Do Banks Hedge Using Interest Rate Swaps?

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April 10, 2023

ABSTRACT

We ask whether banks use interest rate swaps to hedge the interest rate risk of their assets, primarily loans and securities. To this end, we use regulatory data on individual swap positions for the largest 250 U.S. banks. We find that the average bank has a large notional amount of $434 billion. But after accounting for the significant extent to which swap positions offset each other, the average bank has essentially no net interest rate risk from swaps: a 100-basis-point increase in rates increases the value of its swaps by 0.1% of equity. There is variation across banks, with some bank swap positions decreasing and some increasing with rates, but aggregating swap positions at the level of the banking system reveals that most swap exposures are offsetting. Therefore, as a description of prevailing practice, we conclude that swap positions are not economically significant in hedging the interest rate risk of bank assets.

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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 declines when market interest rates rise.

Market interest rates increased from January 2022 to March 2023 as central banks 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 around 4.5% in February 2023. Furthermore, over the same period, the long-term or more specifically 10-year rate– which can be conceptualized as depending on the expected sequence of short-term rates plus a term premium– increased from around 1.5% to 4%. These large increases in market interest rates significantly lowered the value of bank loans and securities. Drechsler et al. (2023a), conducting a simple back-of-the-envelope calculation, estimate that the U.S. banking sector lost around $700 billion on security investments and a total of $1.75 trillion on both securities and loans.

These large losses raise the question of whether banks use interest rate swaps ("swaps") to hedge their holdings of securities and loans. Because swap values are themselves subject to interest rate risk, swaps can and are commonly used to manage interest rate risk exposures, not only in the banking sector but across the financial system. According to the Commodity Futures Trading Commission, the notional amount outstanding of swaps at the end of 2021 was $215 trillion.[2] There is, of course, a cost to hedging securities and loans with swaps: whatever term premium is earned from holding securities and loans is likely given up by hedging with swaps. But this observation does not diminish the importance of our primary question, namely, whether or not banks use swaps to hedge the value of their assets against changes in rates.

It is difficult for researchers and the public to answer this question because granular data as to bank swap positions are not publicly available. In theory, the reported market values of swaps positions over time, as interest rates change, can be used to back-out the interest rate exposure of those positions. In practice, however, these efforts are complicated by accounting complexities and by the fact that swap positions typically change between the reporting dates of their market values.

By contrast, this paper can precisely measure the interest rate exposure of bank swap positions because we have regulatory (non-public) contract-level data on those positions. Our

[2] Baker, Mixon, and Orlov (2022).

analysis focuses on the positions of the largest 250 U.S. commercial banks, which amount to more than 8 million contracts and constitute nearly the entirety of swap positions of the U.S. banking sector. In this way, our data allow us to measure and evaluate the interest rate exposure of swaps both at the level of individual banks and for the banking sector in aggregate.

We present bank swap positions using two common metrics. The first, notional amount, measures the total dollar amount (or foreign currency amount converted to dollars) that is referenced by all relevant swap positions. 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 widely reported, although as discussed later, they cannot be interpreted as measuring the interest rate exposure of swap positions.

The notional amount of the swap positions of the largest 250 U.S. banks is \$94.7 trillion, which is large and equal to about seven times the total assets of the U.S. banking system. The swap positions are concentrated among larger banks, especially among swap dealers. Swap dealers are banks that are registered with the CFTC to make markets in swaps. The notional amount of their swap positions is \$93.7 trillion or 11 times their assets.

The second metric we use to present bank swap positions is DV01 (the dollar value of an '01), which is the change in value of a swap position due to a one-basis-point decline in a suitably-defined interest rate. Computing this direct measure of risk is impossible without detailed information about the relevant swap positions that is not publicly available. DV01 is used to measure interest rate risk not only by banks, but widely across the financial industry, and not only for swaps, but for all assets with values that are sensitive to interest rates, including a bank's securities and loans.

