regression procedure to estimate $\widehat{OBX}$ and $\widehat{CCF}$ as in the main text. We instead include all other business income, which includes credit card fees, and reduce the franchise costs with such income (note that other business income does not comove with interest rates in a statistically significant fashion). This approach effectively includes all income and costs from other business lines, and we use the screen to eliminate banks where those other business lines are too large.

Table C.3 redoes Table 5. We note that the floating FV is similar in magnitude across the tables, while the fixed FV increases and is significantly above zero. That is, the median and mean bank have a positive duration.

C.5 Security losses and franchise value

The left panel (orange) of Figure C.2 presents a histogram of security losses from 2021Q2 to 2023Q1, replicating the analysis of Jiang et al. (2023). We note in the main text that banks with higher security losses also happen to be banks that have a higher initial franchise value (note: it is <u>not</u> that these banks gained franchise value). The right panel (blue) of the figure illustrates this point. We project the franchise value on security losses in the cross-section of banks. We then use the regression fit to adjust the security losses to include the (projected) franchise value. We can see that the loss distribution is tighter and remains above zero. Note that we do not include loan losses from interest rate increases and potential losses on commercial real estate lending, which would tend to shift this distribution the left.

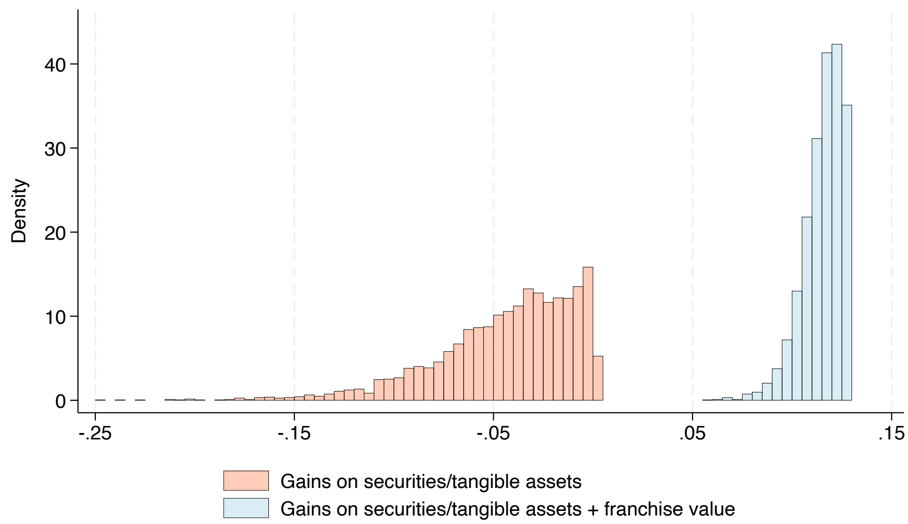

FIGURE C.2
Histogram of security losses in 2023 (orange), with FV adjusted based on projection (blue)