Underwater: Strategic Trading and Risk Management in Bank Securities Portfolios*

Andreas Fuster   Teodora Paligorova   James Vickery

March 20, 2025

We use bond-level data to study how US banks manage risk in their securities portfolios, focusing on the period of rapidly-rising interest rates in 2022-23, and examine the role of financial and regulatory frictions in shaping bank behavior. Interest rate risk in bank portfolios increased markedly as rates rose, with significant cross-bank heterogeneity depending on *ex ante* holdings of bonds with embedded options. In response, exposed banks shortened the duration of bond purchases but did not actively sell risky securities or expand "qualified" hedging activity; securities also played a limited role in banks' responses to deposit outflows. We identify two frictions that can help explain this inertia. First, we find that banks are highly averse to selling underwater bonds at a discount to book value—e.g., banks were 8-9 times more likely to trade bonds with unrealized gains than unrealized losses in 2022-23. This "strategic" trading is more pronounced for banks that do not recognize unrealized losses in regulatory capital and banks facing stock market pressure. Second, frictions in establishing qualified accounting hedges limited hedging activity depending on bond type and accounting classification. Banks did, however, reduce the interest-rate sensitivity of *regulatory* capital by classifying the riskiest bonds as held-to-maturity.

Keywords: securities, gains trading, bank, capital regulation, bonds

JEL classification: G11, G21, G23, G28

*Fuster: EPFL, Swiss Finance Institute and CEPR. Paligorova: Federal Reserve Board. Vickery: Federal Reserve Bank of Philadelphia. We thank Xu Lu, Ralf Meisenzahl, Christoph Memmel, Tim Schmidt, Philipp Schnabl, Skander Van den Heuvel, and seminar and conference participants at American University, Bank of England, Bank of Italy, Bayes Business School, Boston College, Bundesbank, Columbia University/BPI Bank Regulation Conference, ESSEC, European Central Bank, Federal Reserve ASSA Day-Ahead Conference (San Francisco), Federal Reserve Board, Goethe University/SAFE, Texas A&M University, Tilburg University, UCL, UNSW, University of Bonn, University of Cyprus, University of Sydney, University of Virginia, Wharton, and Wisconsin School of Business for helpful comments. We are also very grateful to Omar Ahmad and Shawn Kimble for outstanding research assistance. The opinions expressed in this paper are those of the authors and do not represent the opinions of the Federal Reserve Board, Federal Reserve Bank of Philadelphia, or the Federal Reserve System.

"By Mar. 31, 2022, Silicon Valley Bank already had about $7 billion in market value loss. If it sold any of its underwater securities to shorten the average maturity of its holdings and thereby to reduce its downside if rates continued to go up, it would have had to recognize that $7 billion loss. And if it recognized that loss, it would have lost almost half of its equity capital of $16 billion and would have been in danger of failing. Instead, it chose to roll the dice."

Litan, Lowy, and White, *Fortune Magazine*, April 14, 2023

1 Introduction

The bank failures of March 2023 have drawn new attention to the risks of bank securities portfolios. Investment securities make up a quarter of commercial bank assets and are sensitive to interest rates and other risks. On the other hand, the bonds in bank portfolios are typically highly liquid and can therefore play a key role in bank *management* of risk. For example, a bank seeking to reduce interest-rate risk can in principle do so quickly by selling long-term bonds or hedging risk using qualified interest rate hedges.

This paper uses bond-level data to study in practice how large US banks manage risk in their securities portfolios and how financial and regulatory frictions shape bank behavior. We focus on bank responses to the sharp increase in interest rates in 2022-23, which we show led to a sizeable shift in bank interest-rate risk with significant heterogeneity depending on the *ex ante* composition of the bank's portfolio—specifically the share of bonds with embedded prepayment options (e.g., mortgage-backed securities) that extended in maturity as rates went up.

While banks shortened the maturity of new bond purchases in response to the shifting environment, we find little evidence of active management on two key margins: banks with portfolios that became more exposed to interest-rate risk did not actively sell long-term bonds to rebalance their exposure, or expand qualified interest-rate hedging. Consequently, such banks experienced a much larger net increase in interest-rate risk as rates rose, and at the bank level, a larger decline in mark-to-market asset values. In the second part of the paper we investigate the drivers of this inertia, identifying financial and regulatory frictions related to the costs of realizing losses and the use of hedge accounting that can help explain why banks did not manage their portfolios more actively.

Our analysis makes use of detailed position-level data on bank investment securities holdings and qualified hedges from the FR Y-14Q collection, covering US banks with

$100bn or more in assets representing over three-quarters of aggregate bank assets and securities. We link the Y-14 data to security characteristics such as coupon, maturity, duration and convexity, measured using leading industry valuation models that account for the time-varying value of prepayment options for agency MBS and other "callable" bonds.[1] We develop a methodology to use the Y-14 data to infer bank trading activity at the bond level and present new stylized facts on bank trading behavior. We further supplement the Y-14 data with public bank regulatory data and 10-K disclosures regarding bank interest rate risk and asset values, among other sources.

First, we show that the interest-rate risk of bank portfolios is significantly time-varying due to holdings of fixed-rate bonds with embedded call features. Such assets make up about 60% of bond holdings for our Y-14 sample, and as yields rose in 2022-23, the effective maturity of these bonds increased because the option to prepay became significantly out of the money (e.g., mortgage refinancing fell to very low levels).[2]

As a result we observe a substantial increase in aggregate interest-rate risk in bank portfolios in 2022-23 (as measured by duration) as well as very significant cross-bank heterogeneity in the evolution of risk due to variation in banks' holdings of callable bonds.[3] Furthermore, these cross-bank differences were not offset by natural hedges elsewhere on bank balance sheets—we show that banks with large *ex ante* callable bond holdings experienced a significantly larger decline in the *total* market value of assets after interest rates rose. This heterogeneity and dependence on historical asset mix is difficult to reconcile with the simple view that banks just wanted to take on more risk (e.g., because they expected rates to soon mean-revert).[4]

[1] As shorthand we refer to bonds that can be redeemed or prepaid at par collectively as "callable" bonds. Strictly though, a callable bond is a security that can be redeemed by the *issuer* prior to maturity (e.g., municipal bonds or "munis" often have this feature), whereas for MBS the option instead rests with the underlying mortgage borrowers, who can typically prepay without penalty (e.g., if they decide to refinance).

[2] For an option-free fixed-rate bond, there is a convex (and inverse) relationship between the bond price and its yield, meaning that increases in yields have progressively smaller effects on price. This is not necessarily the case if the bond features a prepayment or call option, however, since an increase in yields reduces the value of the option, which the investor is short; in other words, such bonds exhibit "negative convexity" (see e.g., Fabozzi, 1988) for further details). Intuitively, in the case of agency MBS, it became unattractive for borrowers to refinance or sell their homes as interest rates rose in 2022-23 (Fonseca and Liu, 2024); this sharply reduced mortgage prepayment and increased the effective maturity of MBS held by investors.

[3] For example, at the 80th percentile of the distribution, bank-level net portfolio duration peaked at 5.9 in 2022:Q3 compared to 4.2 in 2021:Q4 and only 3.1 in 2020:Q4. But at the 20th percentile, duration barely increased in 2022, and by 2023:Q3, it was well *below* 2021:Q4 levels—2.5 compared to 2.9. We show that these divergent outcomes are tightly connected to the share of callable bonds in the bank's portfolio measured as of 2019:Q4.

[4] Two other facts also speak against this "greater risk appetite" hypothesis. First, banks did significantly

We then study bank responses to this shift in risk, finding that there was little active management on two key margins. First, banks did not sell long-duration bonds in significant quantities to rebalance risk; in fact, the volume of bond sales was unusually low in 2022-23 both on average and for a very high share of the banks in our sample. Consistent with a low willingness to actively sell bonds, we find that securities portfolio holdings adjusted less elastically to deposit outflows than deposit inflows during this period, at least at horizons up to a year. Second, banks did not significantly increase their use of qualified hedges to offset increased interest rate risk. Perhaps most notably, banks most exposed to rising interest-rate risk through their holdings of callable bonds did not sell or hedge risky bonds more actively than other institutions. However, banks did actively reduce the interest-rate exposure of *regulatory* capital and book equity by classifying the riskiest bonds as "held-to-maturity."[5]

In the second half of the paper, we study mechanisms underlying this lack of active bank portfolio risk management, identifying two types of frictions that discourage active management and can help explain the inertia in bank portfolios. First, we find that banks display a version of the "disposition effect"—they are unwilling to crystallize unrealized losses by selling "underwater" securities at a discount to book value. In a rising-rate environment, this behavior prevents banks from selling long-duration securities since these are exactly the bonds that will have experienced unrealized losses.

