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DO BANKS HEDGE USING INTEREST RATE SWAPS?

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ABSTRACT

We analyze whether banks use interest rate swaps to hedge the interest rate risk of their assets, primarily loans and securities. By examining regulatory data on individual swap positions from the largest 250 U.S. banks, we find that banks hold large swap positions with an average notional value of $434 billion. However, after accounting for offsetting swap positions, the average bank exhibits almost no net interest rate risk from swaps: a 100-basis-point increase in rates reduces the value of its swaps by only 0.1% of bank equity. The variation in swap positions across banks indicates that banks use swaps to hedge interest rate risk, thereby facilitating risk transfer within the banking sector. Additionally, we find that swap dealer banks primarily hold swap positions for market making, while non-dealer banks use swaps to meet borrower demand for fixed-rate loans. Despite the substantial notional amounts, our findings suggest that swap positions are not economically significant in hedging the overall interest rate risk of bank assets. Instead, banks primarily rely on their deposit franchise to hedge interest rate risk.

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I. Introduction

Banks are in the business of borrowing short and lending long, which exposes them to interest rate risk. In particular, on the lending side, the values of fixed-rate loans and investments in fixed-rate securities decline when market interest rates rise.

Recently, market interest rates increased from January 2022 to March 2023 as central banks around the world tightened monetary policy to combat inflation. In the United States, the Federal Reserve Bank increased the market short-term rate, i.e., the Fed Funds rate, from close to 0% in early January 2022 to more than 5% in March 2023. As a result, the long-term interest rate, i.e., 10-year Treasury rate, increased by about 2.5%. These large increases in market interest rates significantly lowered the value of bank loans and securities. Drechsler et al. (2023) estimate that the U.S. banking sector lost around $700 billion on security investments and a total of $1.5 trillion on both securities and loans.

These large losses raise the question of how banks manage their interest rate risk. Interest rate swaps ("swaps"') are a commonly used financial instrument for this purpose. Swaps involve exchanging fixed interest rate payments for floating rate payments, thus allowing banks to transfer interest rate risk within the banking sector or across to other sectors. Almost all large U.S. banks use swaps, and the total notional value of swap positions amounts to six times the total assets of the banking sector.

In this paper, we ask whether banks use swaps to hedge the interest rate risk of their assets. Banks can use swaps to hedge the interest rate risk of individual assets, a portfolio of loans or securities, or their entire balance sheet. The aggregate banking sector may also use swaps to move interest rate risk to non-bank financial institutions such as insurance companies, pension funds, or sovereign wealth funds. At the same time, banks may use swaps to increase their exposure to interest rate risk, possibly because they engage in risk taking or risk shifting. Banks may prefer swaps over fixed-rate assets for taking on interest rate risk because swaps have embedded leverage, may require less regulatory capital, and may be harder for outsiders to evaluate.

The main challenge in answering our research question is that banks' exposure to swaps is notoriously hard to measure. A proper evaluation of whether swaps hedge bank assets requires highly granular data on swap positions including swap-specific information on notional amount, maturity, interest rate, and the direction of the swap. In practice, however, publicly available data on swaps is mostly limited to bank-level data on total notional amounts and market values. This information is insufficient to provide a proper evaluation of the interest rate risk embedded in swaps.

We address this challenge by using regulatory (non-public) data on bank swap positions collected from the Commodity Futures Trading Commission (CFTC). Our analysis focuses on the positions of the largest 250 U.S. commercial banks, which amount to more than 8 million swap contracts and constitute nearly all swap positions of the U.S. banking sector. In this way, our data allow us to measure and evaluate the interest rate exposure at the swap-level, at the bank-level, and at the aggregate banking sector level. To the best of our knowledge, this is the first paper examining the interest rate risk of bank swap positions using such detailed data.

We evaluate bank exposure to swap positions using two common metrics. The first metric is the notional amount, which measures the total dollar amount that is referenced in a swap. For example, the notional amount of a fixed-for-floating interest rate swap is the dollar amount used to calculate the interest rate payments required by the contract. Notional amounts are straightforward to compute and commonly reported, although they cannot be interpreted as measuring the interest rate exposure of swap positions.

The second metric is the DV01 (the dollar value of an '01), which is the change in the value of a swap position due to a one-basis-point change in interest rates. The DV01 of a swap can only be computed using detailed information on swap positions including information on notional value, maturity, swap rate, and direction of the swap. Banks use DV01 as the main measure of the interest rate risk of their swap positions. More broadly, banks and non-bank financial institutions use DV01 to measure the interest rate risk of all interest-rate-sensitive assets, including bonds and loans. This is because DV01 can be computed for all assets and aggregated to the portfolio or firm level. Therefore, financial institutions generally use DV01 to manage their interest rate risk exposure.

Our analysis finds that the U.S. banking sector holds swap positions with a total notional amount of $140 trillion in 2022. The positions are concentrated among the top 250 banks, which account for 99.9% total notional value. Among the top 250 banks, the average bank has swap positions with a notional amount of $434 billion, which is about 7 times average bank assets.

Despite the large notional amounts, we find that the interest rate risk of swap positions is close to zero for the average bank. The average DV01 among the largest 250 banks is $3 million and the median DV01 is $10,000. To put these values into perspective, we scale banks' swap DV01, i.e., their interest rate risk exposure in swaps, with bank equity, i.e., their capacity to absorb risk. The mean ratio of DV01 to bank equity is −0.001% and the median ratio is 0.001%. This means that for the average bank a 100 basis-point increase in interest rates reduces bank equity by less than 0.1%. We further note the sign switches when comparing the mean and the median ratio, which shows that the average bank essentially has no interest rate risk from swaps. Hence, changes in interest rates barely affect the value of the average bank's swap positions.

We find some variation in DV01 across banks. Among the top 250 banks, DV01 varies from −$1 million at the 5^{th} percentile to $3 million at the 95^{th} percentile, and the ratio of DV01 to bank equity varies from -0.031% to 0.025%. The distribution of the ratio of DV01 to equity is close to symmetric, implying that losses from interest rate changes at one bank are offset by gains at another bank. We find a similar result when aggregating DV01 for the banking system as a whole. Total DV01 is $585 million, or 0.038% of aggregate bank equity. Hence, most swap positions cancel out within the banking sector, and there is limited risk transfer from the banking sector to other sectors.

We also separately analyze banks that are swap dealers and banks that are not. Swap dealers are banks that are designated by the CFTC to make markets in swaps. There are 12 swap dealers during our analysis period. All swap dealers are part of large banks: the 7 largest banks by assets are all swap dealers and all swap dealers are among the 20 largest banks by assets. We find that notional amounts are significantly higher for swap dealers relative to non-swap dealers. The average swap dealer has swap positions with a notional amount of $8.5 trillion, or about 11 times bank assets. The average DV01 is $52 million, or about 0.01% of bank equity. Hence, swap dealers have even larger notional exposure than non-swap dealers but, similar to non-swap dealers, swap dealers have very limited interest rate risk from swaps.

Next, we examine the economic motivation for using interest rate swaps. We start by examining whether the variation in DV01 across banks is driven by hedging or risk-taking. If a bank uses a swap to hedge long-term asset holdings, we expect that the bank equity return is unaffected by interest rate changes. Conversely, if a bank uses interest rate swaps for speculation, we expect that the change in interest rates affects the bank equity return. To distinguish between the two explanations empirically, we compute the quarterly swap return, defined as the bank equity return coming solely from changes in the value of swap portfolio over the quarter. We then regress the realized bank equity return on the swap return. If we find the coefficient of zero, this suggests that banks use swaps for hedging. If we find a coefficient of one, it suggests that banks use swaps for risk-taking.

We implement our test using quarterly data for publicly listed banks from September 2017 until December 2019. We find a small and statistically insignificant coefficient of 0.059 with an R-squared of only 0.001%. The result is similar when controlling for bank and time effects. These findings suggest that banks use swaps for hedging, albeit to a limited extent. The standard deviation of swap returns is only 0.99%, compared to the standard deviation of bank equity returns at 10.0%. Therefore, while swaps are used for hedging on the margin, they are not economically significant in mitigating a bank's overall interest rate risk. As discussed below, we find that banks primarily use deposits to hedge their overall interest rate risk.

We also examine alternative reasons for using interest rate swaps beyond hedging. First, we show that swap dealers have larger notional amounts relative to other banks but do not take on additional interest rate risk as a result of swap dealing. This result remains robust even when controlling for firm characteristics such as bank size, the share of assets held as loans or securities, and the share of liabilities financed with core deposits. This suggests that swap dealers' large notional amounts are primarily due to their swap dealing activities, which they manage without incurring significant interest rate risk.

Second, we find that many banks use swaps in conjunction with making loans. Banks typically prefer issuing floating-rate loans to firms due to their ease of securitization, while many borrowers prefer fixed-rate loans. This prompts banks to offer floating-rate loans paired with swaps to hedge the interest rate risk, effectively creating fixed-rate loans. Consistent with this interpretation, we find that non-swap-dealers primarily sell swaps to customers and hedge these positions with swap dealers.

More specifically, when a bank makes a floating-rate loan to a borrower and sells a corresponding swap to turn it into a fixed-rate loan, the bank often simultaneously hedges its swap position with a swap dealer. This involves entering into an offsetting swap initiated on the same day and with the same notional amount and maturity. Using contract-level data, we find that non-swap-dealers with less than $100 billion in assets (116 banks) hedge at least 73% of their swaps with customers in this way. Non-swap-dealers with more than $100 billion in assets (11 banks) hedge at least 39% of swaps with customers in this way. These percentages are lower bounds on bank hedging of swaps with customers because they include only single swaps with perfectly offsetting terms.

The last step of our analysis is to evaluate the economic importance of using swaps to hedge overall bank interest rate risk. We use bank call report data to estimate interest rate risk from assets and liabilities, excluding deposits. We develop a new methodology to compute duration and DV01 for each type of asset and liability. We find that the average bank holds securities with an average duration of 4.3 years and a DV01 of $5.1 million, and loans with an average duration of 2.9 years and a DV01 of $7.5 million. They also have non-deposit liabilities with a duration of 1.4 years and a DV01 of $2.1 million. Considering bank cash holdings, the average bank duration is 3 years, and the average DV01 is $12.2 million.

These estimates allow us to compare the rate exposure from bank assets and liabilities versus swaps. we measure interest rate risk as the DV01 scaled by bank equity. We find that bank equity declines by 23.8% due to bank assets for a 100 bps increase in interest rates. In contrast, the average value of bank equity due to swap positions increases by 0.23% for a 100 bps increase. This shows that for the average bank, interest rate risk comes mostly from their assets and liabilities, not swaps.

However, this does not mean banks are unhedged against interest rate risk. Drechsler, Savov and Schnabl (2021) find that banks hedge interest rate risk with their deposits, as deposits have negative duration and offset the positive duration of bank assets. To test this explanation, we define a bank's implied deposit duration as the deposit duration that would hedge the combined interest rate risk of the bank's assets, other liabilities, and swaps. We then regress the implied deposit durations on deposit betas, where lower deposit betas are associated with higher deposit durations. We find that banks use deposits to hedge the overall interest rate exposure from assets, non-deposit liabilities, and swaps.

Overall, we show that banks face significant interest rate risk due to their business model of investing in securities and making loans. To manage this risk, banks often use interest rate swaps. Our analysis finds that while banks hold large notional swap positions, the actual interest rate risk exposure from swaps is minimal for the average bank. The large notional amounts can be explained by banks acting as market makers for swaps and selling swaps as part of their loan business. To the extent that banks take on interest rate risk with swaps, they use them for hedging, but this hedging is economically small. Instead, banks primarily hedge interest rate risk through their deposit franchise, with swaps playing a limited role in mitigating overall bank interest rate exposure.

Our paper contributes to the literature on bank exposure to interest rate risk. Flannery (1981) finds that bank equity has a low sensitivity to interest rate shocks and frames this as a puzzle.[2] Begenau, Piazzesi and Schneider (2015) argue that bank balance sheets are heavily exposed to interest rates. Hoffmann et al. (2019) analyze the distribution of interest rate risk across European banks. Drechsler, Savov and Schnabl (2021) show that banks hedge their holdings of long-term fixed-rate assets with the deposit franchise, thereby explaining the low sensitivity of bank equity to interest rate shocks. Drechsler, Savov and Schnabl (2017) find that hedging with deposits leads to higher spreads and lower deposit growth when interest rates increase, giving rise to the deposits channel of monetary policy. Purnanandam (2007) shows that banks using interest rate derivatives respond less to changes in monetary policy than banks without interest derivatives. Our paper complements this literature by showing that banks use swaps for hedging on the margin, but swaps alone cannot explain the lower overall interest rate sensitivity of banks.

The results also connect to the literature on the economic role and magnitude of swaps in the banking sector.[3] Gorton and Rosen (1995) propose a methodology to infer swap positions from bank balance sheets. Begenau, Piazzesi and Schneider (2015) build on this methodol-

[2] Flannery (1983) confirms the result with a larger sample. English et al. (2002) finds mixed results for exposure to level and slope interest rate shocks in a sample of 10 countries. Flannery and James (1984) and English, Van den Heuvel and Zakrajšek (2018) examine the cross-section of banks' stock price exposures. Drechsler, Savov and Schnabl (2021) show that banks' stock price exposures to interest rate risk is similar to the stock price exposures of non-financial firms.