Despite the large notional amounts just described, we find that the swap position of the average U.S. bank has essentially zero exposure to interest rates. The stark difference between the two metrics arises mostly because the notional amount of a portfolio of swaps adds the notional amounts of individual positions, even though typically some positions increase in value as rates decline while other positions decrease in value as rates decline. Put another way, the interest rate risks of swap positions within a bank typically offset each other.[3] In any case, the average DV01 across the largest U.S. banks is only \$3 million and the median DV01 is only \$10,000. To put these values into perspective, compare banks' swap DV01– their interest rate risk exposure in swaps– to bank equity– their capacity to absorb risk. The mean ratio of DV01 to bank equity is only -0.001% and the median ratio

[3]Another reason for the discrepancy is that there is a very large notional amount of short-term swaps, which have particularly low exposure to interest rates. See Baker at al. (2021).

is less than 0.001%. Put another way, a 100 basis-point increase in interest rates changes average bank equity by less than 0.1%.

The DV01 of bank swap positions is economically small when compared with the interest rate risk of bank assets. Drechsler et al. (2021) report that the average U.S. bank has an asset duration of around 3.9 years (i.e., a 100-basis-point increase in interest rates reduces asset value by 3.9%). Given bank leverage of about 10 to 1, this decline in bank assets reduces bank equity by 39%. Hence, bank swap positions do not have significant interest rate risk relative to that of bank assets. Equivalently, the average bank does not rely on swaps to hedge the interest risk of its securities and loans.

This conclusion holds both for the large banks that are and that are not swap dealers. The average swap dealer has an average DV01 of $52 million, or about 0.01% of bank equity, which means that a 100 basis-point-increase in rates reduces bank equity by 1.0%. For the average non-swap-dealer, DV01 is less than $10,000 and, in absolute magnitude, about 0.002% of bank equity. Again, these estimates are economically small when compared to the interest rate risk of bank assets.

We gain additional insight from the variation of DV01 across the 250 largest 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. Furthermore, for some banks the negative DV01 of swap positions offsets some of the DV01 of assets, while for other banks the positive DV01 of swap positions adds to the DV01 of assets. But, as discussed above, these offsetting or additive contributions to DV01 are limited relative to the DV01 of assets. Hence, the swap positions of banks do not seem to be motivated by the interest rate risk of bank assets.

We also analyze the interest rate risk of swap positions for the banking system as a whole, proxied by that of the largest 250 banks. Aggregate DV01 is $585 million, or 0.038% of aggregate bank equity. Alternatively, a 100-basis-point increase in rates would lower the value of aggregate bank equity by 3.8%. The suggestion, again, is that swap positions in the banking industry are not primarily motivated by the interest risk of bank assets.[4]

In summary, while the notional amount of bank swap positions is very large, the interest rate risk of those positions for the average bank is close to zero, both for swap dealers and non-swap-dealers. Furthermore, while the aggregate interest rate risk of swap positions of the banking sector is small, for some banks swaps somewhat offset the risk of assets and for

[4]Note that data from the Commodity Futures Trading Commission for Q1 2023 show that swap-dealer banks have positive DV01, non-swap-dealer banks have negative DV01, and, when combined, these positions effectively cancel and result in an essentially zero exposure across the sector. https://www.cftc.gov/sites/default/files/2023-01/ENNs_IRS_2022Q3_ada.pdf.

others swaps somewhat add to the risk of assets. We conclude that bank swap positions are not economically significant in hedging the interest rate risk of bank assets.

We emphasize that these findings do not imply that individual banks or the banking system overall are unhedged to interest rate risk. Drechsler et al. (2021) shows that banks hedge long-term asset holdings with their deposit franchise. While the deposit franchise is difficult to analyze, as its valuation depends on assumptions about depositor behavior, Drechsler et al. (2023b) provide back-of-the-envelope estimates. They find that from January 2022 to March 2023, as interest rates increased, the value of the banking sector's deposit franchise increased by around $1.7 trillion, which is the same order of magnitude as the losses on bank assets over that period. They emphasize that this valuation is uncertain and depends on behavioral assumptions regarding depositor behavior.