We identify these effects based on within-bank variation in which bonds were underwater at a point in time, finding that in 2022-23, banks were about 3.5 times more likely

shorten the duration of their Treasury portfolios in 2022-23 by shifting new purchases towards shorter-maturity securities as old bonds matured. Second, banks shifted the riskiest bonds into their HTM portfolios. As we discuss, changes in other parts of bank balance sheets likely reinforced the increase in duration we observe in bank securities portfolios, suggesting that banks would "naturally" want to take steps to reduce the duration of their bond book if targeting a particular duration gap. First, on the asset side, many loans (in particular whole residential mortgages) that banks hold also feature embedded call options and therefore likely saw the same duration extension as agency MBS. Such loans are generally much less liquid than securities, however, and selling them is thus costly, while waiting for them to mature (and then replacing them with lower-duration assets) is slow. Second, on the liability side, evidence reviewed below suggests that deposits (the main liability) shorten in duration as interest rates increase, which would further increase the mismatch between asset and liability duration. Consistent with these factors, section 4 shows that the economic value of bank equity became increasingly exposed to higher interest rates since 2021.

[5] As discussed in detail in Section 2, banks classify investment securities as "available-for-sale" (AFS) or "held-to-maturity" (HTM). AFS securities are marked-to-market on the balance sheet, but unrealized gains/losses do not flow through net income and, for most banks, regulatory capital. AFS securities are eligible for hedge accounting, allowing the bank to net out gains and losses on the derivatives position and underlying hedged security. HTM securities are not marked-to-market but instead recognized at amortized cost. Two "costs" of the HTM classification are that i) selling such bonds has significant accounting consequences, and ii) HTM bonds do not qualify for hedge accounting.

to sell a bond at par, and about 8.5 times more likely to sell a bond at premium, compared to a bond trading below book value. These estimates are robust to controlling finely for bond fundamentals or even bond-by-time fixed effects. The tendency to avoid selling underwater bonds is also evident prior to 2022-23, although in prior years bank trading behavior appears motivated by smoothing gains and losses from securities sales, rather than maximizing gains. Investigating potential mechanisms, we find that banks' aversion to realizing losses is partially driven by the design of capital regulation—it is about twice as strong for banks that do not recognize unrealized losses in regulatory capital. We also study whether the effect is due in part to banks catering to investors or depositors, using different proxies for stock market valuations and liquidity risk. We indeed find that the effect is amplified for banks with low price-to-book ratios, suggesting that banks may be concerned about the negative market signal associated with realizing losses.

The second source of frictions we study relates to the costs of hedging interest rate risk through "qualified" accounting hedges (such qualified hedges are preferred because they prevent unwanted volatility in banks' net income and regulatory capital). Even in our sample, which reflects the largest banks, about half are at a corner solution where they persistently do not use qualified hedges. Non-hedging is much more common among smaller banks, suggestive of fixed costs. A further constraint is that hedge accounting is not permitted for bonds classified as "held-to-maturity"; indeed, banks with larger HTM portfolios are less likely to hedge. Finally, hedging varies widely across securities with different complexity of hedging—e.g., in 2022-23, banks in aggregate hedged 49% of the duration in their available-for-sale Treasury portfolios but only 9% of MBS duration.

To sum up, while bank securities holdings are large and liquid, we find that active management of these portfolios played a surprisingly small role in bank interest rate risk management during the recent interest rate tightening cycle. We also uncover evidence of financial and regulatory frictions that limit active portfolio management and are likely to be particularly binding during rising-rate environments. While our results primarily reflect the behavior of the largest 30-35 banks, we conjecture that smaller banks may be even less active in dynamically managing risk (e.g., Purnanandam, 2007 shows that small banks are less likely to use derivatives). Given ongoing volatility in the interest rate environment, the constraints on active risk management we observe present potential financial stability concerns which could in principle be addressed through changes to financial regulations and accounting standards.

Related literature. Our paper contributes to several strands of the literature. First, we contribute to research on why banks hold securities, how they trade, and how securities portfolios affect the transmission of shocks to bank lending and the real economy. Hanson et al. (2015) propose that banks act as patient long-term investors taking advantage of stable deposit funding. Hanson and Stein (2015) argue that banks are yield-oriented investors that buy long-term securities when the yield curve is steep. Stulz et al. (2022) document that bank securities holdings have increased over time, finding that this growth is related to a lack of lending opportunities. Hanson et al. (2024) document similar trends, noting that especially large US banks increasingly look like long-term bond mutual funds financed by uninsured deposits. Kashyap and Stein (2000) find that bank security holdings insulate banks against liquidity shocks due to monetary policy. Drechsler et al. (2024) study the evolution of banks' (and the Fed's) aggregate MBS portfolios over 2020-24 and how this evolution affected mortgage rates and borrowing. Greenwald et al. (2024) study the transmission of interest rate shocks to lending through bank securities portfolios, also making use of Y-14Q data. Rosen and Zhong (2022) use Call Reports data to study how the securities portfolio reacts to funding shocks, finding like us that securities play a limited role in responding to deposit outflows.

More directly related to our use of granular security-level data, Abbassi et al. (2016) classify German banks in the period around the global financial crisis (GFC) into groups with higher vs. lower trading activity and expertise, and show that the former group of banks increases their securities holdings (especially of securities that had lost value) and reduces their lending during crisis times.[6] Peydró et al. (2023) use similar data from Italian banks to study how negative shocks to bank health during the GFC and the COVID-19 period affect banks' propensity to take risks in the securities they hold. Greenwald et al. (2024) use the US Y-14Q data like we do and study how market-to-market losses on securities during the recent interest rate hike period affect banks' lending to firms. They document larger effects of unrealized losses on lending for banks that include unrealized losses in regulatory capital.[7]

Next, we relate to work that has studied the role of regulation and accounting standards for bank behavior (see, e.g., Barth et al., 1995; Laux and Leuz, 2009). The "gains trading" we identify for banks during 2022-23 has been documented for insurance com-

[6] Abbassi et al. also study selling behavior, finding that banks that have more unrealized losses on investment securities sell less; this effect is stronger for banks with high borrowing from the central bank.

[7] Orame et al. (2024) use data from Italian banks to study how historical cost accounting vs. mark-to-market accounting affect the transmission of QE to bank lending.

panies that use historical cost accounting by Ellul et al. (2015).[8] Related work in the accounting literature has documented strategic trading behavior by banks in order to manage their reported earnings (e.g., Barth et al., 2017; Dong and Zhang, 2018; Aland and Burks, 2023). This literature mostly uses realized net gains/losses at the bank level, showing that this is related to earnings net of these gains and losses.[9] We are instead able to observe trading, and therefore gain or loss realization, at the security level, and can therefore quantify gain/loss selling within a bank at a point in time. Furthermore, our unique contribution is to illustrate that banks' unwillingness to realize losses leads to higher duration risk taking in a rising-rate environment, and to link this to different bank and portfolio characteristics.

A number of papers have studied how banks strategically choose to classify securities as AFS or HTM, and how this choice is affected by whether a bank is required to include unrealized securities losses in regulatory capital (Chircop and Novotny-Farkas, 2016; Fuster and Vickery, 2018; Kim et al., 2019, 2023; Hamilton, 2019) and to banks' financial fragility in the period we study (Granja et al., 2024).[10] Earlier work had studied how banks use accounting discretion when credit losses arise (e.g., Huizinga and Laeven, 2012; Bischof et al., 2021). Our finding of limited hedging by banks is in line with similar results (based on different data sources) by McPhail et al. (2023) and Granja et al. (2024).