[3] Our focus is on hedging by banks. There is also a large literature on hedging that focuses on firms and analyzes how firms can increase value by hedging, that is, by reducing the volatility of cash flows or profitability: reducing the likelihood of costly episodes of financial distress (Smith and Stulz (1985), Stulz (1996)); minimizing expected taxes, either directly, because the tax function is convex, or indirectly by increasing debt capacity, which, in turn, provides valuable tax shields (Smith and Stulz (1985), Stulz (1996), Leland (1998), Graham and Rogers (2002)); mitigating underinvestment, risk-shifting, and other agency problems (Campbell and Kracaw (1990), Stulz (1990), Bessembinder (1991)); avoiding the need for costly external financing of future investments (Froot, Scharfstein and Stein (1993)); and reducing the volatility of executive compensation (Stulz (1984), DeMarzo and Duffie (1995)).

ogy using newly available market value data to infer time-varying swap positions. Hirtle (1997) argues that notional amounts of interest rate derivatives marginally increase the interest rate sensitivities of bank stocks. Brewer, Minton and Moser (2000) show that banks using interest rate derivatives experience greater loan growth. Stulz (2004) analyzes the costs and benefits of derivatives such as interest rate swaps. Baker et al. (2021) study how swaps are used to transfer interest rate risk across industry sectors. Our paper is unique in the existing literature in studying this subject using regulatory data on individual swap positions throughout the U.S. banking system.

Our study also contributes to the growing literature on the 2023 U.S. banking crisis. Metrick (2024) provides a succinct overview of the crisis. Jiang et al. (2023) argue that rising interest rates lowered bank asset values by $2.2 trillion, rendering many U.S. banks insolvent. Flannery and Sorescu (2023) also estimate large losses, leading many banks to fall below regulatory capital levels if losses are fully accounted for. Drechsler et al. (2023) argue that banks hedge assets with their deposit franchise but can suffer runs if deposits are uninsured. Greenwald, Schulhofer-Wohl and Younger (2023) argue that higher interest rates caused a decline in deposit franchise values due to convexity, thereby leading to financial fragility. Haddad, Hartman-Glaser and Muir (2023) find deposit relationships are sticky but can lead to fragility during a crisis. Hanson et al. (2024) document the rise of uninsured deposits and examine the role of liquidity regulation. Most closely related to our paper, Granja et al. (2024) use call report data to argue that banks did not hedge their assets but instead reclassified securities to held-to-maturity portfolios to avoid accounting losses. We complement this work using regulatory swap data to evaluate the importance of interest rate swaps for hedging bank assets.[4]

[4]There is also a growing literature exploring the run dynamics during the crisis. Caglio, Dlugosz and Rezende (2023) document a flight to safety by depositors to large banks in 2023. Benmelech, Yang and Zator (2023) find that banks with low branch density suffered larger deposit outflows and stock price declines in 2023. Koont, Santos and Zingales (2023) show that digital banks are more exposed to the banking crisis. Cookson et al. (2023) argue that social media postings were a catalyst for bank runs.

II. Measuring Interest Rate Risk from Swaps

In this section, we discuss the measurement of interest rate risk for banks, which results from their exposure to interest rate derivatives, assets, and liabilities. Our primary focus is on interest rate risk stemming from interest rate swaps. To begin, we provide an overview of interest rate swaps and explain how they generate interest rate risk exposure. Subsequently, we describe how we measure a bank's interest rate risk using CFTC data on interest rate swaps. Finally, we describe our methodology for measuring the interest rate risk associated with a bank's assets and liabilities.

A. Primer on Interest Rate Swaps

The most prevalent form of swaps is a fixed-for-floating swap, in which one party agrees to receive a fixed rate and to pay a floating rate on some notional amount for a fixed term, while the other party agrees to pay that fixed rate and to receive that floating rate on the same notional amount for the same term.[5]

To illustrate with a simple example, suppose that Bank A and Bank B enter into an agreement in which Bank A will receive annual interest payments from Bank B at a rate of 2% per year for 10 years on a notional amount of $100 million and, in exchange, Bank A will pay Bank B quarterly interest payments on future realizations of 3-month London Inter-Bank Offered Rate (LIBOR) for 10 years on the same $100 million.[6] In other words, Bank A and Bank B agree to exchange interest payments such that Bank A receives payments based on a fixed rate and makes payments based on a floating rate, while Bank B receives payments based on a floating rate and makes payments based on a fixed rate.

The fixed rate of 2% on the swap in the example is called the swap rate and is determined

[5]For a textbook description of interest rate swaps and their risks, see Tuckman and Serrat (2022), chapters 2 and 13.

[6]The floating-rate index of swaps has transitioned away from LIBOR to SOFR (Secured Overnight Financing Rate). However, since the sample period of this paper overlaps mostly with the LIBOR regime, the text describes swaps in terms of LIBOR. Swaps based on SOFR are identical to swaps based on LIBOR except for the difference in the floating interest rate.

by market conditions at the time of the trade. Specifically, the swap rate is set such that the two counterparties are willing to enter into the swap without either paying the other an upfront amount, or, equivalently, such that the value of the swap at initiation is zero. The $100 million is called a notional amount rather than a principal amount or face amount because it is used only to calculate contractual interest rate payments. The notional amount is not paid or received by either counterparty through the swap.

While the value of a swap is zero at initiation, its value changes over time as interest rate change. In the example, suppose that just after the initiation of the swap the market 10-year swap rate suddenly declined from 2% to 1%. From the perspective of Bank A, the value of the swap– commonly referred to as its "net present value" or NPV– would then increase from $0 to about $9.5 million: it locked in receiving 2% over 10 years in a market in which the fair rate is now only 1%. The increase in the NPV represents the discounted value of the expected above-market interest rate payments received over the lifetime of the swap. By the same logic, the NPV of the swap to Bank B is approximately negative $9.5 million. If, on the other hand, the market 10-year market swap rate suddenly rose from 2% to 3%, then the NPV of the swap would be about negative $8.5 million to Bank A and positive $8.5 million to Bank B. [7]

It is helpful to think of receiving fixed in a fixed-for-floating swap as a levered purchase of a default-free bond financed by short-term borrowing. In the context of the example, Bank A pays nothing at the initiation of the swap; receives 2% on $100 million over 10 years; and pays the floating interest rate on the same amount over the same time period. These cash flows are the same as those from purchasing a 10-year bond financed fully by short-term borrowing over time at prevailing short-term rates. Hence, the fixed receiver in a fixed-for-floating swap (Bank A in the example) may be said to be "long" the swap, just as the purchaser of a bond is long the bond, while the fixed payer (Bank B in the example) may be

[7]The positive NPV of one counterparty to a swap is usually protected from a default of the other counterparty by collateral or margin posted by that counterparty.

said to be “short” the swap, just as a short seller of a bond is short the bond.[8]

With this background, the discussion can turn to metrics of “exposure” for swaps. For a single swap, notional amount is used to compute the amount of interest exchanged, but is a very coarse measure of interest rate risk: the NPV of a 1-year fixed-for-floating swap with a notional amount of $100 million is much less exposed to interest rate risk than a 30-year fixed-for-floating swap with the same $100 million notional amount.

For a portfolio of swaps, “long notional amount” is defined as the sum of the notional amounts of all individual swaps that increase in value when rates fall; “short notional amount” is defined as the sum of the notional amounts of all individual swaps that decrease in value when rates fall; and “notional amount” is defined as the sum of long and short notional amounts. Long and short notional amounts suffer as measures of interest rate risk and counterparty risk along the same lines as does the notional amount of an individual swap. Total notional amount is an even worse metric as it adds long and short exposures, while the risks of the long and short sides typically offset each other. Net notional amount, defined as the difference between the long and short notional amounts, corrects this problem, and is a metric that is comparable to the notional amount of an individual swap.

Another common metric of exposure for swaps is the market value of an individual or of a portfolio of swaps, which is defined as the sum of the NPVs of the individual swaps in that portfolio. Market value is not a measure of the interest rate risk of a swap, as it simply reflects the change in NPV from the initiation of the swap to the present. Put another way, the interest rate risk of a swap can be high even if its market value of zero. For this reason, we do not consider the market value as informative about a swap’s interest rate risk.[9]

Our preferred measure of the interest rate risk of a swap or of a portfolio of swaps is DV01,

[8]While this terminology is convenient here, note that practitioners almost always speak in terms of "receiving fixed" and "paying fixed" rather than ”long" and ”short," respectively. Note too that, historically, the convention was actually the reverse of that suggested in the text, namely, to refer to receiving fixed as "short" and paying fixed as ”long," as in Gorton and Rosen (1995).

[9]Market value is also not a good measure of the counterparty risk of a swap. First, market value adds NPVs across counterparties, that is, across claims that do not offset in the event of a default. Second, market value does not incorporate posted collateral, which protects NPV in the event of a counterparty default.

which is defined as the change in the NPV of the swap or portfolio of swaps in response to a one-basis-point decline in interest rates. DV01 is the most commonly used metric of interest rate risk for trading and internal risk management across the financial industry, by banks along with other financial institutions, and for swaps along with bonds and structured products. In the example above, the value of the swap changed by $9.5 million when interest rates declined by 1%, or 100 basis points. Hence, the DV01 in the example above is $95,000, i.e., the value of the swap to Bank A increased by $95,000 for a one-basis-point decline in interest rates. Similarly, the value of the swap to Bank B declined by $95,000.

Our discussion so far focused on fixed-for-floating swaps, which is the most prevalent form of an interest rate swap, but there are other forms of swaps, most notably overnight index swaps (OIS), swaptions, forward rate agreements (FRA), and caps and floors. OIS are similar to interest rate swaps, but fixed-rate payments are exchanged for floating payments that are based on compounded interest of an overnight rate, like the federal funds rate, rather than on a term rate, like LIBOR. FRAs require a single payment that depends on the difference between a fixed rate and a short-term rate, which means that they are effectively single-period IRS for forward settlement. Caps, floors, and swaptions are various forms of options on rates or IRS.

According to data from the Commodity Futures Trading Commission, the proportions (as measured by risk outstanding) of interest rate swaps are: fixed-for floating swaps, 87%; OIS, 6%; swaptions, 5%; FRAs, 2%; and caps or floors, less than 1%. There are also interest rate derivatives that are not swaps, most notably futures contracts on short-term rates and on longer-term bonds. However, the outstanding quantity of interest rate risk in swaps is between 6 and 9 times as large as that of other contracts.[10]

[10] See Baker et al. (2021) and Baker, Haynes and Tuckman (2019).

B. Measuring interest rate risk of interest rate swaps

We obtain data on swap contracts from the Commodity Futures Trading Commission (CFTC). Historically, the CFTC regulated futures markets, but the Dodd-Frank Act expanded its mandate to include "swap" markets, which refers very broadly to over-the-counter derivatives markets.[11] In accordance with this expanded mandate, the CFTC subsequently promulgated various regulations including the requirement that "U.S.-reporting entities" report swap trades and open positions to swap data repositories (SDRs), which, in turn, make these data available to the CFTC. "U.S.-reporting entities" include U.S. entities, U.S. subsidiaries of foreign entities, and swap dealers registered with the CFTC, who from all other perspectives are foreign entities. Not surprisingly, U.S. commercial banks, the focus of this study, generally qualify as U.S.-reporting entities and their swap trades are included in our data.

Swap positions are concentrated in large banks. Our analysis therefore focuses on the 250 largest U.S. commercial banks, by assets, as reported by the Federal Reserve Board as of June 2018.[12] The assets of these top 250 banks range from about $3 billion to over $2 trillion. We obtain CFTC data on the swap positions of these banks from the third quarter of 2017 through the fourth quarter of 2019. We drop banks that are subsidiaries of other banks in the list along with those that were acquired over the sample period. This leaves a sample of 218 banks that we use throughout the paper.

CFTC data include the contractual features of every swap position at each bank in the sample. From these data, we compute long notional amount, short notional amount, and net notional amount for each bank. The DV01 of each swap is also available from the CFTC, calculated by the CFTC's Office of the Chief Economist as part of its ongoing public re-

[11]The Dodd-Frank Act actually divides over-the-counter derivatives into "swaps" and "security-based swaps." "Swaps" are derivatives on general market variables and indexes, like interest rate swaps, and are regulated by the CFTC, while "security-based swaps" are derivatives on particular entities, like credit default swaps on individual corporations or total return swaps on individual stocks, and are regulated by the Securities and Exchange Commission.

[12]https://www.federalreserve.gov/releases/lbr/20180630/default.htm

porting of Entity-Netted Notionals (ENNs), a risk-adjusted measure of the size of various derivatives markets. ENNs, and therefore these DV01s, are computed quarterly as of a date in the middle of the last month of each quarter so as to avoid any quarter-end effects that might temporarily distort notional amounts outstanding. The methodology used by the CFTC to compute DV01s follows standard industry conventions and takes as input industry-generated curves of fixed-for-floating swap rates across tenors.[13]

We note that the direct measurement of DV01 represents a significant improvement over alternative measures, as interest rate risk exposure is difficult to measure from publicly available data. Gorton and Rosen (1995) propose a methodology using a combination of notional amounts, reported swap market values, and assumptions about the evolution of swap positions over time. Granja et al. (2024) suggest using the total notional value of pay floating swaps not held for trading from call reports to proxy for the value of hedged assets. They also collect additional data from regulatory filings for a subset of banks. Begenau, Piazzesi and Schneider (2015) estimate the interest rate exposure of bank swap positions from changes in the market values of swap positions over time. The first two papers argue that there is limited interest rate risk from swaps, while the last paper finds significant risk-taking using both swaps held for trading and swaps not held for trading. All papers note that measurement relies on assumptions that cannot be tested with publicly available data.