Our paper contributes to the literature on the interest rate risk of bank swap positions. Brewer, Minton, and Moser (2000) show that banks using interest rate derivatives experience greater growth in their books of commercial and industrial loans. Purnanandam (2007) finds that banks using derivatives do not need to adjust either lending volumes or the gap between the maturities of assets and liabilities in response to tighter monetary policy. Gorton and Rosen (1995) devise a methodology to infer exposure from a combination of notional amounts, reported swap market values, and assumptions about the evolution of swap positions over time. Stulz (2004) analyzes the cost and benefits of derivatives such as interest rate swaps. Begenau et. al (2015) estimate the interest rate exposure of bank swap positions from changes in the market values of swap positions over time. Hoffmann et. al (2019) analyze the distribution of interest rate risk of European banks using regulatory data. Drechsler et al. (2021) show that the deposit franchise functions like swap positions in hedging the interest rate risk of bank assets. Baker et al. (2021) study how swaps are used to tranfer interest rate risk from various sectors to others, including banks. 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.

II. Aggregate interest rate derivative positions

Interest rate derivative positions in the U.S. banking sector have grown enormously since the birth of the market in the 1980s. Panel A of Table 1 gives summary statistics computed from 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, e.g., exchange-traded derivatives, the vast majority of positions are swaps, as discussed further below. In any case, the notional amount of interest rate derivatives in 1985 was $186 billion, which was roughly the size of bank equity 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 6.4 times bank assets.[5]

Interest rate derivative notional amounts are highly concentrated in the largest 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, that percentage remains limited. Or, put another way, the median bank has no exposure to these derivatives. Furthermore, Panel B shows that the participation rates of the largest 250 banks, by asset size, are much more significant, growing from 53% to 90%, and that their notional amounts dominate the market. Even though the largest 250 banks constitute less than 5% of banks, their notional amounts account for more than 99.9% of all notional amount over the entire history. Not surprisingly then, notional amount relative to assets or to equity is greater for the largest banks than for banking sector as a whole, peaking at about 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 essentially identifies market makers. There were 12 registered swap dealers from 2010 to 2018, and 11 after 2018. The data show that these relatively few 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.

Table 2 provides additional insight into the concentration of notional amounts across banks by listing the largest 20 banks by assets as of December 2022. 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

[5]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.

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.

III. Background, Data, and Measurement

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. 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 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 by market conditions at the time of the trade. More generally, 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.

[6] The floating-rate index of swaps has transitioned away from LIBOR to SOFR (Secured Overnight Financing Rate). For details on this transition see, for example, Tuckman and Serrat (2022), pp. 289-295. In any case, because the sample period of this paper falls firmly in the LIBOR regime, the text describes swaps in terms of LIBOR.

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

A fixed-for-floating swap essentially resembles 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. But 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 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 directly related to the size of the interest payments 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. And the notional amount of a single fixed-for-floating swap is a very poor measure of counterparty default risk: the contract never calls for the exchange of notional amounts and, as just mentioned, collateral arrangement typically protect positive NPVs from counterparty defaults.

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

[7] For more detail on the pricing of swaps and collateral protection, see Tuckman and Serrat (2022), Chapters 2 and 13.

[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).

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, 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 one of the most commonly-used metrics 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.[10]

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 very 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 these products are: IRS, 87%; OIS, 6%; swaptions, 5%; FRAs, 2%; and caps or floors, less than 1%.[11] There are also

[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.

[10]For a more detailed exposition, see Tuckman and Serrat (2022), Chapter 4.

[11]Baker et al. (2021), Table 2.

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 these futures contracts.[12]

B. Data Source

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 in this legal context refers very broadly to over-the-counter derivatives markets.[13] 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 this regulatory data set.