Finally, our paper directly relates to recent literature discussing to what extent banks choose their assets (including securities) to match the effective duration of their liabilities, and how this affects monetary policy transmission and bank fragility (Drechsler et al., 2017, 2021, 2023; DeMarzo et al., 2024).[11] Evidence suggests that banks' "deposit betas" vary over the interest rate cycle, and in particular, that they increase as rates increase,

[8] Ellul et al. are able to compare insurance companies that are subject to mark-to-market accounting to others that use historical cost accounting, exploiting variation across insurer types and US states.

[9] Aland and Burks (2023) use data from banks' 10-K and 10-Q disclosures that separately report gross unrealized and realized gains and losses, rather than just the net values in regulatory reports (Y9-C/Call Reports) like earlier work. They find that banks use strategic selling to boost low earnings, while there is no evidence of loss selling to curtail high earnings in order to smooth earnings over time. They also find that banks are generally more willing to liquidate gains than losses, in line with our findings.

[10] A growing literature is studying other aspects of the 2023 US banking turmoil. Jiang et al. (2023) study banks' unrealized losses and their exposure to uninsured deposits. Dursun-de Neef et al. (2023) focus on uninsured deposit withdrawals as a function of unrealized HTM losses. Flannery and Sorescu (2023) estimate the effects of mark-to-market losses on banks' capital positions. Choi et al. (2023) study which bank characteristics were associated with bank stock returns following the SVB failure. Cipriani et al. (2024) use interbank payments to identify which banks suffered a run, and discuss how these banks responded; consistent with our results, they find that affected banks borrowed more, rather than selling securities.

[11] Also related is work studying how bank equity valuations and lending heterogeneously respond to interest rate changes (e.g., English et al., 2018; Gomez et al., 2021).

meaning the effective duration of liabilities falls (Emin et al., 2024; Greenwald et al., 2023; Kang-Landsberg et al., 2023). This means that banks should shorten the duration of assets as rates increase in order to remain hedged. We show that, during the recent rate increase period, they did not do so (neither by selling long-duration securities nor by hedging them) and discuss the frictions that may explain this.

2 Institutional setting and data

Securities held for long-term investment are an important part of bank balance sheets, making up 26% of commercial bank assets at the start of the 2022-23 interest rate tightening cycle.[12] These portfolios primarily consist of agency MBS and US treasury and agency debt, with smaller shares of other fixed income instruments such as municipal bonds and corporate bonds, and a small volume of equities.

Accounting. For accounting purposes, investment securities are classified either as "held-to-maturity" (HTM) or "available-for-sale" (AFS). HTM consists of debt securities that the bank has the positive intent and ability to hold until maturity, while AFS reflects bonds that the bank may expect to sell in the intermediate term. The distinction between AFS and HTM is important for understanding how realized and unrealized losses affect bank earnings, financial ratios and regulatory capital. These differences are summarized in Table 1. For our purposes, we highlight several key points:

1. The accounting treatment of HTM securities is similar to a balance sheet loan. The investment is recorded at amortized cost rather than market value, and unrealized gains and losses do not affect net income, assets, book equity or regulatory capital. (Amortized cost is a security's adjusted carrying value, reflecting the gradual write-down over its life of any premium or discount at purchase. The market value, or fair value, is the current trading price of the security. Finally, the face value is the security's principal amount to be repaid at maturity.)

[12] Banks also hold securities for short-term trading and market-making, primarily held in investment banking subsidiaries of bank holding companies (BHCs). These trading portfolios are small or nonexistent for most banks, but are very material for large dealer banks. From an accounting perspective, trading assets that are bought and held principally for the purpose of selling in the near term are marked-to-market with gains and losses reflected in net income and retained earnings as they occur. This accounting treatment removes many of the disincentives to actively manage risk that we document for banks' investment securities portfolios.

2. Accounting rules discourage banks from selling or reclassifying HTM bonds. Doing so typically causes the entire HTM portfolio to become "tainted", meaning that the HTM classification can no longer be used. (For an exception, see Kim et al., 2023.)

3. AFS securities are held at *market value*, not amortized cost. But unrealized losses still do not flow through net income. Instead, the difference between market value and amortized cost is reflected in a component of equity called "accumulated other comprehensive income" (AOCI).

4. Most banks do not include unrealized AFS losses in regulatory capital because they have adopted a regulatory treatment known as the "AOCI filter." Exceptions include the largest banks, which are not permitted to use the filter, and some smaller banks that have voluntarily elected not to use it.[13] For these banks, regulatory capital is effectively "marked to market" as securities values fluctuate.

The bottom line is that *realizing* unrealized securities losses by selling underwater bonds will typically have significant financial implications for the bank. For HTM securities, there will be a drop in equity capital, net income, and regulatory capital at the time of the sale, as well as accounting (and possibly regulatory) implications of tainting. For AFS securities, the bank will experience a drop in net income, and for most banks also a decline in regulatory capital.

Hedging. Banks make active use of swaps and other derivatives to hedge the exposure of their securities portfolio. This is typically done through the use of *qualified* accounting hedges. The key feature of a qualified hedge is that the bank effectively "nets out" offsetting gains and losses on the hedge and the underlying hedged asset.[14] This is important because otherwise even a perfect hedge would generate volatility in net income, because gains (losses) on the derivative would be recorded in net income while the offsetting losses (gains) on the underlying security would not.

Banks face various constraints in their use of qualified hedge accounting (PricewaterhouseCoopers, 2024). First, to qualify, the hedge position must meet several criteria (e.g., it must be highly effective at offsetting the specified risk during the period the hedge is

[13]The set of banks not permitted to use the AOCI filter has changed over time, but during the period of our study, it includes banks with at least $700bn in total assets or significant cross-border exposures.

[14]Specifically, the gain or loss on *both* the hedging instrument and the hedged asset are recognized in earnings. To the extent the hedge is effective, the two will cancel, leaving earnings unchanged on net. The carrying value of the hedged asset is also adjusted for these gains and losses as they occur. See PricewaterhouseCoopers (2024) for details.

designated). The bank must document its claim that the position qualifies. Second, qualified hedging of assets with embedded prepayment options (e.g., MBS) is more complex since the asset may not exist for the duration the hedge.[15] Finally, banks cannot obtain qualified hedges for interest rate risk on HTM securities. We analyze bank hedging decisions and these constraints in detail in Section 6.

2.1 Data

Our analysis is based on security-level data on the investment security holdings of large US banking organizations with at least $100bn in total assets, reported at a quarterly frequency in FR Y-14Q schedule B.1 regulatory filings, encompassing securities held in banks' AFS and HTM portfolios.[16] Y-14Q filers held 77% of total assets and 78% of securities of all US commercial banks as of 2021:Q4. The number of banks that file the Y-14Q fluctuates between 30 and 35 over our sample period. In 2023:Q4, the last quarter in our sample, there are 34 banks, of which 11 include AOCI in capital. These tend to be the largest banks, and they hold 65% of the securities (weighted by market value) in that quarter.

Y-14Q securities data include information on the amortized cost, market value and face value of each position, the purchase date, the accounting classification (AFS or HTM), and security type (e.g., agency MBS, US Treasuries,[17] corporate bonds).

There can be multiple reported transactions of the same security for a bank in a given quarter because banks report individual security positions based on the date of the purchase. Indeed, for roughly 15% of the CUSIP-bank-quarter observations in the raw data, more than one position is reported. For our analysis, however, we collapse the original data at the CUSIP-bank-quarter level. Next, we merge each security position with security characteristics drawn from International Data Corporation (IDC) and Morgan

[15] Recent changes do, however, allow banks to employ "last-of-layer" hedges to a portion of their exposure.

[16] FR Y-14Q filers include US bank holding companies (BHCs) as well as US intermediate holding companies of foreign banking organizations, and covered savings and loan holding companies. As a shorthand, we refer to our sample as "banks." In practice, all BHC investment securities are held in commercial banking subsidiaries, while trading securities (not reflected in the FR Y-14Q schedule B.1) are held by investment banking subsidiaries. For the full list of variables, see https://www.federalreserve.gov/apps/reportingforms/Report/Index/FR_Y-14Q.

[17] The reported category in the Y-14Q data is "US Treasuries & Agencies," meaning that agency bonds are also included. About 95% of the bonds in the sample period in this category are Treasury bills and bonds. For the rest of the paper, we will for simplicity use "Treasuries" to refer to the combined category.