III. The Rise of Interest Rate Swaps

Interest rate swaps in the U.S. banking sector have grown enormously since the birth of the interest rate swap market in the 1980s. We collect historical data on bank-level exposure to interest rate swaps from U.S. call reports. Banks report the total notional amount of a bank's interest rate swap positions and interest rate derivative positions each quarter.

[13]When computing the DV01 of a swap, it is most common to start with a term structure of fixed-for-floating swap rates, value the swap, reduce the term structure of rates across all terms by one basis point, recompute the value of the swap, and take the change in the value of the swap as its DV01.

Panel A of Table 1 gives summary statistics computed from publicly available call reports on banks' usage of interest rate derivatives in five-year intervals from 1985 to 2020 and for the year 2022. While 1995 and later data include interest rate derivatives other than swaps, the vast majority of derivative interest rate risk is from swaps. We find that the notional amount of interest rate derivatives in 1985 was $186 billion, which was about 10% of bank assets at the time. By 2010, notional value had increased more than 1,000-fold to $193.4 trillion, which was 16.3 times bank assets. Notional amounts declined after 2010 because the regulatory mandate to clear swaps facilitated "compression," that is, the reduction of notional amounts without altering risk profiles. In 2022, the total notional amount was $139.6 trillion, which was still large at 6.4 times bank assets.[14]

Interest rate derivative are highly concentrated in large banks. Panel A of Table 1 shows that the percentage of all commercial banks with interest rate derivative positions increased from 2% to 23% from 1985 to 2022. Hence, while the percentage of banks having exposure to these derivatives gradually increased, most banks still have no exposure to interest rate derivatives. Panel B shows that the participation of the largest 250 banks, by asset size, is more significant, growing from 53% to 90%, and that their notional amounts dominate the market. Although the largest 250 banks represented less than 5% of the total 4,060 banks operating in 2022, they accounted for over 99.9% of all notional amounts outstanding. Not surprisingly then, notional amount relative to assets (or to equity) is greater for largest 250 banks than for banking sector as a whole, peaking at 18.7 times assets in 2010 and remaining at a relatively high multiple of 7.1 times assets in 2022.

Panel C of Table 1 focuses on banks registered with the CFTC as swap dealers, a designation created by the Dodd-Frank Act that identifies market makers. There were 12 registered swap dealers from 2010 to 2018, and 11 after 2018. The data show that these relatively few

[14]Before the clearing mandate, swap contracts were bilateral, that is, between pairs of individual market participants. Since the mandate, the vast majority of swap notional amount is between individual market participants and a clearinghouse or central counterparty (CCP). This change in market structure enabled compression cycles in which the risks of all swaps between each market participant and a CCP are aggregated, netted, and then replaced by a smaller number of swaps that preserve each of these aggregated and netted risks.

dealers account for about 99% of interest rate derivative notional amounts, $191 trillion of the total $193 trillion in 2010 and $136 trillion of the total $139 trillion in 2022. Notional amount relative to assets for this group is larger than for the largest 250 banks at 28.9 times assets in 2010 and 11.9 times assets in 2022. This is not surprising since dealers engage in the sale and purchase of interest rate derivatives when acting as market markers.

Table 2 exmaines the concentration of notional amounts across banks by analyzing the largest 20 banks by assets as of December 2022.[15] The eight largest banks include seven swap dealers. These seven swap dealers stand out with large notional amounts ranging from $45.9 trillion to $537 billion. These notional amounts are also large multiples of assets, ranging from nearly 94.2 to 1.0. The remaining 12 banks on this top-20 list have significantly lower notional amounts. Four of them are swap dealers, but collectively they are smaller banks by assets and notional amounts. Their total notional amount ranges from $359 billion to $0 billion, or, as multiples of assets, from 1.0 to zero.

All in all, Tables 1 and 2 show that the notional amount of interest rate derivatives is highly concentrated in a small number of banks. Not only is almost all of the outstanding notional amount accounted for by the largest 250 banks, but notional amount is also concentrated in the very largest of these banks, particularly in swap dealers. Motivated by these findings, our empirical work focuses on the largest 250 banks and we pay special attention to swap dealers.

IV. How exposed are banks to interest rate swaps?

A. Interest rate swap positions

Table 3 presents summary statistics on swap positions at the bank level and in aggregate for the banking sector. As discussed earlier, our data is quarterly from the third quarter of 2017 to the fourth quarter of 2019 and includes 218 of the largest U.S. banks. The total

[15] This table is based on publicly available call reports. It does not contain confidential CFTC data.

value of bank assets in our sample is $13.5 trillion (Column 1), which constitutes around 93% of total bank assets during the analysis period. The mean bank size is $62 billion and the median is $9 billion (Columns 2 and 4). Banks are primarily funded with core deposits, which constitute 66.1% of overall bank liabilities and around 74.9% for the average bank. On the asset side, loans account for 54.8% of aggregate assets and 69.3% for the average bank; securities account for 19.7% in aggregate and 17.7% for the average bank; and cash accounts for 9.7% in aggregate and 4.5% for the average bank.

The notional amount of swaps in the U.S. banking system is $94.7 trillion. Notional value is about seven times as large as total assets in the U.S. banking system. Most of the notional value is concentrated in the largest banks, as can be seen from the distribution of notional value across banks. As shown in Column 2 to 4, the mean notional value per bank is $434 billion, or 10.8% of bank asset value, which is significantly larger than the median notional value of $0.4 billion, or 3.91% of bank asset value. There is also large dispersion in terms of notional value relative to bank assets ranging from 0% at the 5^{th} percentile of the distribution to 60% at the 95^{th} percentile. We find that 74% of banks hold some swap positions, meaning that even among the top 250 banks, 26% do not use any swaps. Note that this is consistent with our finding in Section III that the vast majority of small banks, which are not included in our sample, have no position in swaps.

Table 3 also presents data indicating that banks use swaps to facilitate their business of making loans to customers. On average across banks, 80.4% of the swap notional amount in which banks receive fixed is with customers rather than other dealers. These swaps likely facilitate customers' transforming the floating-rate loans they take from banks into fixed-rate obligations: a customer paying a floating-rate on a bank loan combined with a swap with the bank in which the customer receives a floating rate and pays a fixed rate nets to a fixed-rate obligation. The significance of these swaps is similar in risk terms, as 82.1% of the DV01 of swaps in which banks receive fixed is with customers. The corresponding percentages for the banking system as a whole are much lower, at about 47% each, because the largest banks are swap dealers for whom the lending business is much smaller relative to the market making business.[16]

Our data also include the fair market value of swaps. As discussed earlier, the market value of an interest rate swap is zero at initiation and changes as interest rates change. As shown in Column 1 of Table 3, the total market value of bank derivatives is $50 billion, or about 0.4% of bank asset values. Similar to notional value, the market value is concentrated among large banks. The mean market value is $232 million, which is a small fraction of bank asset value, and the median market value is close to zero. There is significant dispersion across banks with market value relative to bank asset value ranging from -0.122% at the 5^{th} percentile to 0.312% at the 95^{th} percentile. As discussed above, even though market value is commonly reported, it does not provide any information on a bank's exposure to interest rate risk.

B. Interest rate risk of swap positions

Table 3 shows that the $94.7 trillion aggregate notional amount falls by a factor of 100 to $784 billion after netting. This illustrates, as discussed earlier, that notional amount without netting is effectively meaningless in terms of measuring interest rate risk. Netting long and short positions further reveals that most smaller banks have little net interest rate exposure. Across all banks, the mean net notional is $3.6 billion, while the median is nearly zero. Also, net notional is concentrated in the largest banks.[17]

We now turn to our preferred measure of interest rate exposure, DV01, described earlier. Swap DV01 for the aggregate banking system is $585 million and, like notional and net notional amounts, is concentrated among large banks. The mean and median swap DV01 are

[16] All of these percentages are computed using the positions of banks with strictly positive notional amounts.

[17] Net notional actually exaggerates the reduction of exposure, because, in the presence of counterparty risk, longs with one counterparty do not fully offset the risk of shorts with another counterparty. Baker et al. (2021) show, however, that exposure is dramatically reduced even when netting longs and shorts only within counterparty relationships. In their sample, $231 trillion of notional exposure reduces to $13.9 trillion in 5-year risk equivalents.

\$3 million and \$10,000, respectively. And there is considerable dispersion across banks: the swap DV01 is \$3 million at the 95^{th} percentile and $-\$1$ million at the 5^{th} percentile. Furthermore, as discussed earlier, swap DV01, which measures risk, can be compared with bank equity, which measures capacity to absorb risk. Swap DV01 relative to equity is 0.038% for the aggregate banking system, and the mean and median values of this ratio are both less than 0.001% in magnitude.

We find that the interest rate risk of swaps varies across banks. Figure 1 shows the distribution of interest rate risk in terms of the ratio of net notional to asset (Panel A) and the ratio of DV01 to equity (Panel B). The large mass at zero in both panels reflects absence of any swap position in about one quarter of banks. The ratio DV01 to equity varies from -0.031% at the 5^{th} percentile to 0.025% at the 95^{th} percentile. That this distribution is close to symmetric indicates that losses from interest rate changes at one bank are offset by gains at another bank.

Another way to understand the magnitude of swap DV01 is in terms of balance sheet volatility, i.e., in terms of swap gains or losses, quantified using historical rate volatility, relative to bank assets. Along these lines, we assume a daily standard deviation of interest rates of 5 basis points, which is in line with historical data for intermediate-term rates. In that case, a one-standard deviation change in rates over a 63-trading day quarter is about $5 \times \sqrt{63}$, or 40 basis points. Combining this standard deviation with DV01 statistics gives balance sheet volatilities. More specifically, with a mean bank DV01 of \$3 million, the quarterly standard deviation of changes to the value of swap positions due to changes in rates is 40 times \$3 million, or \$120 million. For the median bank, with a DV01 of \$10,000, the quarterly standard deviation is only \$400,000. These standard deviations of \$120 million and \$400,000 are economically small compared with mean and median bank assets of \$62 billion and \$9 billion, respectively.

C. Swap dealers vs. non-swap dealers

Table 4 provides a breakdown of the summary statistics for swap dealers relative to non-swap dealers. Total bank assets of swap dealers are much larger than for non-swap dealers. Swap dealers account for \$8.8 trillion in bank assets with an average of \$798 billion per bank. Non-swap-dealers account for \$4.7 trillion in banks assets and an average of \$22 billion.

Swap dealers and non-swap dealers are comparable in terms of their funding mix and their asset holdings. They both primarily use core deposits, 70.9% for dealers versus 75.1% for non-dealers; non-core liabilities, 19.9% versus 14.4%; and equity, 11.4% versus 12.1%. Both dealers and non- dealers primarily hold loans, 53.1% versus 70.2%, but dealers hold fewer than non-dealers. Finally, dealers hold more securities than non-dealers, 21.9% versus 17.5%, and also hold more cash, 8.8% versus 4.3%.

The empirical evidence is consistent with a large portion of swap positions being generated by market-making businesses, which are characterized by large notional amounts and offsetting long and short positions. First, swap dealers account for the vast majority of swap notional amount, with \$93.7 trillion versus \$0.94 trillion for non-swap-dealers. Second, the vast majority of netting happens at the swap dealers: their notional amount of \$93.7 trillion falls by a factor of more than 100 to a net notional of \$628 billion. While netting reduces non-swap-dealer notional amount as well, the reduction is not nearly as large, falling from \$937 billion to \$155 billion.

Turning to our preferred measure of interest rate risk, DV01, we find that the aggregate DV01 of swap dealers is almost the same as that of the entire banking system at \$568 million. Conversely, the DV01 of non-swap-dealers is close to zero at \$17 million. Aggregate DV01 to equity is limited for both groups, however, at 0.06% for swap dealers and less than 0.003% for non-swap-dealers. In contrast, the interest rate risk of bank assets relative to equity is much larger.

Taken together, the summary statistics reveal a striking finding. Notional amounts– the most commonly-cited measure of banks' exposure to swaps– suggest that large banks are significantly exposed to swaps. Our results show, however, that the swap positions of most large banks have close to zero interest rate risk. Aggregate interest rate risk from swaps is quantitatively small and concentrated among a small number of swap dealers.

V. Do banks use swaps for hedging?

A. Hedging bank assets

In this section we analyze the impact of interest rate swap exposure on bank returns. If banks use interest rate swaps for hedging, we expect that the change in the market value of the swap portfolio is offset by a corresponding change in the market value of the asset or liability that the derivative is hedging.

For example, if a bank uses interest rate swaps to hedge the interest rate exposure of their long-term asset holdings, we expect that the bank return is unchanged if interest rates increase. In contrast, if banks use interest rate swaps for speculation, we expect to find that a change in the market value of a bank's swap portfolio has a significant effect on the bank's return. For example, if a bank is speculating on a decline in interest rates, then the bank should realize a positive return when interest rates decrease and a negative return if interest rate increase.

We empirically test whether banks use interest rate swaps for speculation or hedging using data on DV01s and bank stock returns. We measure the change in value of a bank i's swap portfolio, $SwapReturn_{i,t}$, from $t-1$ to t as follows:

$$SwapReturn_{it} = -\frac{SwapDV01_{it-1} \times \Delta y_t \times 10{,}000}{Equity_{it-1}}, \tag{1}$$

where $SwapDV01_{i,t-1}$ is the Swap DV01 at $t-1$, Δy_t is the change in the five-year swap rate from $t-1$ to t, and $Equity_{it-1}$ is the market equity of bank i at $t-1$.