Motivated by the findings in Section II that swap positions are concentrated in the largest banks, we focus on the 250 largest U.S. banks, by assets, as reported by the Federal Reserve Board as of June 2018.[14] The assets of these top 250 banks, by the way, 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 or participated in a merger of equals 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, for each bank and for the all banks, long notional amount, short notional amount, and net notional amount. 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 reporting of Entity-Netted Notionals (ENNs), a risk-adjusted mea-

[12]Compare, for example, Baker et al. (2021) with Baker et al. (2019).

[13]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 IRS, 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.

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

sure of the size of various derivatives markets.[15] 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.[16]

IV. Empirical Analysis

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 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.[17] Notional value is about seven times as large as total assets in the U.S. banking system and about twice as large as the amount outstanding of U.S. debt securities. 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 much greater 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 60% at the 95^{th} percentile of the distribution to 0% at the 5^{th} percentile. Further along these lines, many smaller banks in the sample

[15]See Baker et al. (2021).

[16]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.

[17]This value is computed from data obtained from the CFTC, which does not include exchange-traded interest rate derivatives.

have no position in swaps. More specifically, in a given quarter, about 26% of banks have no swaps position. Note that this is consistent with our finding in Section II that many mid-sized banks and 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 of the large banks are swap dealers for whom the lending business is much smaller relative to the market making business.[18]

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 rate 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 over and above our other measures of swap positions.

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

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

zero. Also, net notional is concentrated in the largest banks.[19]

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 $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 somewhat high for our sample period but representative of longer time periods. 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.

[19]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. As an aside, note that net notional also almost certainly exaggerates the reduction of operational risk, for which notional amount may actually be the best indicator: the likelihood of operational problems most likely increases with the number of line items, which is likely highly correlated with notional amount.

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. Conclusion

This paper asks whether banks use interest rate swaps to hedge the interest rate risk of their long-term assets. We use transaction-level data to estimate the interest rate risk of the swap positions of the 250 largest U.S. banks. We find that the average bank has a large notional amount of swaps of $434 billion.But after accounting for offsetting swap positions, the average bank has essentially no exposure to interest rate risk: a 100-basis-point increase in rates increases the value of its swaps by 0.1% of equity. There is variation across banks, with some bank swap positions decreasing and some increasing with rates, but aggregating swap positions at the level of the banking system reveals that most swap exposures are offsetting. Therefore, as a description of prevailing practice, we conclude that swap positions are not economically significant in hedging the interest rate risk of bank assets.

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Table 1

Growth in Interest Rate Derivatives

The data are from the publicly available Call Reports. 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.

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

The data are collected from publicly available bank call reports as of the fourth quarter of 2022. Swap dealers are banks that are registered as dealers with the Commodity Futures Trading Commission. Panel A reports interest rate derivative positions for the 20 largest banks. 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

The sample includes quarterly observations for the 218 largest banks from the third quarter of 2017 to the fourth quarter of 2019. Aggregate amounts are computed by first summing across banks in each quarter and then averaging across quarters. Derivative exposure variables are scaled by assets or equity. Bank characteristics ratios are scaled by assets or liabilities. Equity is book equity. The derivatives exposure variables are winsorized at the 5% level.

	All Banks					
	Aggregate (1)	Mean (2)	St. Dev. (3)	Median (4)	p5 (5)	p95 (6)
Derivatives 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
Derivatives Exposure						
Uses Interest Rate Derivatives		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%
Derivatives 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

The sample includes quarterly observations for the 218 largest banks from the third quarter of 2017 to the fourth quarter of 2019. Aggregate amounts are computed by first summing across banks in each quarter and then averaging across quarters. Derivative exposure variables are scaled by assets or equity. Bank characteristics ratios are scaled by assets or liabilities. Equity is book equity. The derivatives 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)
Derivatives 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)
Derivatives Exposure						
Uses Interest Rate Derivatives		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%)
Derivatives 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	