Stanley Capital International (MSCI), including maturity, coupon type (fixed or floating), coupon rate, effective duration, and credit rating. The data also report whether the bond is callable. While we cannot match every security in our FR Y-14Q data, the share of unmatched securities has declined to less than 5% in recent years.[18]

We also merge the security-level data with FR Y-14Q schedule B.2, which reports information on qualified accounting hedges. These data include information on the fraction of the position hedged, the type of hedged risk (e.g., interest rate, exchange rate, credit risk), the type of hedge (e.g., fair value vs. cash flow), hedge interest rate (for hedges of interest rate risk, indicates the benchmark interest rates) and hedge horizon (if the hedge is a fair value hedge, reports the remaining life of the derivative instrument or an applicable shorter period). For the purposes of our study, we use fair value interest rate risk hedges that account for almost 85% of all hedges.

Finally, we also merge the data with aggregate bank-level information such as total assets drawn from Call Report and FR Y-9C regulatory filings. We also conduct some analysis directly at the bank level using these public filings, as discussed below.

2.1.1 Summary statistics

Figure 1 shows the total amount of securities (and the composition of the total in percent) held by banks in our sample over the period 2015 to 2023. The total amount increased slowly over 2015 to 2018, but then almost doubled between 2019:Q1 and 2022:Q1 when it peaked around USD 4.65 trillion. Throughout this period, more than half of securities were held in the form of agency MBS, and another 20-35% in US Treasuries, with that share increasing over time.

Table 2 summarizes information from the security-level data, focusing on the period 2020 to 2023.[19] Panel A shows all the security categories present in the data, sorted by their share of total amortized cost. As already noted above, agency MBS and Treasuries account for about 88% of holdings; the third-largest category is municipal bonds at 3.2%.

Panel B shows various summary statistics for each of the main security categories. Among other things, it shows that all agency MBS, but also more than half of municipal

[18] The unmatched observations are concentrated in a small number of banks. In terms of the distribution of missing observations across different security types, the categories most subject to missing maturity and/or duration information are corporate bonds/CLOs, municipal bonds and "other."

[19] Appendix Table A.1 provides the same statistics for the entire period from 2015 to 2023.

bonds and corporate bonds/CLO, are callable, such that the remaining maturity is often much larger than the effective duration.[20] This implies that if one uses just the contractual maturity to proxy for duration risk, the resulting measurement error can be large and time-varying (see Figure A.2 for the time series of weighted-average duration and remaining maturity). About 55% of securities are held as AFS, with this share being below half only for MBS. The share of hedged securities also differ substantially across security types; they are highest for US Treasuries at 26% and lowest for MBS at 3%. We return to the question of why agency MBS holdings are typically unhedged in Section 6. Finally, the bottom row shows that the quarterly sales hazard over this period averages 1.5% but is more than twice as high for corporate bonds/CLOs and municipal bonds. We next describe how this sales hazard is measured.

2.1.2 Measuring trading

Bank securities purchases are simple to measure because the date and time of each purchase is reported directly in the Y-14 data. Identifying sales is less straightforward, however. Our basic approach is as follows:

1. We identify all instances where a bank-CUSIP pair exists in quarter t but does not exist in $t + 1$.[21]

2. Based on the security characteristics, if in $t + 1$ the security matures, is paid down early (i.e., is called) or is involved in an MBS exchange, we reset the sale indicator to zero.[22]

3. If the bank is not a Y-14 filer in quarter $t + 1$ (e.g., because they drop, are acquired or it is the most recent period), we reset the sale indicator to missing.

[20] Figure A.1 shows that the duration measures produced by different models by IDC and MSCI are very similar.

[21] This initial step means that we restrict ourselves to examining "complete" sales where the entire holding of the security is sold, rather than just a part of it. In the next version of the paper, we will incorporate partial sales; our current results indicated that doing so somewhat increases the total volume of bank securities trading but does not change the qualitative results of our study. (Partial sales are more complex to measure, in particular for agency MBS, as the principal balance of these bonds declines gradually over time even if the bank does not sell, due to scheduled and unscheduled paydowns.)

[22] If the maturity is missing and we cannot attribute the disappearance of the position to a pay down or exchange, we reset the sale indicator to missing.

4. If the bank-CUSIP pair exists in time t, disappears in $t+1$, but reappears at a future $t+n$, we treat the disappearance as a sale only if the above conditions are not met and the $t+n$ purchase date differs from the original purchase date (since this would suggest an actual sale followed by a later purchase of the same bond).

As a cross-validation exercise, we use the sale indicators constructed via the above steps to calculate an estimate of total *realized* gains and losses on securities sales (using the unrealized gain or loss at the end of the quarter prior to sale as a proxy for the realized gain or loss, since we cannot directly observe the latter). We then compare this estimate at the bank-quarter level to realized gains and losses reported in Call Reports. Although our measure of realized gains/losses based on the sales indicator is imperfect (e.g., because we do not include partial sales and do not know the exact timing of the sale within the quarter), it is nonetheless matching the realized gains or losses as reported in Call Reports pretty closely on average (see Figure A.3).

Our estimates of sale volume indicate that while banks are primarily buy-and-hold securities investors (in line with Hanson et al., 2015), they sell on average 1-5% of their portfolios each quarter. The volume of sales fluctuates significantly over time, and was unusually low in 2022-23, as we discuss in more detail in the following sections.

3 The rising rate environment of 2022-2023

Figure 2 summarizes some of the relevant developments over the course of 2022-23. First, panel A shows that the Federal Reserve started raising interest rates in March 2022 after rates had been at zero during the pandemic period. The fed funds rate then gradually increased until reaching the 5.25-5.5% range in July 2023. Longer-maturity yields similarly rose strongly over the period January to October 2022, although they had started increasing slightly already over the second half of 2021 (anticipating the Fed's rate hikes).

As market rates increased over the course of 2022, the (mostly) fixed-rate securities in banks' investment portfolios rapidly lost value, as illustrated in panel B of the figure. By 2022:Q3, the total unrealized losses of US banks amounted to about \$675bn; slightly more than half of these losses were in HTM securities.[23]

[23] Panel A of Appendix Figure A.4 shows that Y-14 filers had about \$500bn in unrealized losses, with a disproportionate share of those losses occurring in the HTM portfolio relative.

Panel C of the figure shows the security-level distribution of fair value over amortized cost ("FV/AC")—i.e., the current price of a security relative to the price at which it was purchased, adjusted for amortization of premium/discount at which it was purchased relative to par—for the banks in our sample. Securities with FV/AC>1 have increased in value relative to their amortized-cost accounting value, while those with FV/AC<1 have lost value—they are "underwater." The figure shows that in mid-2021, most securities were quite close to par; about half the securities had increased in value and just under half had decreased in value, but typically by less than 5%. The distribution looks dramatically different one year later, in mid-2022, after market rates had already increased substantially: almost all securities are underwater, and about one-third (value-weighted) by more than 10%. Only few securities still had FV/AC≥1; for the most part, these were floating-rate securities, hedged securities, or ones with negative duration (e.g., interest-only strips of MBS). In mid-2023, the distribution had shifted even further to the left.

Finally, deposit flows started reversing over the course of 2022-23: after very strong deposit growth at many banks over the course of the pandemic, the median bank in the US experienced year-on-year decreases in deposits from mid-2023 onward. This was similar for Y-14 filers and more pronounced when looking at uninsured deposits only (see Appendix Figure A.4).

Deposit outflows put pressure on banks to either increase the interest they pay on deposits or replace the deposits with wholesale funding—both of which are costly options. Alternatively, they could shorten their balance sheet, and selling (AFS) securities would be one of the most immediate ways of doing so. The need to act in this situation was amplified by the fact that deposit betas typically increase over the course of a rate hiking cycle (Emin et al., 2024; Greenwald et al., 2023; Kang-Landsberg et al., 2023), meaning the effective duration of liabilities shortens and the duration of callable assets such as mortgages and MBS increases (as shown below). This means that the durations of bank assets and liabilities can become increasingly mismatched as rates increase, unless the bank dynamically adjusts its balance sheet or hedges the risks using derivatives.

Finally, interest rate volatility implied by option markets also substantially increased in 2022 (Sarisoy, 2023), meaning that large rate movements were thought to be likely. The realization of a further rate increase in case a bank's asset duration exceeds its liabilities duration would have large negative effects on its economic net worth.