The variable $SwapReturn_{i,t}$ captures the return on bank equity over a quarter coming *solely* from changes in the value of the bank's swap portfolio because of interest rate changes. By convention, $SwapDV01_{it}$ is defined as the change in the value of the swap portfolio for a one-basis-point decline in interest rates. Furthermore, Δy_t is the change in the interest rate over the analysis period, measured by the change in the five-year swap rate, so that $-10,000 \times \Delta y_t$ is that change in basis points. Hence, the right-hand side of the equation is the change in value of the bank's swap portfolio as a fraction of its equity.

For example, consider a bank with a swap DV01 of $1 million and a market equity of $1 billion at the start of the quarter. Suppose the five-swap swap rate increases by 20 basis points over the quarter. Hence, $SwapReturn_{it} = -\frac{\$1 \times 0.2\% \times 10{,}000}{\$1{,}000} = -0.02$, i.e. the bank equity value would drop by 2% because of its swap exposure to the interest rate increase.

Panel A of Table 5 reports average $SwapReturn_{it}$ from Q4 2017 to Q4 2019. We restrict our sample to publicly listed banks (145 banks) because we need the bank equity return for our empirical analysis. We find that the average quarterly swap return is economically small at −0.008% with a standard deviation of 0.985%. The 10^{th} and 90^{th} percentiles of the distribution are also economically small at −0.194% and 0.209%, respectively. For comparison, the average bank equity return is 0.508% and the standard deviation is 9.964%. This shows that the variation in swap return is small relative to the variation in bank equity returns.

We examine the relationship between the bank equity return and the return on the swap portfolio using the following OLS regression:

$$BankReturn_{it} = \alpha_t + \delta_i + \beta \times SwapReturn_{it} + \epsilon_{it} \tag{2}$$

where $BankReturn_{it}$ is bank i's equity return in quarter t, $SwapReturn_{it}$ is bank i's return on the swap portfolio in quarter t, and α_t and δ_i are quarter and bank fixed effects, respectively. Standard errors are double-clustered at the bank time level.

The coefficient of interest is β, which captures whether the return on the swap portfolio covaries with the bank's equity return. As a benchmark, we expect a coefficient of 0 if the bank uses interest rate swaps for hedging because swaps would hedge offsetting asset holdings, thereby leaving overall bank returns unaffected. In contrast, if banks use interest rate swaps for speculating on a decrease in interest rates we would expect a coefficient of 1 because the negative swap return would lower the bank equity return.[18]

Panel B of Table 5 presents the results. Column (1) reports the specification without bank and time fixed effects. We find a statistically insignificant coefficient of 0.059. We cannot reject the hypothesis that the coefficient is equal to 0 but we reject the hypothesis that it is equal to 1 at the 1% level. Columns (2) and (3) report the specifications that include time fixed effects and time and bank fixed effects, respectively. The coefficients are statistically insignificant at −0.009 and −0.077, respectively. In both specifications, we again cannot reject a coefficient of 0 but reject a coefficient of 1 at the 1%-level. These results suggest that banks use swaps for hedging purposes.

Moreover, we find that the explanatory power of Swap DV01 for bank equity returns is low. Across the two specifications, the marginal R2 of including Swap DV01 is 0.001% or less. This indicates that swap returns have no statistical power in explaining variation in bank stock returns, which is inconsistent with banks using swap for speculation. Instead, it suggests that bank use swaps to hedge the interest rate exposure of interest-rate sensitive assets or liabilities, thereby reducing the explanatory power of changes in the swap value.

Figure 2 shows a graphical representation of this result for each quarter during our analysis period. The figure provides binscatter plots of the bank equity return (y-axis) and $SwapReturn_{i,t}$ (x-axis) from 2017Q3 to 2019Q4. We winsorize both variables at the 5%-level to minimize the impact of outliers. The figures show that there is no consistent relationship between bank equity return and swap return. The coefficient of regressing the equity return on $SwapReturn_{i,t}$ varies across quarters but this relationship is driven by a handful of outliers each quarter. The $R2$s across quarters are low varying between 0.1%

[18] We assume that banks speculate by buying interest rate swaps to generate interest rate exposure equivalent to investing in long-term, fixed-rate assets. If instead banks use interest rate swaps for speculating on increasing interest rates, i.e., effectively shorting long-term, fixed-rate assets, the coefficient would be −1. Either way, a bank speculating on interest rates does not use swaps to hedge offsetting asset holdings.

and 3.7%. This indicates that bank use swaps for hedging rather than speculation.

B. Alternative usage of interest rate swaps

In this section, we examine alternative motivations to hold swap positions beyond hedging purposes. The first motivation is to serve as a dealer for interest rate swaps, i.e., engaging in the active trading of swaps to capitalize on bid-ask spreads. This involves earning profits from facilitating trades in swaps across a large number of counterparties and entails taking on both long and short positions without holding any significant exposure to interest rates. The second motivation revolves around meeting corporate demand for fixed-rate loans. Banks achieve this by combining floating-rate loans with interest rate swaps, effectively transforming customer borrowing into fixed-rate loans. This approach enables banks to cater to the preferences of borrowers seeking stable interest rate payments, while issuing floating-rate loans that can be securitized more easily.

B.1. Swap-dealing business

Swap dealers are authorized by the Commodity Futures Trading Commission to operate as market makers. Swap dealing activities are highly concentrated in the banking sector, with only 12 U.S. banks registered as swap dealers during our sample period.[19] As a consequence, we expect that swap dealers would generally exhibit larger notional amounts compared with non-swap dealers, even when adjusting for other bank characteristics. Nevertheless, we expect swap dealers to hedge their swap positions as part of their risk management strategy. This implies that the presence of swap positions should not create interest rate risk exposure for swap dealers relative to non-swap dealers.

We analyze the impact of being a swap dealer using the following OLS regression:

$$Notional_{it} = \alpha_t + \beta \times Dealer_i + \gamma \times X_{it} + \epsilon_{it} \tag{3}$$

[19]There were 12 registered swap dealers from 2010 to 2018, and 11 after 2018.

where $Notional_{it}$ is the total notional of swaps of bank i at time t, $Dealer_i$ is an indicator variable equal to 1 if bank i is a swap dealer and zero otherwise, X_{it} are bank characteristics, and α_t are time fixed effects. We do not include bank fixed effects since they would be collinear with the indicator variable of being a swap dealer. We double cluster the standard errors at the bank level and quarter level.

Panel A of Table 6 presents the results. Column 1 finds that being a swap dealer leads to a substantial increase in the notional amount relative to assets, with a coefficient of 43. This indicates a significantly higher notional amount for swap dealers compared to non-swap dealers. Column 2 shows that, after controlling for asset size, the coefficient decreases to 23.2, remaining economically sizable and statistically significant. For comparison, the coefficient for bank size stands at 5.3, suggesting that being a swap dealer is equivalent to a fourfold increase in bank size. Columns 3, 4, and 5 incorporate additional controls for various bank characteristics, such as the core deposit ratio, loan ratio, and securities for sale ratio. The coefficients on these variables are not statistically significant, while the impact of being a swap dealer on the notional amount remains consistent and unchanged. These results suggest that a considerable proportion of the notional amount is attributed to banks' swap-dealing business.

Panel B of Table 6 examines interest rate risk. We estimate equation (3) after replacing notional value with swap DV01 relative to bank equity. Column 1 finds that being a swap dealer leads to a slight increase in swap DV01 to equity, with a coefficient of 1.1%. However, in Column 2, after accounting for asset size, the coefficient drops to 0.4% and loses its statistical significance. Furthermore, in Columns 3, 4, and 5, we incorporate additional controls for the core deposit ratio, the loan ratio, and the securities for sale ratio. These controls have minimal impact on the results, and the coefficient associated with being a swap dealer remains largely unchanged. These results show that being a swap dealer does not have an economically significant effect on swap DV01 to equity.

Overall, our findings indicate that swap dealers maintain notably larger swap positions compared to non-swap dealers, all while effectively managing interest rate risk. These results imply that swap dealer's substantial notional exposures are largely attributed to their swap-dealing activities.

B.2. Hedging floating-rate loans

Banks extend loans to firms and other borrowers, and these loans often take the form of floating-rate loans. The bank's preference for floating-rate loans is driven, at least in part, by their ease of securitization when compared to fixed-rate loans. However, many borrowers have a preference for fixed-rate loans, prompting banks make a floating-rate loan to and receive fixed in swap from the borrower. In this way, the borrower's floating rate loan has been synthetically transformed into a fixed-rate loan: it makes fixed payments on the swap while its floating rate payments on the loan are returned from receiving floating on the swap. Furthermore, the bank's long swap position accomplishes this transformation while accommodating the bank's preference for offering floating-rate loans. This raises the question whether banks use swaps to hedge the interest rate risk of this long swap position.

To answer this question, we analyze the proportion of swap transactions conducted with customers, where customers are defined as all swap counterparties other than swap dealers and clearinghouses. We start by analyzing the impact of bank characteristics using the following OLS regression:

$$CustomerShare_{it} = \alpha_t + \beta \times Dealer_i + \gamma \times X_{it} + \epsilon_i \quad (4)$$

where $CustomerShare_{it}$ is the share of bank i's long (i.e., receiving fixed) swaps with customers at time t. The other variables are the same as in (3). We compute the customer share based alternately on the national value and the DV01 of long swaps. We restrict the analysis to banks with a non-zero notional value for long swaps (143 banks).

Panel A of Table 7 provides the results. Column 1 finds that swap dealers have a lower share of notional with customers with a coefficient of −0.33. However, the relationship flips once we control for bank size and the coefficient becomes positive at 0.15. The effect of bank size is negative and statistically significant. A doubling of bank size leads to a decline in the share of the notional amount by customers by 14 percentage points. Columns 3, 4, and 5 show that these results are similar when adding the same controls as in Table 6. Panel B of Table 7 finds similar results when using the share of DV01 with customers as the outcome variable. These results show that long swap positions with customers are largely a function of bank size and that smaller banks do more of it.

Next, we analyze whether banks hedge the interest rate risk associated with long swap positions with customers. We can gauge whether banks effectively mitigate this exposure using our detailed data. Specifically, we identify instances where a bank hedges a long swap by simultaneously initiating a short swap position on the same day through an identical, offsetting contract with a dealer. This practice is particularly relevant for non-swap-dealer banks, whose smaller swap businesses make it practical to hedge swaps one at a time instead of hedging all swaps together as a large portfolio.

To conduct our hedging analysis, we focus on all non-swap dealer banks. Given the significance of bank size, as highlighted earlier, we first examine non-swap dealers with assets less than $100 billion (116 banks). Our findings, as illustrated in Panel A of Table 8, indicate that these banks hold long swaps with an aggregate notional value of $167 billion. Out of these, an aggregate notional value of $113 billion of long swaps are with customers and the remaining $53 billion are with dealers. This means that 68% of long swaps are with customers. Among long swaps with customers, we identify $79.7 billion worth of long swaps hedged through back-to-back short swaps executed with dealers. This indicates that banks hedge at least 71% of their long swaps with customers using identical offsetting short swaps. Importantly, this percentage is a lower bound for overall hedging activity, because swaps can be hedged on a portfolio basis instead of one at a time. The portfolio approach is often more efficient in terms of trading costs, but makes more sense for businesses with high volumes and requires more sophisticated technology and operations.

The outcomes for the average and median bank are similar, but with even more pronounced customer involvement and higher hedging rates. The average bank has a customer share of 86% and the median bank exclusively trades long swaps with customers, resulting in a customer share of 100%. Moreover, we are able to match 57% for the average bank and 73%, respectively, of the long swap positions to identical offsetting short swap positions executed on the same day with a dealer.[20]

These findings suggest that most banks primarily hold swap positions to provide services to their customers. Furthermore, many banks hedge interest rate risk by promptly offsetting the vast majority of their long swap exposure with back-to-back or perfectly offsetting short swaps. In other words, banks receive fixed in swaps as part of their lending business and hedge the resulting interest rate risk by paying fixed to dealers.

To provide a comparative analysis, we perform the same examination for non-swap dealers with assets exceeding $100 billion (11 banks). As shown in Panel B of Table 8, we find that these banks hold an aggregate notional value of $326 billion and about $87 billion are with customers. Notably, these banks have a large amount of long swaps with dealers, which can be attributed to their use of long swaps to hedge interest rate exposure for fixed-rate liabilities, particularly long-term fixed-rate debt. For long swaps with customers, we identify about $34 billion worth of back-to-back short swaps with dealers, serving as a hedge against long swaps sold to customers. This indicates that banks hedge out 39% of long swaps with identical short swaps. As before, it is essential to recognize that this value is a lower bound as banks have alternative hedging methods for these swaps. Anecdotally, the use of alternative methods is more prevalent among large banks.

Overall, our findings demonstrate that non-swap dealer banks actively hedge out a substantial portion of their interest rate exposure from long swaps with customers with perfectly offsetting short swaps with dealers. This aligns with non-swap dealer banks accommodating borrowers seeking to swap floating-rate loans into fixed-rate loans while simulta-

[20]We note that mean and median customer and hedging shares do not have to equal the appropriate ratios of the mean and median notional amounts.

neously mitigating the interest rate risk of those accommodations.

VI. How important are swaps for banks' overall exposure to interest rate risk?

In this section, we address the significance of swaps in banks' overall interest rate risk hedging. To accomplish this, we first assess banks' interest rate risk stemming from their assets and liabilities. We present our methodology for measuring this exposure and subsequently compare it to interest rate exposure from swaps. Furthermore, we explore how banks hedge their overall interest rate risk.