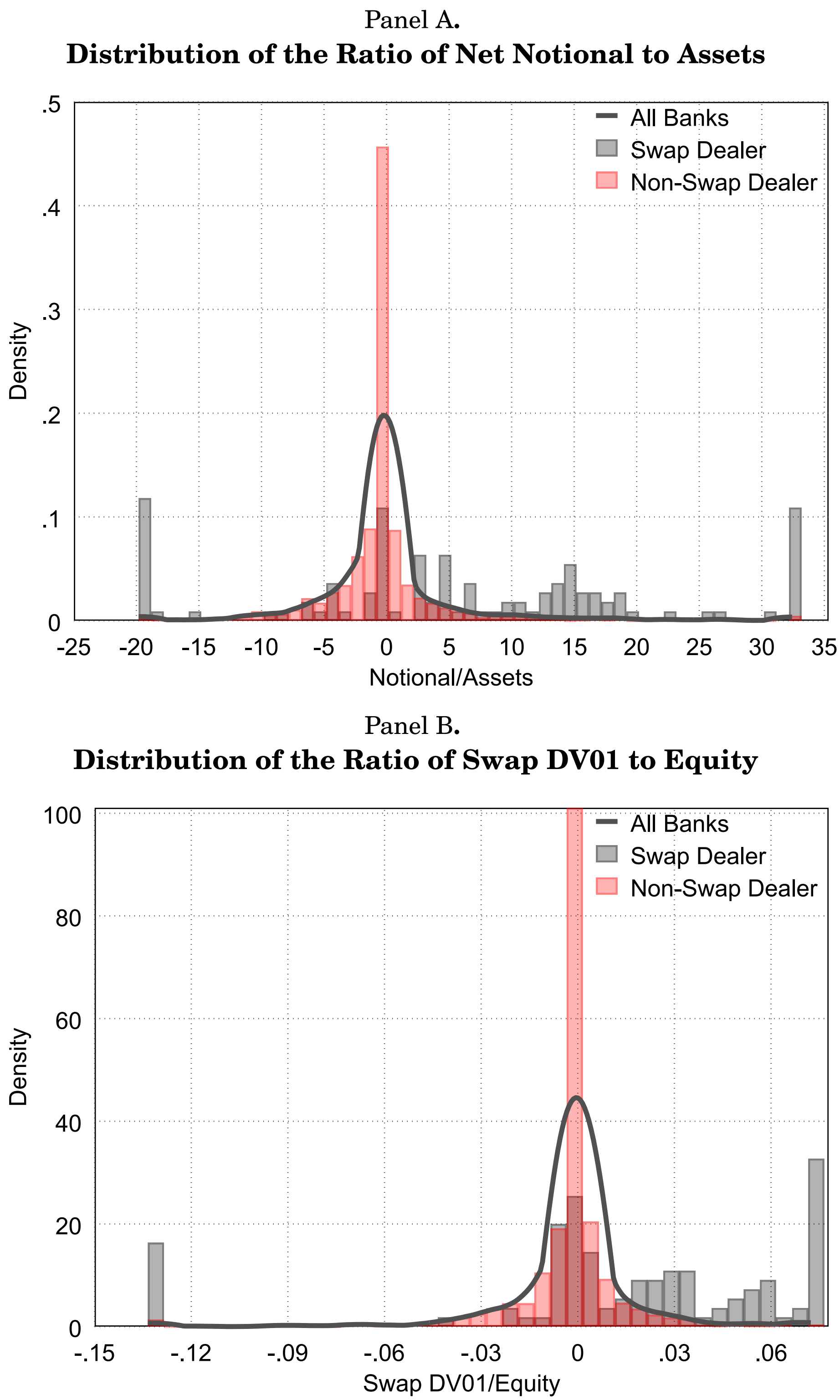

Figure 1. **Net notional/assets and swap DV01/equity**. The figure plots the distributions of the ratio of net notional to assets in percent (Panel A) and the ratio of swap DV01 to equity in percent (Panel B). The data are quarterly from the third quarter of 2017 to the fourth quarter of 2019. A black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