To summarize, banks faced a significant shift in their exposure to interest rate risk in 2022-23, due to a combination of lower deposit duration, an increase in the duration of callable assets, and a spike in interest rate volatility. Some banks also experienced significant deposit outflows.

4 Bank responses to rising rates

Given its size, liquidity, and risk profile, the securities portfolio is perhaps the most natural margin for a bank to manage its exposure to interest rate risk in response to the changing environment in 2022-23. In this section, we establish eight facts about banks' responses and what happened to the risk exposure of their securities portfolios and their balance sheet overall. For the initial five facts, we focus on the large banks for which we observe Y-14 CUSIP-level data; for the remaining three facts, we broaden the sample of banks we study and incorporate additional data sources.

Fact 1: Interest rate risk in securities portfolios increased, driven by callable bonds. Panel A of Figure 3 plots the overall weighted average duration of bank securities portfolios. Notably, rather than banks reducing interest rate risk in response to rising deposit betas (as discussed above), we observe a significant *increase* in duration, from about 3 years in 2020 to a peak of over 5 years by late 2022.[24] Duration in 2022-23 is significantly higher than in any prior year (starting in 2015).[25]

Panel B of Figure 3 shows that this rise in risk is explained by a sharp increase in duration for *callable* bonds, predominantly agency MBS. Duration for callable bonds naturally increases when rates rise because the option to call the debt becomes further out of the money. For example, mortgage prepayment was very high in 2020-21 but fell to extremely low levels in 2022-23, extending the effective maturity of agency MBS.

In contrast, duration for noncallable bonds (e.g., US Treasuries) increased in 2020-21, but then started declining, and by late 2023 had returned to levels similar to 2015-20 (of around 3-3.5). Appendix Figure A.5 shows that, especially in 2021, banks shifted their Treasury purchases to longer maturities, but then started to reverse course and concentrated their purchases increasingly in T-bills with a maturity below one year.

[24] A significant share of this increase occurs in 2021, as rates start creeping up and bank MBS portfolios are replaced by lower coupon bonds due to high refinancing. But duration jumps up further in 2022 as the Federal Reserve begins to tighten monetary policy.

[25] The same remains true if we extend the time series back to 2012 for those banks that already started reporting then — see Figure A.2. That figure also shows that the weighted-average remaining maturity of securities evolved very differently over time to the weighted-average duration.

Fact 2: Banks did not offset rising duration by hedging. Panel C of Figure 3 compares the gross duration of bank portfolios to duration net of qualified interest rate hedges. We measure these hedges using the Y-14Q schedule B.2, which reports hedged positions, the instrument used, the risk hedged and hedge percentage.

While hedging does reduce the duration of bank portfolios (by about half a year), the figure shows that the amount of duration absorbed by hedging did not substantially increase from 2020 to 2023.[26] As a result, the increase in interest rate risk on bank portfolios is similar whether measured on a gross basis or net of hedging. Either way, the interest rate risk of bank securities portfolios was higher in 2022-23 than anytime earlier in the sample period.

Fact 3: Banks did not offset rising risk by selling risky bonds. A natural margin to reduce interest rate risk would be for banks to sell long-duration bonds and replace them with cash or short-term securities such as T-bills. In Figure 4, we investigate this margin by plotting the intensity of bank sales and purchases of securities over time (using the methodology described in Section 2.1.2 to identify trades).

Purchases always significantly exceed sales. This is because bank portfolios were generally growing over the sample period (especially in 2020-21) and due to replacement of bonds as they matured. Purchases dropped dramatically in 2022-23, however, due to slower balance sheet growth and deposit outflows. For a subset of the banks in our sample, purchases of securities fell essentially to zero (see Appendix Figure A.7 for the evolution of the distribution of purchases across banks).

Banks did not, however, step up outright sales of securities to raise cash or rebalance their portfolios towards shorter-duration assets. In fact, sales were significantly *lower* in 2022-23 than at any earlier time in the sample period. This drop in trading was broadly based across security types as shown in panel B of Figure 4. The decrease in sales propensities was also shared across most banks in our sample (see Appendix Figure A.7 for the distribution). We furthermore note that sales were particularly low in the second half of 2022, before the banking turmoil of 2023:Q1. This also means that the policy response, notably the Bank Term Funding Program (BTFP; see Glancy et al., 2024) was not the cause

[26] Appendix Figure A.6 shows directly how the aggregate portfolio share that is hedged evolved over time. While the share of the AFS portfolio that is hedged increased, this is offset by increased classification of securities as HTM (as further discussed below) such that the overall share hedged only increased by about 2 percentage points from 2019 to 2023.

of the low overall sales propensity over this period.[27]

Fact 4: Banks classified more bonds as HTM. While there is little evidence that banks took significant steps to dampen the exposure of their portfolios to interest rate risk by selling or hedging, they did increasingly insulate *regulatory* capital from changes in security values by classifying a larger share of bonds as HTM rather than AFS. This trend, which has also been highlighted by Kim et al. (2023), Granja et al. (2024) and Greenwald et al. (2024), is shown in Figure 5. The figure further shows that the aggregate share of securities classified as HTM is significantly higher for banks that include AOCI in regulatory capital, consistent with a desire to reduce the volatility of regulatory capital. Such banks also steadily increased the HTM share well before the rate hike period, whereas for the remainder of our sample, the HTM share rises quite rapidly only over 2022.[28]

Figure 6 plots the evolution of portfolio duration separately for AFS and HTM portfolios. The figure illustrates that the rise in duration documented earlier is much more pronounced for securities classified as HTM; for the AFS portfolio, duration also increased relative to the pandemic period, but did not exceed earlier peaks. Thus, banks used the classification margin to isolate their regulatory capital from interest rate risk and make unrealized losses less salient to investors. In Section 7, we shed further light on what determined banks' classification decision over this period.

Fact 5: Bank risk is highly related to ex ante asset mix. The facts presented above indicate that banks engaged in relatively little active management of the securities portfolio in 2022-23. This in turn suggests that the change in portfolio risk experienced by the bank would be related to the types of bonds held ex ante — in particular, whether banks held a large concentration of callable bonds whose duration increased significantly. This is relevant because portfolio composition varies significantly across banks (e.g., agency MBS made up about 3/4 of Silicon Valley Bank's securities portfolio at the time of its failure).

We examine this issue by aggregating the securities-level data on interest rate risk to the bank-quarter level. First, Figure 7 shows that the heterogeneity of portfolio duration increased substantially after interest rates started increasing. For both gross duration and net duration after hedges, the gap between the 20th percentile bank and the 80th

[27] In Section 5.1, we show that the cross-sectional patterns are also not driven by what happened in 2023.

[28] The drop between 2019:Q4 and 2021:Q4 reflects that four banks changed status as part of the 2019 "tailoring rules" and were allowed to move their HTM portfolios into AFS; see Kim et al. (2023) for extensive discussion.

percentile bank was less than 1 in 2020, only slightly higher in 2021, but above 2 in 2022 and 2023. Thus, the interest rate risk that the different banks in our sample held in their securities portfolio "fanned out" over the rate hike period.

Next, we estimate regressions to test which bank or portfolio characteristics were associated with a larger increase in portfolio duration as interest rates started to rise (by interacting these characteristics with a "post-2022" dummy). Results are reported in Table 3. The table's key finding is that banks with larger ex ante holdings of callable assets (predominantly agency MBS) experienced a much larger increase in interest rate risk as the rate cycle turned. Quantitatively, in column 4, a bank holding entirely callable bonds would experience an increase in duration of 1.39 in 2022-23 relative to a bank holding no such bonds. Strikingly, the effect net of interest rate hedging is if anything *larger* (the point estimate rises to 1.67 in column 8). This means that we find no evidence of dynamic hedging behavior that would be required to manage the interest rate risk of an MBS portfolio during a rising-rate episode like 2022-23, when MBS duration extends.

Turning to the remainder of the table, we also find some evidence that banks that include AOCI in regulatory capital experienced a smaller increase in risk. This effect is significant only in the bivariate specifications, however, not in the multivariate models.