A. *Measuring interest rate of bank asset and liabilities*

We obtain data on bank assets and liabilities from U.S. Call Reports provided by Wharton Research Data Services. The data contain quarterly observations of the income statements and balance sheets of all U.S. commercial banks. The data also contain bank-level identifiers that we use to match the bank data to the CFTC data. We double-check the accuracy of the merge using information on bank names and location contained in both datasets. We construct bank asset, liability, and income variables following Drechsler, Savov and Schnabl (2021).

Call reports provide detailed information on loans, securities, deposits, and non-deposit liabilities. For securities, call reports provide maturity information on mortgage-backed securities (RMBS), other mortgage-backed securities (other MBS), and other non-MBS debt securities. For loans, call reports provide maturity information for residential mortgage loans and other loans and leases. Additionally, call reports specify information on total deposits by type (checking, savings, small and large time) and total non-deposit liabilities. For assets and liabilities other than deposits, call reports provide term buckets that specify the remaining maturity or the next repricing date. The level of detail for term buckets varies slightly across categories and is less comprehensive for the category of other MBS.

For deposits, call reports include maturity information for term deposits.

We estimate the interest rate risk for each asset and liability, measured as DV01 and duration, as follows:

1. Non-MBS debt securities are mostly non-amortizing, fixed-rate assets, in which most of the present value is paid at maturity, For these assets maturity is a good indicator of interest rate risk. Therefore, we compute the interest rate risk assuming that it is equivalent to that of a par bond of corresponding maturity. For easy reference, we refer below to this methodology as the "par correspondence."

   Call reports provide information on remaining maturity (or, in the case of floating-rate assets, the time until the next interest rate reset) for the following buckets: less than 3 months, 3 months to 12 months, 1-3 years, 3-5 years, 5-15 years, and greater than 15 years. For all but the last bucket, we assume that the maturity (or time to reset) is equal to the center of the relevant term bucket. For the bucket of 15 years or greater we assume a maturity of 22.5, which is halfway between 15 years and the typically longest maturity of 30 years. We further assume that the interest rate appropriate for discounting cash flows is equal to the swap rate of the matching maturity in that quarter.

   For example, say that, in a given quarter, when the 10-year swap rate was 2%, a bank had $100 million of non-MBS securities in the term bucket of 5 to 15 years. In this case, the paper assumes that the bank's DV01 or duration in that bucket is that of a 10-year par bond at a yield of 2%. This approximation for interest rate risk works well if non-MBS debt securities are mostly non-amortizing (which they are).[21]

   We note that our data include floating-rate instruments, in which periodic resets of interest rates to prevailing market rates cause these instruments to sell for nearly

[21] We also make the reasonable assumptions that instruments in a bucket do not sell lopsidedly at significant premiums or significant discounts and that instruments in a term bucket have maturities or times to next repricing symmetrically around the center of the bucket.

par on those reset dates, i.e., the time to the next repricing is the appropriate indicator of interest rate risk (e.g., floating-rate bond).[22] Given that securities are allocated to term buckets based on the reset dates for floating-rate instruments, our methodology ensures that loans with short-term resets have close to zero duration.

2. RMBS are amortizing, fixed-rate assets, in which much of the principal is paid before maturity and subject to the borrower's prepayment option. Both of these features shorten the effective duration of mortgage-backed securities, with the prepayment option doing so in a rate-contingent manner.

   Call reports provide the same term buckets as for non-MBS securities. We again assume that the term of assets is equal to the center of the distribution. For RMBS with a remaining maturity of less than 1 year, the prepayment risk is less relevant and we compute duration and DV01 the same as we do for non-MBS securities using par correspondence.

   To account for the prepayment option for RMBS with a remaining maturity of more than one year, we make use of industry risk models. We assign the duration corresponding to those of the nearest applicable indexes available on Bloomberg. For example, RMBS in the 5- to 15-year buckets are assigned a duration equal to that of U.S. MBS Fixed-Rate GNMA 15-year index in that quarter.

3. Other MBS are amortizing, fixed-rate assets, similar to RMBS. However, as mentioned above, we have less information on their term buckets because call reports only specify whether the expected average life is less or more than 3 years. We assume that the remaining maturity is either 1.5 years (half between 0 and 3) or 4.5 years (half between 0 and 5), respectively, and apply par correspondence using expected average life.

[22] For example, a 30-year floating-rate bond that resets its interest rate every three months has interest rate risk equivalent to that of a three-month fixed-rate asset.

4. Residential mortgage loans are generally amortizing, fixed-rate assets, like RMBS. Call reports provide the same information on term buckets as for RMBS. We follow the same methodology to compute interest rate risk.

5. Other loans and leases are mostly non-amortizing, fixed-rate assets, similar to non-MBS securities. Call reports provide the same information on term buckets as for non-MBS securities. We therefore apply the par correspondence developed for non-MBS securities to compute interest rate risk.

6. Non-deposit liabilities are usually fixed-rate borrowings with the principal being paid at maturity. Call reports provide information on term buckets that is similar to non-MBS securities. We therefore apply the par correspondence developed for non-MBS securities to compute interest rate risk.

7. We handle the duration of deposits separately, as discussed below.

We note that our methodology for estimating a bank's interest rate risk does not include assets and liabilities for which the call reports do not provide detailed maturity data. The main omitted categories are federal funds and repurchase agreements; trading assets and liabilities; direct holdings of real estate; investments in subsidiaries; intangibles; equity; and items classified as "other."

However, we believe that our estimation still provides a sensible representation of a bank's interest rate risk for the following reason. Federal funds and repurchase agreements do have interest rate sensitivity, but typically very little, as their terms are typically very short, with the majority overnight. Omitting trading assets and liabilities are potentially more of a concern, although it turns out that they comprise a very small fraction of assets and liabilities in the sample.[23] The remaining categories of assets and liabilities not included in

[23]Across the 250 banks as of June 2018, trading assets were, on average, about 0.4% of individual bank assets, with a standard deviation of less than 2%, and with just three banks having ratios of more than 10%. Trading liabilities are of even less importance, with an average ratio of trading to total liabilities of less than 0.2%, a standard deviation of about 0.6%, and with a maximum of just over 5%.

the estimation of interest rate sensitivity and not traditionally included in the analysis or hedging of interest rate risk.

To summarize, our methodology quantifies interest rate risk for a large fraction of bank balance sheets. On average, our analysis covers 86% of assets, with a standard deviation of 11%, and only 13 banks have ratios less than 70%. Coverage on the liability side is even greater, with an average of 96% of individual bank liabilities covered, a standard deviation of 6%, and only 6 banks have ratios less than 70%.

B. Overall interest rate risk

Panel A of Table 9 presents the results on aggregate interest rate risk for the main sample (218 banks) from 2017Q3 to 2019Q4. Banks primarily hold cash, loans, and securities. Total cash holdings are $1.3 trillion with zero duration. Total loans are $7.4 trillion, with $1.46 trillion being residential mortgage loans and $5.99 trillion being other loans. The average loan duration is 2.21 years, with residential loans having a duration of 3.47 years and other loans having an average duration of 1.90 years. Total securities are $2.66 trillion, with $1.1 trillion in non-MBS securities, $1.2 trillion in RMBS, and $0.44 trillion in other MBS. The average security duration is 4.18 years. Non-MBS securities have a duration of 4.84 years, while RMBS and other MBS have an average duration of 4.02 and 2.92 years, respectively.

On the liabilities side, banks hold deposits and non-deposit liabilities, with total non-deposit liabilities amounting to $0.7 trillion and an average duration of 1.16 years. Given the short duration of non-deposit liabilities, long-term debt does not play an important role in funding most banks. Summing up, banks have total net holdings of $10.7 trillion with an average duration of 2.49 years.

Panel B of Table 9 presents the results for the average bank. The average bank has a loan duration of 2.86 years and a securities duration of 4.32 years. These estimates are slightly above the corresponding estimates for the overall system, suggesting that larger banks hold slightly shorter duration assets. There is significant variation in exposure across banks, with a standard deviation of loan and securities duration of 1.37 and 1.75 years, respectively. In total, the average bank has a duration of 2.98 years.

To compare the interest rate risk of bank assets to exposure from swaps, it helps to express the exposure in terms of DV01 relative to equity. Panel C of Table 9 reports the change in equity for a 100 basis points increase in interest rates. This is computed separately for banks assets (net of non-deposit liablities) and swaps scaled by equity. Column 1 finds that the average bank would suffer a loss equivalent to 23.8% of bank equity. In contrast, as shown in Column 3, the average bank would suffer a small gain equivalent to 0.23% of bank equity. Hence, even though notional swap exposure is much larger than bank assets, the DV01 of bank assets is about 10 times larger than the DV01 of interest rate swaps. In other words, the main source of interest rate risk for banks comes from holding long-term assets, not swaps. Moreover, even though swaps have the opposite sign and can be considered a hedge, the interest rate exposure is economically small. Hence, we conclude that the average bank does not use swaps to either hedge or speculate.

C. Hedging interest rate risk with deposits

Our results indicate that the average bank does not use swaps to hedge the interest rate risk of their assets and liabilities. While the notional amounts of swaps is large, they are not an economically significant hedge. But if banks do not use swaps to hedge the interest rate exposure of their assets, how might they be hedged?

Deposits are an alternative way to hedge interest rate risk. While conventional wisdom suggests that deposits have zero or very short duration, Drechsler, Savov and Schnabl (2021) show that this view is incorrect. They show that banks actively invest in building and maintaining deposit relationships, and that this has two related implications. First, a bank's deposit beta– the increase of a bank's funding cost from an increase in the short-term interest rate– is less than one. Second, a bank's deposit franchise has duration, which falls as beta increases. As a result, because deposits are bank liabilities, deposit duration contributes negative duration to a bank's overall interest rate exposure and can hedge the interest rate risk of bank assets. To investigate this view of hedging at banks, we test whether the deposit durations of banks in our sample that would be consistent with hedging interest rate risk do indeed fall as deposit betas increase. This extends the work of Drechsler, Savov and Schnabl (2021) as we include the interest rate exposure of swaps in our measurement of interest rate risk.

We begin by defining the implied deposit DV01 or duration of a bank as the DV01 or duration of deposits that completely hedges the overall interest rate exposure of a bank, or, in other words, that sets the sum of exposures of all assets and liabilities, including deposits, to zero.[24] We then compute the implied deposit duration for each bank using the DV01 of assets, liabilities, and swaps, as calculated above. We find that the banking industry's total DV01 across assets and non-deposit liabilities is \$2.67 billion (Table 9) and the total swap DV01 is \$0.585 billion (Table 3). Therefore, assuming that the aggregate sector is fully hedged with a zero DV01, the implied DV01 of deposits is negative \$3.26 billion, and– with assets net of non-deposit liabilities of 10.7 trillion (Table 9)– the implied duration of these deposits is \$3.26 billion × 10,000 / 10.7 trillion, or 3.05 years.[25]

We compute the implied deposit duration for each bank separately. We find an average implied deposit duration of 2.74 years with a standard deviation of 1.17 years. Panel A of Figure 3 plots a histogram of the implied deposit duration winsorized at 1% and 99% level. We find significant variation ranging from close to 0 to slightly above 6 years with the mass of the distribution at around 3 years.

We measure a bank's deposit beta following Drechsler, Savov and Schnabl (2021). Our dataset covers the period from Q32017 to Q42019. We therefore use the deposit beta esti-

[24]We also consider an alternative estimate of implied deposits that assumes that bank hedge their cash flows, i.e., they choose bank assets and deposits to target a stable NIM and ROA. This yields an economically small and positive duration of bank equity, consistent with the results of regresssing bank equity returns on interest rate shocks as documented in Drechsler, Savov and Schnabl (2021)). Our main results reported below are similar when using this alternative measure.

[25]DV01 is defined as the change in value for a one-basis-point decline in rate, and duration is defined as the percentage change in value for a unit decline in rate. Hence, duration equals $10,000 \times DV01$ divided by value.

mated for the 2015-2019 interest rate cycle following Drechsler et al. (2023). Specifically, the deposit beta is the change in the bank-level interest expense rate at the start of the hiking cycle (Q2 2015) to the end of the hiking cycle (Q2 2019) scaled by the change in Fed funds rate over the same period. As mentioned earlier, the deposit beta captures the increase in a bank's funding cost as a function of the short-term interest rate. For example, a deposit beta of 0.3 means that a bank's interest expenses increase by 30 bps for each 100 bps increase in the Fed funds rate.

Panel B of Figure 3 plots a histogram of the deposit beta. The average deposit beta is 0.27 with a standard deviation of 0.12. We find significant variation in betas ranging from close to 0 to 0.6.

Next, we examine whether, as predicted by Drechsler et al. (2023), implied deposit duration falls with deposit beta. We start with our main bank sample and drop 5 banks that do not have a deposit beta because they were not operating in the second quarter of 2015. This leaves a sample of 213 banks over 10 quarters. We estimate the following OLS regression:

$$Duration_{it} = \alpha_t + \gamma \times \beta_i^{Deposit} + \delta X_{it} + \epsilon_{it}, \tag{5}$$

where $Duration_{it}$ is the implied deposit duration of bank i at time t, $\beta_i^{Deposit}$ is the bank i's deposit beta, and X_{it} are control variables. The control variables are the share of liabilities financed with equity, transaction deposits, savings deposits, small time deposits, and foreign deposits. We do not include asset side controls since we would be overcontrolling for variation in duration on the asset side. We cluster the standard errors at the bank-level to account for the fact that the deposit beta only varies at the bank level.

Figure 4 provides a binscatter plot of the relationship between the implied deposit duration and the deposit beta for the cross-section of banks at the end of our sample period. We find a strong negative relationship: a higher implied deposit duration is associated with a lower deposit beta. The relationship is economically significant in that a 0.1 increase in the deposit beta is associated with a 0.3 decrease in deposit duration. The relationship appears to be linear in the deposit beta. This finding indicates that banks use deposits to hedge their interest rate exposure.

Table 10 presents the results from the OLS regression specified in equation (5). Column (1) reports the results without using control variables. We find a statistically significant of coefficient of −3.01, which means that 0.1 increase in the deposit beta lowers the implied deposit duration by around 0.3 years. We note that the constant is 3.52. This suggests that a hypothetical bank with a (particularly high) deposit beta of 1 has an implied deposit duration of less than 1 year, similar to a money market fund, and would be close to hedged. In other words, banks without a meaningful deposit franchise should have a very short asset duration, a conclusion consistent with banks using deposits to hedge most of their interest rate risk.

Column (2) finds that the coefficient of interest remains similar at −3.01 after adding quarter fixed effects. Columns (3) and (4) show that the coefficient is similar at −3.4 and −3.5 after adding controls for the share of funding coming from transaction deposits, savings deposits, small time deposits, foreign deposits, and equity. The coefficient on the control variables are statistically insignificant. This suggests that the deposit beta is a sufficient statistic for a bank's exposure to interest rate risk.

In summary, we find that banks use deposits, rather than swaps, to economically hedge their overall interest rate exposure from bank assets, liabilities, and swaps.

VII. Conclusion

Our analysis shows that banks' use of interest rate swaps plays a minimal role in hedging the interest rate risk associated with their assets. Despite holding substantial swap positions with an average notional value of $434 billion, the net impact on their interest rate risk is negligible. A 100-basis-point increase in rates only reduces the value of an average bank's swaps by 0.1% of equity, highlighting the limited effectiveness of swaps in mitigating overall interest rate exposure. The variation in swap positions across banks shows that some use swaps to decrease while others use them to increase interest rate risk, thus facilitating risk transfer within the banking sector. Swap dealer banks primarily hold swap positions for market making, while non-dealer banks use swaps to satisfy borrower demand for fixed-rate loans.

The differentiation in swap usage between swap dealer banks and non-dealer banks highlights distinct operational focuses within the banking sector. Swap dealer banks engage in market making, holding large swap positions primarily to facilitate trading activities and provide liquidity in the swap markets. In contrast, non-dealer banks use swaps to meet borrower demand for fixed-rate loans, aligning their swap activities more closely with their lending operations. This division of swap usage functions reflects the different approaches banks take to manage their specific business needs and customer requirements.

In conclusion, while interest rate swaps are widely used within the banking sector, their role in hedging overall interest rate risk is limited. Banks rely more significantly on their deposit franchise to hedge the interest rate risk of bank assets. This reliance on deposits as a primary risk management tool suggests that banks' deposit funding sources play an important role in their ability to hedge interest rate fluctuations, with swaps serving a more limited role.

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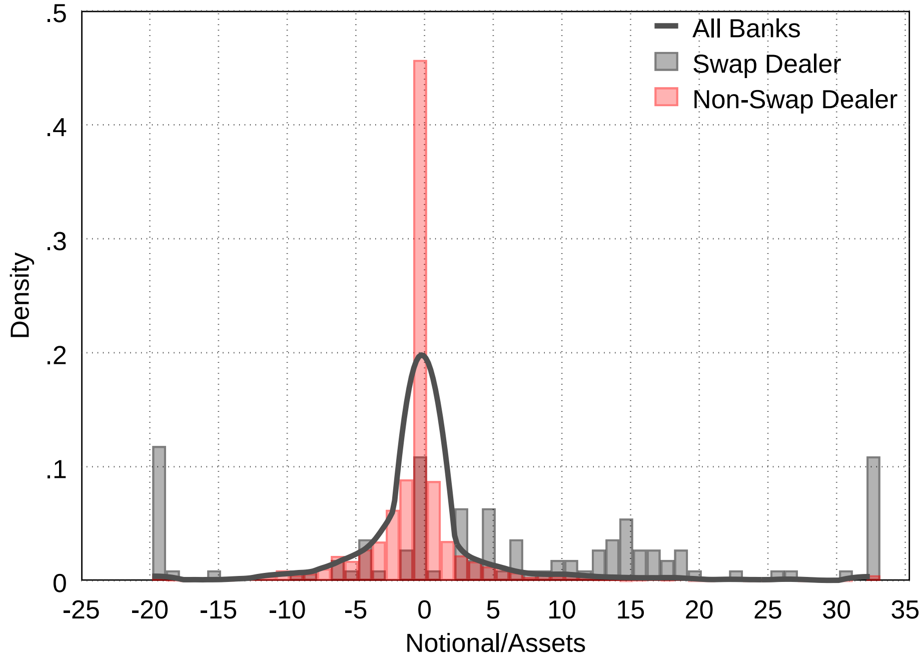
Panel A.

Distribution of the Ratio of Net Notional to Assets



Panel B.

Distribution of the Ratio of Swap DV01 to Equity

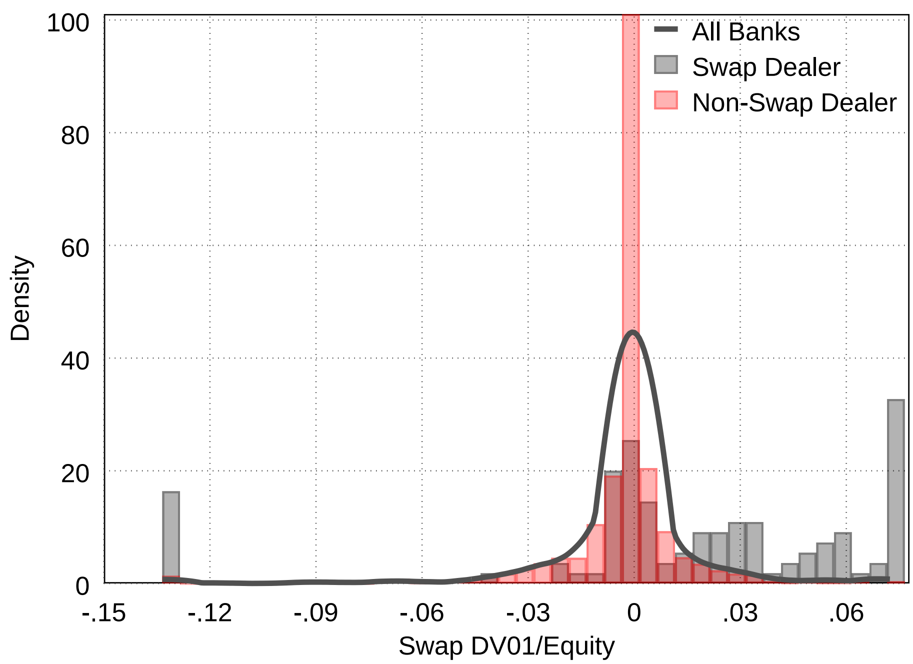


Figure 1. **Net notional/assets and swap DV01/equity**. The figure plots the distributions of the ratio of net notional to assets in percent (Panel A) and the ratio of swap DV01 to equity in percent (Panel B). The data are quarterly from the third quarter of 2017 to the fourth quarter of 2019. A black kernel density estimate line approximates the aggregate banking sector, while red and gray bins represent non-swap and swap dealers, respectively.

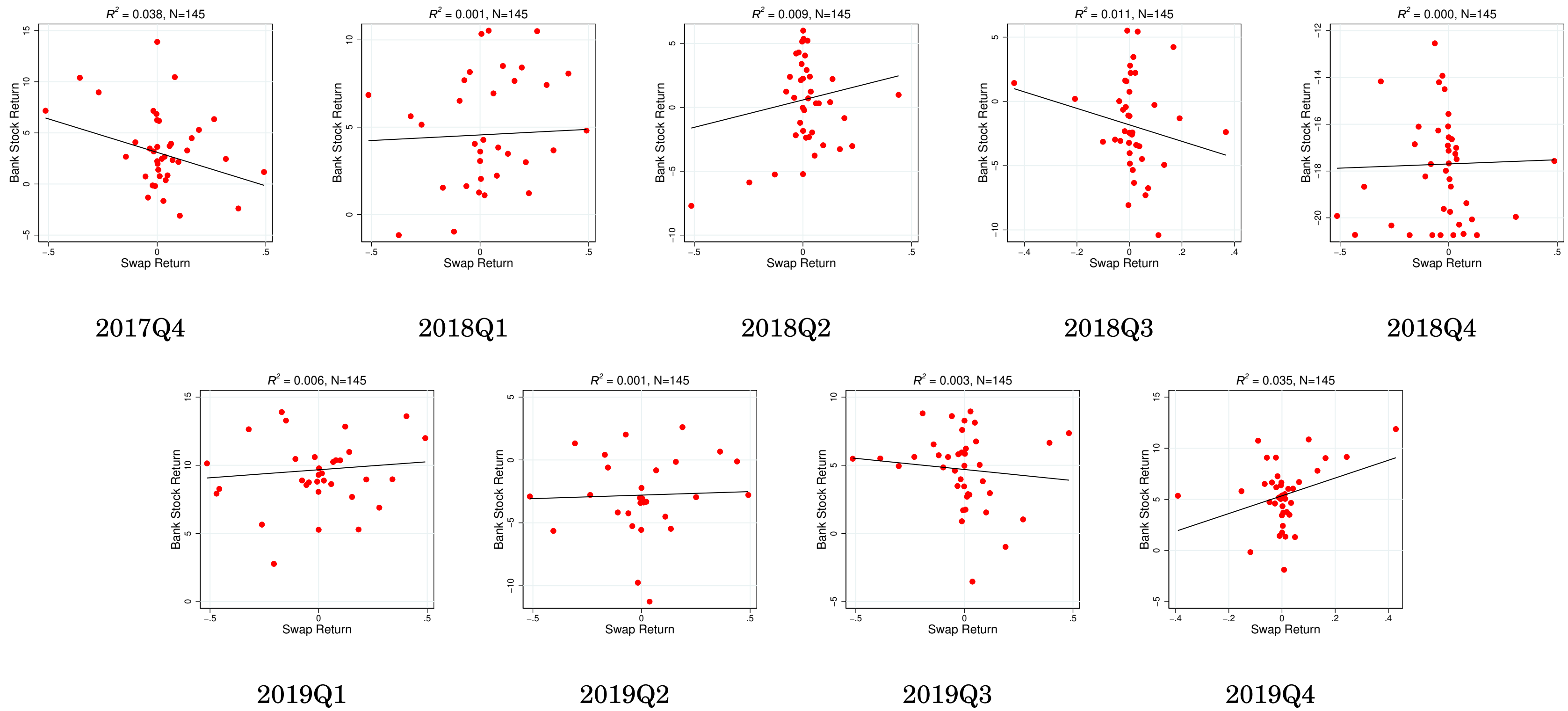
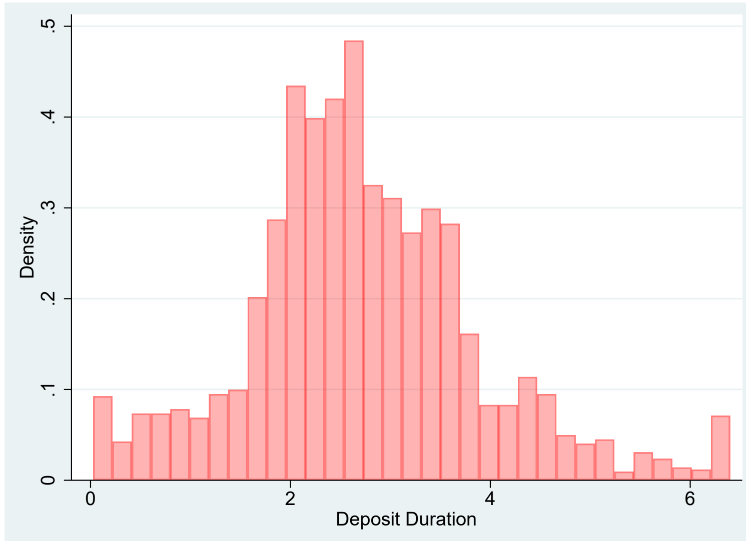
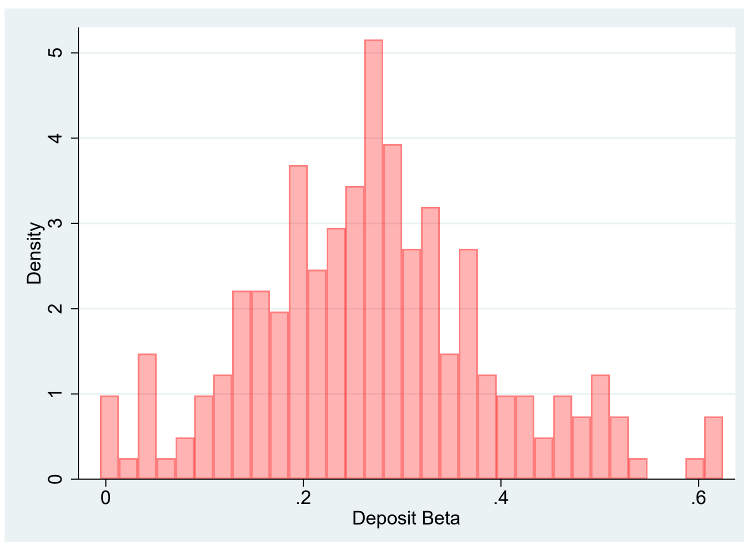


Figure 2. **Swap returns and bank stock returns by quarter**. This figure shows the relationship between bank stock return and swap return by quarter. Each figure is a binscatter plot, and the sample includes all publicly listed banks among the top 250 banks (145 banks). In each figure, we also plot the regression line from regressing the bank stock return on the swap return (defined in equation (1)). Both the dependent and the independent variables are winsorized at the 5% level by quarter. We report the R^2 and sample size on top of each figure. Quarter-end dates align with the reporting dates of the CFTC swap data in calculating bank stock returns and swap returns. These dates are 9/29/2017, 12/15/2017, 3/16/2018, 6/15/2018, 9/14/2018, 12/14/2018, 3/15/2019, 6/14/2019, 9/13/2019, and 12/13/2019.