The results so far indicate that the interest rate risk exposure of bank portfolios increased significantly in 2022, especially for banks holding high concentrations of callable bonds such as agency MBS. However, since we have so far considered securities portfolios in isolation, it is difficult to know whether banks' *overall* risk exposure changed in the same way. It is possible, for instance, that other parts of the balance sheet (e.g., the loan book or the composition of deposits) provide a "natural hedge" for the banks most exposed to the increase in risk in their securities portfolio. Our next two facts show that the data indicate otherwise. Then, our final fact shows that in the cross section of banks, bank portfolios responded asymmetrically to deposit inflows vs. outflows.

Fact 6: Banks' realized exposure to interest rate risk was not offset by natural hedges. We first study whether banks' fair-value losses on securities and especially MBS, which experienced larger fair-value losses during the rate hike period, were offset by more limited losses elsewhere due to lower exposure to interest rate risk embedded in their remaining assets. To do so, we use data on fair-value adjustments reported by publicly traded banks in their 10Q/10K quarterly disclosures.[29] For each bank, we construct quarterly mark-to-market (MtM) equity ratios based on the fair value of assets (consisting of the book value adjusted for fair-value changes in the value of securities and net loans held at amortized cost).[30] We then test in the cross-section of banks whether banks with a higher ratio of securities over assets, and higher MBS over assets, see a larger decrease in their MtM equity ratios in 2022-23 relative to the two years before. If that is the case, it implies that banks' high and rising interest rate risk exposure from securities was not offset by lower exposure of other assets.

Results are reported in Table 4. In the first column, we simply regress banks' MtM equity ratio on a dummy equal to one from 2022:Q1 onward; the negative coefficient indicates that the fair value adjustments on average reduced equity by about 3.35 percentage points over this period, relative to a sample average of 10%.

The next two columns show that these adjustments were significantly larger for banks with a higher share of securities and especially MBS as a fraction of total assets. In particular, columns (3) and (4), where the latter is estimated with quarter fixed effects so the uninteracted post-2022 dummy is no longer identified, indicate that once we control for MBS over assets, the coefficient on securities over assets is no longer significant—suggesting that MBS holdings are a key determinant of banks' realized exposure to the interest rate increases—reflecting the negative convexity of these bonds—and that the exposure via MBS is not offset by a reduced exposure in loans.

A limitation of these MtM equity ratios is that only assets are adjusted for fair-value changes, while liabilities remain at their book value. However, it is possible that banks that experienced larger losses on the asset side (due to holding longer-duration assets) simultaneously experienced larger gains on the value of their deposit franchise. This could be the case, for instance, if the bank has particularly low-beta depositors (such that the deposits effectively have long duration). To control for this possibility, we add either the deposit beta (as estimated by Drechsler et al., 2021) or quarterly deposit expenses to the regression. As shown in columns (5) and (6), these additional regressors barely affect our coefficients of interest.[31]

[29] These data (collected by S&P Global, formerly SNL) are available for 172 to 183 banks over our sample period. Among those, between 50 and 62 (depending on the quarter) are among the top-100 banks by assets in the US.

[30] This is similar to Jiang et al. (2023), although our estimates are based directly on banks' own estimates of the fair market value of their assets, rather than estimating these fair values based on asset composition and aggregate price indices.

[31] The positive coefficient on the interaction of post-2022 with deposit beta indicates that banks with higher

Fact 7: Banks' overall exposure to interest rate risk increased in 2022-23. While the previous fact indicates that banks with larger securities holdings and especially a larger share of callable bonds experienced larger overall mark-to-market losses on their balance sheet, it is possible that banks tried to adjust other aspects of their balance sheet to reduce the *forward-looking* exposure to further interest rate increases. For instance, a bank could replace short-term money market funding by longer-term bond funding. While we do not have the granular information on the entire balance sheet available to construct our own risk exposure measure, we can rely on supervisory information collected by the Office of the Comptroller of the Currency (OCC).

The OCC collects data on the projected sensitivity of individual banks' "economic value of equity" (EVE, given by the fair value of assets minus the fair value of liabilities) to assumed interest rate shocks of different sizes.[32] The OCC then semi-annually discloses the aggregate distribution of these sensitivities across different bank size classes. We focus on the largest size class that is reported, banks with more than $10bn in assets; however, the OCC does not include "large banks" (typically those with more than $100bn in assets) in the calculation, meaning that the banks we focus on in our securities-level analysis are not in this sample. Another caveat is that the metrics reported by the OCC are not necessarily "point-in-time"; instead, they always include the most recent observation available from a given bank. That observation may be up to seven quarters old, but the OCC states that most observations are from the previous calendar year.[33] We thus use the data reported in spring of year t as indication of EVE sensitivities in year $t-1$.

Figure 8 displays how the distribution of reported EVE sensitivities has evolved over 2020 to 2023. We focus on the scenario of a 300 bp parallel increase in interest rates, although the evolution is qualitatively similar for 100 bp or 200 bp rate increases. The figure shows that banks were substantially more exposed to the risk of further rate increases in 2022 and 2023 than they were in 2020 and 2021, in line with the duration risk increase we documented for securities portfolios. For instance, the median bank with assets above $10bn was projected to see its EVE *increase* in 2020 and 2021 if the yield curve were to shift up; in contrast, in 2022 and 2023, that median bank is projected to experience almost

deposit betas experienced smaller fair-value losses on their assets. This is consistent with these banks holding shorter-duration assets to match their less "sticky" deposits, consistent with the arguments of Drechsler et al. (2021).

[32] The assumption is that the entire yield curve shifts by a constant amount, typically between -200 bp and +400 bp. The reported sensitivities are based on banks' internal interest rate risk models.

[33] For example, the OCC's Spring 2024 report states that "Seventy-five percent of the observations have an as-of date between December 31, 2022, and December 31, 2023."

a 10% *decrease* in EVE. Differences are similarly pronounced across all reported points in the distribution.

This evidence is consistent with stock price reactions around FOMC dates: Emin et al. (2024) show that during periods of low rates, bank stocks tend to respond positively to interest rate hikes, but when rates are already high, the opposite is the case.

Fact 8: Bank portfolios responded asymmetrically to deposit inflows vs. outflows. Finally, we consider the response of bank securities portfolios to *liquidity* shocks. Many banks experienced significant deposit outflows in 2022-23, particularly large regional banks and those with a high reliance on uninsured deposits. Given the illiquidity of loan portfolios, selling securities seems a natural response to deposit outflows, both to raise cash to and rebalance asset risk.[34] But if banks are averse to selling bonds at a discount to book value, such adjustment would be limited, and in particular, we may expect to observe an *asymmetric* response in which the securities portfolio adjusts more to deposit inflows than outflows.

Since we measure deposit flows only at the bank level, we test for the presence of such asymmetric effects using quarterly Call Reports data, estimating regressions of the form:

$$\Delta ln(securities_{b,t}) = \sum_{i=0}^{3} \alpha_i \Delta ln(dep_{b,t-i})^{+} + \sum_{i=0}^{3} \beta_i \Delta ln(dep_{b,t-i})^{-} + \gamma_b + \kappa_t + \varepsilon_{b,t}, \quad (1)$$

where $securities_{b,t}$ is the total amortized cost of the investment securities portfolio for bank b in quarter t (because we want to strip out changes in portfolio size driven by market value fluctuations), $dep_{b,t}$ is total deposits, with the + and – modifiers indicating positive and negative deposit growth respectively, and γ_b and κ_t are bank and time fixed effects included in some specifications. We use log changes on both sides of the estimation equation, so that the estimated coefficients can be interpreted as the elasticity of securities portfolio growth to deposit growth.

Estimates are reported in Table 5. The first four columns focus on the 2022-23 period, varying whether we weight observations by bank assets (with weights summing to one within each quarter) and whether we include bank fixed effects in addition to time fixed

[34] The immediate effect of deposit withdrawals is to reduce the bank's holdings of cash and reserves. This means that the composition of the bank's balance sheet becomes more skewed towards risky assets (i.e., the bank has become smaller, but the size of the bank's loan and securities portfolios have not changed). In this sense, we might expect banks to sell securities to re-attain the prior balance of cash and risky assets.

effects. In each specification, the contemporaneous response of the securities portfolio to positive deposit growth is indeed significantly larger than the response to negative growth.[35] This is particularly true when we weight by bank assets (columns 2 and 4)—in these two specifications, the short-run elasticity of securities growth to deposit growth is about 0.55, but the elasticity with respect to negative growth is close to zero.[36] The table also reports the long-run difference in sensitivity by summing the coefficients across all lags for positive versus negative deposit growth (i.e., $\sum_{i=0}^{3} \hat{\alpha}_i - \sum_{i=0}^{3} \hat{\beta}_i$). These long-run differences are similar to the contemporaneous difference, suggesting the asymmetry persists at least for several quarters.