Panel A. Histogram of the implied deposit duration



Panel B. Histogram of the deposit beta

Figure 3. **Implied deposit duration and deposit beta**. Panel A shows the distribution of implied deposit duration across banks. The sample includes all top 250 banks with a deposit beta (213 banks). The implied deposit duration is the required duration of deposits such that the bank's total DV01 from assets, liabilities, and swaps is fully hedged, i.e., the bank-level DV01 is equal to zero. Panel B shows the distribution of the bank deposit beta estimated during the 2015-2019 interest rate cycle. The deposit beta captures the change in the bank interest rate expenses relative to a change in the Fed funds rate. Both the implied deposit duration and the deposit beta are winsorized at the 1% level.

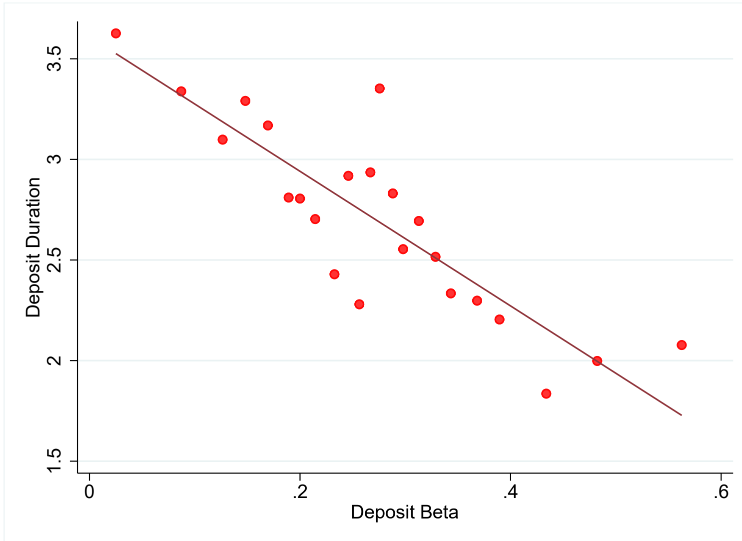


Figure 4. **Hedging bank assets, liabilities and swaps with deposits**. This figure shows a binscatter plot of the implied deposit duration versus the deposit beta. The sample consists of the cross-section of banks in 2019Q4. The implied deposit duration is the required duration of deposits such that the bank's total DV01 from assets, liabilities, and swaps is fully hedged, i.e., the bank-level DV01 is equal to zero. The deposit beta captures the change in the bank interest rate expenses relative to a change in the Fed funds rate. Both the implied deposit duration and the deposit beta are winsorized at the 1% level.

Table 1

Growth in Interest Rate Derivatives

This table examines the growth of interest rate derivatives in the U.S. banking system. The data are from publicly available bank call reports and are aggregated for the entire banking system. Prior to 1995, interest rate derivatives included swaps only. A bank is engaged in these derivatives if it has a non-zero notional amount of interest rate derivative positions. Notional refers to the total notional amount of swap positions. The Ratio of Notional to Assets and Ratio of Notional to Equity are the ratios of the notional to total bank assets and bank equity, respectively. The type refers to the type of interest rate derivatives covered. Panels A, B, and C report summary statistics for the entire banking system, the top 250 banks by asset size, and swap dealers, respectively.

Panel A: All Banks

Year	No. of Banks	Engaged in Derivatives	Notional (bn. $)	Ratio of Notional to Assets	Ratio of Notional to Equity	Type
1985	14,261	2%	186	0.1	1.1	Swaps only
1990	12,195	4%	1,717	0.5	7.9	Swaps only
1995	9,852	2%	10,023	2.3	29.0	All
2000	8,234	2%	32,084	5.3	61.9	All
2005	7,442	10%	84,390	9.6	95.5	All
2010	6,466	16%	193,359	16.3	147.9	All
2015	5,300	22%	138,301	9.4	84.1	All
2020	4,342	27%	115,911	5.7	56.2	All
2022	4,060	23%	139,620	6.4	67.5	All

Panel B: 250 Largest Banks

Year	No. of Banks	Engaged in Derivatives	Notional (bn. $)	Ratio of Notional to Assets	Ratio of Notional to Equity	Type
1985	250	53%	185	0.1	2.1	Swaps only
1990	250	71%	1,703	0.8	13.8	Swaps only
1995	250	50%	10,014	3.3	43.4	All
2000	250	40%	32,081	6.5	79.2	All
2005	250	70%	84,374	11.5	114.4	All
2010	250	76%	193,333	18.7	167.4	All
2015	250	87%	138,271	10.6	94.0	All
2020	250	92%	115,796	6.3	62.6	All
2022	250	90%	139,563	7.1	74.3	All

Panel C: Swap Dealers

Year	No. of Banks	Engaged in Derivatives	Notional (bn. $)	Ratio of Notional to Assets	Ratio of Notional to Equity	Type
2010	12	100%	191,400	28.9	276.3	All
2015	12	100%	136,742	16.9	155.0	All
2020	11	100%	113,231	10.6	110.1	All
2022	11	100%	136,567	11.9	128.9	All

Table 2

Interest Rate Derivative Positions at Banks

This table examines interest rate derivative positions of large U.S. banks. The data are collected from publicly available bank call reports as of the fourth quarter of 2022. Bank rank is the rank in terms of asset size. A bank is a swap dealer if the bank is registered as a dealer with the Commodity Futures Trading Commission. Bank assets are total assets. The other variables are defined in Table 1. Panel A reports interest rate derivative positions for the 20 largest banks by asset size. Panel B reports interest rate derivative positions by bank size and dealer status.

Panel A: Interest Rate Derivative Positions at 20 Largest Banks

Bank Rank	Bank Name	Swap Dealer	Notional (bn. $)	Assets (bn. $)	Ratio of Notional to Assets	Ratio of Notional to Equity
1	J.P. Morgan Chase Bank	Yes	33,585	3,202	10.5	110.6
2	Bank of America	Yes	13,091	2,419	5.4	58.1
3	Citibank	Yes	31,902	1,767	18.1	194.1
4	Wells Fargo Bank	Yes	1,303	1,718	6.0	63.8
5	U.S. Bank	Yes	779	585	1.3	17.7
6	PNC Bank	Yes	537	552	1.0	12.2
7	Truist Bank	No	256	546	0.5	4.3
8	Goldman Sachs Bank	Yes	45,896	487	94.2	950.2
9	Capital One	No	167	453	0.4	3.4
10	TD Bank	No	359	387	0.9	8.4
11	Bank of NY Mellon	No	263	325	0.8	9.8
12	State Street B&TC	No	42	298	0.1	1.6
13	Citizens Bank	No	220	226	1.0	9.3
14	First Republic Bank	No	0	213	0.0	0.0
15	Morgan Stanley Private Bank	Yes	47	210	0.2	2.9
16	Silicon Valley Bank	No	5	209	0.0	0.3
17	Fifth Third Bank	Yes	129	206	0.6	6.6
18	Morgan Stanley Bank	Yes	56	201	0.3	2.8
19	M&T Bank	No	65	200	0.3	2.7
20	Keybank	Yes	118	188	0.6	9.1

Panel B: Interest Rate Derivative Positions by Bank Size and Dealer Status

Bank Group	No. of Banks	Engaged in Derivatives	Notional (bn. $)	Ratio of Notional to Assets	Ratio of Notional to Equity
All Banks	4,060	23%	139,620	6.4	67.5
250 Largest Banks	250	90%	139,620	7.1	74.3
Swap Dealers	11	100%	136,567	11.9	128.9

Table 3

Summary Statistics

This table reports summary statistics of bank holdings of interest rate swaps. The sample includes quarterly observations for the top 250 banks from the third quarter of 2017 to the fourth quarter of 2019. To avoid double-counting, we exclude banks that were subsidiaries or were acquired by other top 250 banks during the analysis period (32 banks). Aggregate amounts are computed by first summing across banks in each quarter and then averaging across quarters. Notional is the total notional amount. Net notional is the notional amount after netting out positive and negative swap positions at the bank level. Market value is the market value of swap positions. Swap DV01 is the DV01 of swap positions. Swap position variables are scaled by assets or equity. Bank characteristics ratios are scaled by assets or liabilities. Equity is book equity. Swap exposure variables are winsorized at the 5% level.

	All Banks					
	Aggregate (1)	Mean (2)	St. Dev. (3)	Median (4)	p5 (5)	p95 (6)
Swap Exposure (in bn. $)						
Notional	94,680	434	(3,016)	0.4	0.000	85.6
Net Notional	784	3.6	(72.9)	0.0	−1.3	9.9
Market Value	50	0.232	(2.199)	0.0	−0.043	0.156
Swap DV01	0.585	0.003	(0.044)	0.000	−0.001	0.003
Swap Exposure						
Uses Interest Rate Swaps		74.0%	(44.0%)	100%	0%	100%
Ratio: Notional to Assets	704%	10.80%	(15.70%)	3.91%	0.00%	60.03%
Ratio: Net Notional to Assets	5.9%	−0.031%	(3.766%)	0.000%	−7.432%	10.395%
Ratio: Market Value to Assets	0.375%	0.030%	(0.095%)	0.001%	−0.122%	0.312%
Ratio: Swap DV01 to Equity	0.038%	−0.001%	(0.012%)	0.000%	−0.031%	0.025%
Swap Characteristics						
Share of DV01 with Customers	47.2%	82.1%	(31.9%)	100%	0%	100%
Share of Swaps with Customers	46.9%	80.4%	(32.9%)	100%	0%	100%
Bank Characteristics						
Swap Dealer		0.050	(0.219)	0.000	0.000	1.000
Assets (bn. $)	13,505	62	(247)	9	3	169
Equity (bn. $)	1,521	7.08	(26.0)	1.1	0.4	22.2
Ratio: Cash to Assets	0.097	0.045	(0.035)	0.032	0.012	0.140
Ratio: Loans to Assets	0.548	0.693	(0.101)	0.714	0.450	0.829
Ratio: Securities to Assets	0.197	0.177	(0.088)	0.162	0.046	0.388
Ratio: Core Deposits to Liabilities	0.661	0.749	(0.062)	0.750	0.629	0.856
Ratio: Non-Core Liabilities to Liabilities	0.255	0.147	(0.069)	0.139	0.044	0.290
Ratio: Trade Liabilities to Liabilities	0.016	0.001	(0.001)	0.000	0.000	0.005
Ratio: Equity to Liabilities	0.113	0.121	(0.024)	0.118	0.083	0.174
Observations		2,180				

Table 4

Summary Statistics: Breakdown by dealer status

This table reports summary statistics of bank holdings of interest rate swaps separately for swap dealers and non-swap dealers. The sample includes quarterly observations for the top 250 banks from the third quarter of 2017 to the fourth quarter of 2019. To avoid double-counting, we exclude banks that were subsidiaries or were acquired by other top 250 banks during the analysis period (32 banks). Aggregate amounts are computed by first summing across banks in each quarter and then averaging across quarters. Notional is the total notional amount. Net notional is the notional amount after netting out positive and negative swap positions at the bank level. Market value is the market value of swap positions. Swap DV01 is the DV01 of swap positions. Swap position variables are scaled by assets or equity. Bank characteristics ratios are scaled by assets or liabilities. Equity is book equity. Swap exposure variables are winsorized at the 5% level.

	Swap Dealers			Non-Swap Dealers		
	Aggregate (1)	Mean (2)	St. Dev. (3)	Aggregate (4)	Mean (5)	St. Dev. (6)
Swap Exposure (in bn. $)						
Notional	93,742	8,522	(10,598)	937	5	(18)
Net Notional	628	57	(320)	155	1	(6)
Market Value	48.7	4.4	(8.8)	1.9	0.0	(0.1)
Swap DV01	0.568	0.052	(0.191)	0.017	0.000	(0.001)
Swap Exposure						
Uses Interest Rate Swaps		96.4%	(18.8%)		72.8%	(44.5%)
Ratio: Notional to Assets	1,069%	51.6%	(18.2%)	19.6%	8.6%	(12.2%)
Ratio: Net Notional to Assets	7.3%	3.734%	(6.843%)	3.2%	−0.231%	(3.417%)
Ratio: Market Value to Assets	0.556%	0.595%	(1.435%)	0.036%	0.025%	(0.146%)
Ratio: Swap DV01 to Equity	0.061%	0.010%	(0.019%)	0.003%	−0.002%	(0.011%)
Swap Characteristics						
Share of DV01 with Customers	47.3%	50.8%	40.3%	55.1%	84.9%	29.5%
Share of Swaps with Customers	47.2%	49.7%	40.9%	36.0%	83.1%	30.6%
Bank Characteristics						
Swap Dealer	1.000	1.000	(0.000)	0.000	0.000	(0.000)
Assets (bn. $)	8,784	798	(778)	4,721	22	(42)
Equity (bn. $)	934	85	(80)	587	3	(5)
Ratio: Cash to Assets	0.117	0.088	(0.042)	0.060	0.043	(0.033)
Ratio: Loans to Assets	0.484	0.531	(0.084)	0.666	0.702	(0.094)
Ratio: Securities to Assets	0.203	0.219	(0.079)	0.187	0.175	(0.088)
Ratio: Core Deposits to Liabilities	0.616	0.709	(0.068)	0.745	0.751	(0.061)
Ratio: Non-Core Liabilities to Liabilities	0.311	0.199	(0.076)	0.150	0.144	(0.068)
Ratio: Trade Liabilities to Liabilities	0.025	0.004	(0.002)	0.001	0.001	(0.001)
Ratio: Equity to Liabilities	0.106	0.114	(0.015)	0.124	0.121	(0.025)
Observations		110			2,070	

Table 5

Swap Return and Bank Return

This table examines the relationship between bank stock returns and swap returns. The sample includes all publicly listed top 250 banks (145 banks). Bank stock return is the return from quarter t to $t+1$. Swap return is the change in the value of the swap portfolio relative to bank market value solely due to interest rate changes from t to $t+1$ (as defined in equation (1)). Quarter-end dates align with the reporting dates of the swap data in calculating stock returns and swap returns. These dates are 9/29/2017, 12/15/2017, 3/16/2018, 6/15/2018, 9/14/2018, 12/14/2018, 3/15/2019, 6/14/2019, 9/13/2019, and 12/13/2019. Panel A reports summary statistics of bank stock return and swap return. Panel B reports regressions of bank stock return on swap return. Column 2 includes time fixed effects. Column 3 includes bank and time fixed effects. Standard errors are clustered at the bank level.

Panel A: Summary Statistics	
Mean of Bank Stock Return	0.508%
… SD	9.964%
Swap DV01 (bn. $)	0.004
Mean of Mkt. Eq. (bn. $)	13.874
Mean of Δ (bps)	−5.57
Swap return	
… Mean	−0.008%
… Standard deviation	0.985%
… 10th Percentile	−0.194%
… 90th Percentile	0.209%
Obs.	1,305

Panel B: Bank Return and Swap Return

	Bank Stock Return		
	(1)	(2)	(3)
Swap return	0.059	−0.009	−0.077
	(0.084)	(0.080)	(0.071)
Time FE	No	Yes	Yes
Bank FE	No	No	Yes
Obs.	1,305	1,305	1,305
R^2	0.0000	0.680	0.704
Within R^2	0.0000	0.0000	0.0002

Table 6

Swap exposure and Bank Characteristics

This table reports regressions of swap exposure on bank characteristics. The sample is the full bank sample as in Table 3. In Panel A, the outcome variable is Notional/Assets, which is computed as the total notional value divided by bank assets. In Panel B, the outcome variable is Swap DV01, which is the total DV01 of a bank's swap positions. The control variables are an indicator variable for whether a bank is a swap dealer, the natural logarithm of bank assets, core deposits scaled by total liabilities, loans scaled by total assets, and securities for sale (excluding Treasuries) scaled by assets. Standard errors are clustered at the bank level.

Panel A: Notional Swap Exposure

	Notional/Assets				
	(1)	(2)	(3)	(4)	(5)
Swap Dealer	43.010***	23.207***	22.675***	23.433***	23.147***
	(5.369)	(6.871)	(6.925)	(6.771)	(6.725)
Log Assets		5.322***	5.211***	5.307***	5.186***
		(0.983)	(0.972)	(0.991)	(1.004)
Core Deposits Ratio			−11.662	−11.056	−10.792
			(10.281)	(10.256)	(10.275)
Loan Ratio				5.581	2.320
				(6.796)	(8.617)
Sec. for Sale Ratio (excl. Treas)					−7.309
					(11.277)
Time FE	Yes	Yes	Yes	Yes	Yes
Obs.	2,180	2,180	2,180	2,180	2,180
No. of clusters	218	218	218	218	218
R^2	0.372	0.500	0.504	0.505	0.506

Panel B: DV01 Exposure

	Swap DV01/Equity				
	(1)	(2)	(3)	(4)	(5)
Swap Dealer	0.011**	0.004	0.004	0.005	0.005
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
Log Assets		0.002***	0.002***	0.002***	0.002***
		(0.001)	(0.001)	(0.001)	(0.001)
Core Deposits Ratio			0.005	0.006	0.007
			(0.009)	(0.009)	(0.009)
Loan Ratio				0.011	0.002
				(0.008)	(0.010)
Sec. for Sale Ratio (excl. Treas)					−0.020
					(0.012)
Time FE	Yes	Yes	Yes	Yes	Yes
Obs.	2,180	2,180	2,180	2,180	2,180
No. of clusters	218	218	218	218	218
R^2	0.054	0.088	0.089	0.098	0.110

Table 7

Share of Swaps with Customers and Bank Characteristics

This table reports regressions of customer share on bank characteristics. The sample consists of the full bank sample as in Table 3, excluding banks with zero notional amounts. A swap counterparty is classified as a customer if they are not a swap dealer or a clearing house. In Panel A, the outcome variable is the share of customers computed based on notional amounts. In Panel B, the outcome variable is the share of customers computed based on DV01. The control variables include an indicator variable for whether a bank is a swap dealer, the natural logarithm of bank assets, core deposits scaled by total liabilities, loans scaled by total assets, and securities for sale (excluding Treasuries) scaled by assets. Standard errors are clustered at the bank level.

Panel A: Share of Notional Amount with Customers

	Share of Notional Amount with Customers				
	(1)	(2)	(3)	(4)	(5)
Swap Dealer	−0.329***	0.154*	0.177*	0.217**	0.240**
	(0.046)	(0.092)	(0.102)	(0.098)	(0.095)
Log Assets		−0.140***	−0.138***	−0.126***	−0.112***
		(0.017)	(0.016)	(0.018)	(0.017)
Core Deposits Ratio			0.338	0.329	0.255
			(0.353)	(0.360)	(0.328)
Loan Ratio				0.436	0.765***
				(0.269)	(0.238)
Sec. for Sale Ratio (excl. Treas)					0.835***
					(0.284)
Constant		1.210***	0.951***	0.618*	0.293
		(0.040)	(0.268)	(0.333)	(0.323)
Time FE	Yes	Yes	Yes	Yes	Yes
Obs.	1,294	1,294	1,294	1,294	1,294
No. of banks	143	143	143	143	143
Within R^2	0.079	0.305	0.311	0.327	0.354

Panel B: Share of DV01 with Customers

	Share of DV01 with Customers				
	(1)	(2)	(3)	(4)	(5)
Swap Dealer	−0.336***	0.079	0.102	0.151	0.177*
	(0.048)	(0.092)	(0.102)	(0.096)	(0.092)
Log Assets		−0.121***	−0.118***	−0.105***	−0.090***
		(0.017)	(0.017)	(0.019)	(0.018)
Core Deposits Ratio			0.349	0.342	0.265
			(0.358)	(0.364)	(0.331)
Loan Ratio				0.510*	0.868***
				(0.275)	(0.231)
Sec. for Sale Ratio (excl. Treas)					0.918***
					(0.284)
Constant	0.849***	1.178***	0.910***	0.519	0.161
	(0.024)	(0.042)	(0.271)	(0.339)	(0.316)
Time FE	Yes	Yes	Yes	Yes	Yes
Obs.	1,290	1,290	1,290	1,290	1,290
No. of banks	143	143	143	143	143
Within R^2	0.087	0.267	0.273	0.298	0.331

Table 8

Hedging floating-rate loans

This table examines whether non-swap dealer banks immediately hedge long swaps with customers. The sample includes all non-swap dealer banks with non-zero swap positions (127 banks). A long swap is a swap in which the bank receives floating and pays fixed, typically used to turn floating-rate loans into fixed-rate loans. A back-to-back hedge is a hedge in which a long swap is offset by a short swap entered on the same day, for the same notional amount, and with the same maturity. The customer share is the share of long swaps where the swap counterparty is a customer. The hedging share is the share of long swaps with customers that have an offsetting back-to-back hedge. Panel A presents results for banks with less than $100 billion in assets (116 banks). Panel B presents results for banks with more than $100 billion in assets (11 banks).

	Panel A: Assets < $100bn				
	Long Swap Notional	Long Swap with Customers	Back-to-back Hedge	Customer Share	Hedging Share
Aggregate ($ bn)	166.8	113.29	79.7	68%	70%
Mean ($ mil)	1,438	977	687	86%	57%
Stand Dev	(3,005)	(1,756)	(1,228)	(28%)	(37%)
Median	385.3	304.60	194.6	100%	73%

	Panel B: Assets >= $100bn				
	Long Swap Notional	Long Swap with Customers	Back-to-back Hedge	Customer Share	Hedging Share
Aggregate ($ bn)	325.9	87.90	34.5	27%	39%
Mean ($ mil)	29,627	7,991	3,135	25%	26%
Stand Dev	(27,899)	(8,394)	(4,275)	(21%)	(27%)
Median	23,750	6,723	194.6	27%	20%

Table 9

Interest Rate Risk of Bank Assets, Liabilities, and Swaps

The sample estimates the interest rate exposure for bank assets, liabilities, and swaps. The sample includes the full bank sample as in Table 3. Holdings are denoted in $ billion and represent either assets or liabilities. We measure interest rate exposure as both duration and DV01 (in $ million). The main text discusses the estimation of these variables. Panel A provides summary statistics by asset and liability type for the aggregate banking sector. Panel B provides summary statistics for the average bank by asset and liability type. Panel C provides summary statistics on interest rate exposure measured as the change in equity value for a 100 basis point increase in interest rates for bank assets and swaps, respectively.

	Panel A: Aggregate Banking Sector		
	Holdings ($ bn)	Duration (yr)	DV01 ($ mil)
Cash	1,307.5	0.00	0.0
Loans	7,443.6	2.21	1,641.1
– Residential Mortgage Loans	1,457.6	3.47	504.0
– Other Loans	5,986.1	1.90	1.137.2
Securities	2,662.6	4.18	1,107.9
– Residential MBS	1,119.9	4.02	445.8
– Other MBS	437.2	2.92	127.5
– Non-MBS	1,105.6	4.84	534.7
Non-deposit liabilities	713.4	1.16	82.8
Total	10,700.5	2.49	2,666.2
	Panel B: Average Bank		
	Holdings ($ bn)	Duration (yr)	DV01 ($ mil)
Cash	8.1	0.00	0.0
	(49.7)	(0.00)	(0.0)
Loans	34.1	2.86	7.5
	(117.5)	(1.37)	(24.1)
– Residential Mortgage Loans	6.7	2.98	2.3
	(28.6)	(0.81)	(10.6)
– Other loans	27.5	2.87	5.2
	(90.5)	(1.68)	(14.0)
Securities	12.2	4.32	5.1
	(49.9)	(1.75)	(21.5)
– Residential MBS	5.1	3.51	2.1
	(27.6)	(0.81)	(11.8)
– Non-MBS	5.1	5.86	2.5
	(24.4)	(3.08)	(10.9)
– Other MBS	2.0	2.82	0.6
	(4.8)	(0.83)	(1.5)
Non-deposit liabilities	3.3	1.43	2.1
	(15.5)	(1.03)	(3.4)
Total	49.1	2.98	12.2
	(181.8)	(1.23)	(43.6)
Observations	2,180	2,180	2,180
	Panel C: Interest Rate Exposure		
	Assets		Swaps
Δ % Equity for 100 bps rate increase	-23.8%		0.23%
	(11.4)		(2.3)

Table 10

Implied Deposit Duration

The table examines whether banks use deposits to hedge their interest rate exposure to assets, liabilities, and swaps. The sample includes the full bank sample as in Table 3, except for banks without a deposit beta. The implied deposit duration is the required duration of deposits such that the bank's total DV01 from assets, liabilities, and swaps is fully hedged. The deposit beta captures the change in the bank's interest rate expenses relative to a change in the Fed funds rate. The control variables are the share of liabilities financed with equity, transaction deposits, savings deposits, small time deposits, and foreign deposits, respectively. The standard errors are clustered at the bank level.

	Implied deposit duration			
	(1)	(2)	(3)	(4)
Deposit beta	−3.009***	−3.009***	−3.440***	−3.449***
	(0.624)	(0.625)	(0.568)	(0.570)
Equity Share			−2.065	-1.952
			(3.143)	(3.171)
Transaction Deposit Share			−3.582	-3.591
			(1.800)	(1.808)
Saving Deposits Share			−2.066	-2.062
			(1.779)	(1.787)
Small Time Share			−2.996	-2.950
			(2.170)	(2.181)
Foreign Deposit Share			−4.162	-4.131
			(3.041)	(2.561)
Constant	3.516***	3.516***	5.709***	5.691***
	(0.172)	(0.172)	(1.644)	(1.652)
Quarter Fixed Effects	No	Yes	No	Yes
Observations	2,130	2,130	2,130	2,130
R^2	0.012	0.013	0.016	0.016