Columns 5-8 repeat the analysis over a longer sample period from 1994-2023. We also find evidence of an asymmetric response of the securities portfolio over this longer time period, although the effect is smaller and less persistent—e.g., in columns 5, 6 and 7, we find no evidence of an economically significant long-run asymmetry; we do find an asymmetry in column 8, although the point estimate is about half as large as the same specification estimated over the 2022-23 period (0.277 compared to 0.519).

With the caveat that we do not isolate exogenous variation in bank deposit growth, our estimates are consistent with the presence of "downward rigidity" in the response of the securities portfolio to deposit outflows, particularly in 2022-23 when portfolios were typically underwater.[37,38] Silicon Valley Bank (SVB) itself is an interesting case study of such rigidity. As shown in Appendix Figure A.10, SVB rapidly acquired investment securities as deposits flowed into the bank in 2020-21; but as deposit inflows turned into outflows in 2022, there was no corresponding reduction in the size of the securities book. Instead, SVB funded deposit outflows by borrowing in the wholesale market from the Federal Home Loan Banks. SVB only liquidated bonds as a last resort in March 2023, an

[35] The difference between the two (i.e., $\hat{\alpha}_0 - \hat{\beta}_0$ in the notation of equation 1) is reported in the row "Diff: pos-neg"; the following row reports p-values from a hypothesis test that the positive and negative coefficients are equal. Similarly, the row "LR Diff: pos-neg" reports the long-run asymmetry measured as $\sum_{i=0}^{3} \hat{\alpha}_i - \sum_{i=0}^{3} \hat{\beta}_i$, with corresponding p-values reported in the subsequent row.

[36] Appendix Figure A.8 provides a binned scatter plot illustrating the relationship between securities growth and deposit growth, and shows that the relationship is flatter below zero than above zero.

[37] Rosen and Zhong (2022) also find evidence of limited adjustment of the securities portfolio over 2001-2019, focusing on a sample of 36 large BHCs.

[38] We emphasize that a bank can reduce the size of its portfolio over time even without outright sales. Indeed, in aggregate, the size of bank portfolios did decrease over 2022-23 along with banks' total deposits (cf. Drechsler et al., 2024), reflecting the fact that paydowns plus the sales that did occur outpaced purchases. However, the decrease in 2024 looks substantially more pronounced in terms of market values than in terms of amortized cost or face value, especially for agency MBS—see Appendix Figure A.9.

event that triggered the failure of the firm a few days later.[39]

4.1 Summary

To sum up this set of facts, we find surprisingly little active management of interest rate risk in bank securities portfolios in 2022-23, either through increased hedging or sales of the most interest-sensitive bonds. As a result, the economic exposure of bank portfolios to interest rate risk increased significantly, particularly for bank portfolios with high concentrations of callable assets such as agency MBS.

5 Strategic trading

The previous section showed that banks became less likely to sell securities after the sharp increase in rates in early 2022, even as purchases of bonds declined sharply. This suggests that banks may be reluctant to sell underwater bonds. In this section, we shed light on this issue more directly by studying security sales at the bond level. We further investigate whether there are systematic differences in trading activity across banks as a function of the regulatory treatment of unrealized losses or other bank characteristics.

5.1 Strategic trading in 2022-23

We test whether banks are reluctant to sell underwater securities by running regressions of the form:

$$P(sale_{cbt}) = f(fair\ value/amort.\ cost)_{cbt} + \delta_b + \kappa_t + \Gamma X_{ct} + \varepsilon_{cbt}, \quad (2)$$

where c indicates a security (CUSIP), b indicates a bank, and t indicates a quarter. The function $f(.)$ applied to a security's ratio of fair (market) value to the amortized cost at which it is carried (abbreviated "FV/AC") is a series of dummies distinguishing between securities that are above par (FV/AC > 1), around par, or underwater (FV/AC < 1). We

[39] As described by Reuters: *"SVB (...) launched a \$1.75 billion share sale on Wednesday to shore up its balance sheet. It said in an investor prospectus it needed the proceeds to plug a \$1.8 billion hole caused by the sale of a \$21 billion loss-making bond portfolio consisting mostly of U.S. Treasuries. The portfolio was yielding it an average 1.79% return, far below the current 10-year Treasury yield of around 3.9%."*

typically use bank fixed effects (δ_b) and quarter fixed effects (κ_t), although some specifications feature bank-by-quarter fixed effects and some even CUSIP-by-quarter fixed effects.[40] Finally, in some specifications, we control for the characteristics X_{ct} of a security—specifically its type (agency MBS, Treasury, etc.), whether it has a floating rate or a fixed rate, and its remaining maturity.

We run these regressions on banks' AFS portfolios only, since sales of HTM securities are unusual and involve significant consequences for the bank as discussed earlier. In most specifications, we weight individual CUSIP observations by their amortized cost and cluster standard errors two ways by bank-quarter and CUSIP. In this subsection, we limit the sample to 2022-23; in the next subsection, we extend it to the period since 2015.

We start by providing non-parametric evidence in Figure 9, where CUSIPs are grouped into bins based on FV/AC, and the average sales propensity for each bin is plotted.[41] The binned scatterplots indicate a much higher sales propensity for securities that are trading at or above par than for securities that are underwater — the raw quarterly sales propensity for premium securities is above 8%, while for underwater securities, it is below 2% (panel A). The pattern barely changes when bank-by-quarter fixed effects are added (panel B). When we further control for security characteristics, the level difference is slightly reduced but remains large (panel C).[42]

We next turn to regressions to better quantify the differences in sales propensities and assess their statistical significance. Since the graphical evidence suggests that what mainly matters is whether a security is underwater vs. not (while "how deeply underwater" seems to have little effect), we group CUSIPs into three bins: $\text{FV/AC} < 0.99$ ("underwater"), $\text{FV/AC} \in [0.99, 1.01]$ ("around par"), and $\text{FV/AC} > 1.01$ ("premium"), and define underwater securities the base category in the regressions.

We start with a linear probability model (i.e., OLS), which corresponds to the regression version of Figure 9. Panel A of Table 6 shows the results. In the first column, we include no further controls and equal-weight all individual CUSIP positions. We see that CUSIPs trading around or above par are about 3.5 percentage points more likely to be sold, relative to a baseline quarterly sale probability for underwater securities of 1.5%. Weighting CUSIPs by their amortized cost has little effect on the around-par coefficient

[40]With CUSIP-by-quarter fixed effects, variation in FV/AC across banks reflects different purchase times of the same CUSIP across banks, or whether one bank hedged a given CUSIP while another bank did not.

[41]This figure is constructed following Cattaneo et al. (2024) and using their "binsreg" package.

[42]In Appendix Figure A.11, we also show that the pattern is qualitatively similar for securities that are hedged and those that are unhedged.

but more than doubles the coefficient for premium securities (column 2). For the rest of the analysis, we focus on weighted results, since they better reflect the economic importance of the different securities included in the regression sample. Columns 3-5 indicate that time or bank-by-time fixed effects have little effect on the results, while controlling for security characteristics slightly reduces the coefficient estimates.

Finally, in the last column, we add CUSIP-by-time fixed effects, meaning we compare the sales propensities of the same security in the same quarter across banks for which the FV/AC of the security differs (which could reflect, e.g., different purchase times, or hedging). This substantially reduces the number of observations in the regression but leaves the qualitative conclusion unaffected. Note that this also suggests that the lower sales propensity of underwater securities does not reflect liquidity differences (which are likely minor anyway, as Treasuries and agency MBS markets are generally highly liquid).[43]

In panel B, we repeat the analysis with logit models, where the reported coefficients are odds ratios. In our preferred specification in column 4, the odds of a security being sold are estimated to be 3.3 times higher for a security around par than for an underwater security, and 8.3 times higher for a premium security than an underwater security.[44] The downside of the logit model is that we are more limited in terms of how many fixed effects can be added to the model; therefore, we use only bank and time (rather than bank-by-time) fixed effects. The advantage of the logit, on the other hand, is that effects on probabilities (or odds) are modeled as multiplicative rather than additive, which is arguably easier to interpret and will be particularly helpful in the coming subsections where we use interaction terms. Whenever we use logit models, we report 95% confidence intervals for the estimated odds ratios, rather than standard errors (which are not easily interpreted).

Note that the results in this section remain qualitatively unchanged if we restrict the sample to 2022 only (see columns 3 and 4 in Table A.2). This indicates that the patterns we document are not driven by the banking turmoil of 2023:Q1 or the policy reaction afterwards (which included the Bank Term Funding Program).

[43] As a further robustness check, Table A.2 shows that results are robust if we restrict the sample to Treasuries only, where liquidity differences across CUSIPs are unlikely to be very important.

[44] Recall that odds are defined as the probability of an outcome happening (in this case a security being sold) divided by the probability of the outcome not happening. For low-probability events, the odds are close to the probabilities.

5.2 Are the patterns in 2022-23 unusual?

The analysis above indicates that banks were much more likely to sell securities around par and especially at premium than if they were underwater during the 2022-23 rate hike period. Does this pattern always hold? To test this, we use the full Y-14Q sample starting in 2015. We use the same logit regressions as above but now further interact the dummies for a security being around par or at a premium with a dummy for an observation being in the period since 2022:Q1. Interaction terms different from one would indicate that the pattern in 2022-23 changed relative to earlier years.

Results are shown in Table 7. They indicate that in the pre-2022 period, banks were also less likely to sell underwater securities. However, the sale probability is not monotonically increasing in FV/AC, but instead had a tent shape—it is highest for securities around par, then slightly lower for premium securities, and lower still for underwater securities.[45] As a consequence, the interaction terms with the post-2022 dummies are particularly large and significant for the premium securities, which had much higher (relative) odds of being sold in 2022-2023 than in earlier years.

These results suggest that the dominant trading motives may have been different in the 2022-23 period compared to earlier years. In 2022-23, banks seemed to sell with the goal of maximizing their income (similar to the gains trading documented by Ellul et al., 2015 for insurance companies during the global financial crisis). Over the 2012-21 period, instead, the selling pattern is more consistent with a goal of smoothing, rather than maximizing, the income from securities trading. This is reminiscent of evidence on earnings smoothing from the accounting literature (e.g., Barth et al., 2017; Dong and Zhang, 2018), although that literature usually relates gain/loss trading at the bank level to a bank's pre-trading earnings, while our evidence here is comparing different securities within bank.

5.3 What drives strategic trading?

In this section, we attempt to shed light on what is driving the strong "disposition effect" we observe in the 2022-23 period, where banks are much less likely to sell underwater securities ("losers") than securities that are trading around or even above par ("winners").

[45] This is shown graphically in Appendix Figure A.12, which is the equivalent of Figure 9, but using data for the 2015-21 period instead of 2022-23.

We do so by using the cross-section of banks and studying which bank characteristics are associated with a more vs. less pronounced disposition effect.

A first hypothesis we test is whether the disposition effect is strengthened by the regulatory treatment of unrealized losses on AFS securities recorded in AOCI. As discussed in Section 2, for most US banks, AOCI does not affect their regulatory capital, meaning that regulatory capital is shielded from unrealized losses. For such banks, selling an underwater AFS security will directly result in a reduction of regulatory capital. However, this is not the case for banks for which this "AOCI filter" does not apply (primarily the largest banks)—for them, unrealized gains or losses on AFS securities are always incorporated in regulatory capital. A first hypothesis is therefore that the difference in sale probability between securities below par and those at or above par is larger for those banks that do not include AOCI in regulatory capital.

We test this hypothesis in panel A of Table 8. As above, we estimate logit models, but now including only a single dummy for $FV/AC > 0.99$ (close to or above par — "not underwater") in order to simplify the analysis. Column 1 shows that, without including time or bank fixed effects, securities that are not underwater are 4.7 times more likely to be sold than securities that are underwater. In column 2, we then interact the not-underwater dummy with a dummy for those banks that do not include AOCI in capital. The coefficient on the interaction term is estimated to be positive and significant at $p < 0.1$, supporting the hypothesis stated above. In terms of magnitudes, the estimates in column 2 imply that banks that do include AOCI in capital are about 2.9 times more likely to sell a security that is not underwater than to sell a security that is underwater, while for those banks that have the AOCI filter in place, meaning losses only affect regulatory capital once they are realized, the corresponding factor is 7.0 ($= 2.911 * 2.414$).[46]

Columns 3 and 4 show that adding bank and time fixed effects as well as security controls has very little effect on these conclusions.[47] Finally, in column 5 we address a potential confound, namely that banks that have to include AOCI in regulatory capital are also larger, and bank size itself might also be a determinant of the relative unwillingness

[46] The uninteracted coefficient on "AOCI not in capital" of 0.263 indicates that for securities that are underwater (the base category in the regression), banks that include AOCI in capital are almost 4 times (1/0.263) more likely to sell. However, we are more interested in variation in the strength of the asymmetry between underwater and not-underwater securities than in variation in the overall sales propensity, which can also be driven by differences in banks' liquidity needs or other factors.

[47] The uninteracted coefficient on "AOCI not in capital" should no longer be interpreted, since it depends on which bank's fixed effect is omitted from the regression. The other reported coefficients do not depend on this.

to sell losers (e.g. due to different capital or liquidity requirements). To test this, we add the log of bank assets to the regression and also interact it with the not-underwater dummy. This interaction term is not significant, and its addition to the regression makes the interaction coefficient of interest (on FV/AC $> 0.99\times$ AOCI not in capital) larger in magnitude.

Next, we use similar regressions to test additional potential drivers of the disposition effect. One possibility is that banks with relatively little regulatory capital are particularly averse to realizing losses. We test this by interacting the not-underwater dummy with a dummy for whether a bank has a CET1 buffer (relative to its capital requirement) below the median in a given quarter. We simultaneously also control for whether a bank includes AOCI in regulatory capital, since we saw above that this appears to matter.[48] Column 1 of panel B of Table 8 shows that banks with below-median capital buffers indeed directionally display a stronger disposition effect, but the difference is not statistically significant. This could reflect that the banks in our sample were generally well capitalized over this period.

Another possibility is that banks avoid selling underwater securities in order not to have to recognize the losses in their net income. This may be particularly important for banks whose stock is already "under pressure." We use two proxies for this: first, a dummy for those banks that have a price-to-book (PB) ratio below the median in our sample of banks; second, a dummy for whether their recent year-over-year stock return is below median.[49] Column 2 of the table shows that banks with a low PB ratio display a much stronger disposition effect—relative to those with high PB ratios, their relative probability of selling not-underwater rather than underwater securities is estimated to be 4 times higher (significant at $p < 0.01$). Column 3 of the same table shows that if we instead use the most recent one-year return as a way to sort banks, there is no significant difference between above-median and below-median-return banks. Thus, these results suggest that banks' strategic trading behavior may be affected by their (longer-term) valuation in the stock market rather than the recent evolution of their stock price.

The following two columns investigate two variables that can be seen as proxies for liquidity risk. Column (4) shows that banks that hold relatively low central bank reserves

[48] All regressions also include the uninteracted variables that we use for our interaction terms, but we do not report them, in order to keep the table readable.

[49] In both cases, the median is calculated within each quarter, such that we have (almost) the same number of below-median banks in each quarter. Results are qualitatively robust to using an indicator for having a PB ratio below one, or to using an indicator for year-over-year returns below zero.

compared to the size of their securities portfolio are significantly less likely to sell underwater securities. This suggests that banks with high reserves are relatively less averse to selling underwater securities. In contrast, column (5) shows that banks with more uninsured deposits (a proxy for run risk) do not display a stronger asymmetry—directionally, the opposite is the case. Finally, column (6) shows that when we control for all these factors simultaneously, a low PB ratio and the AOCI filter remain significantly positively associated with the strength of the disposition effect.

In sum, the analysis in this section shows that banks vary in terms of how strongly they engage in strategic trading whereby they are more likely to sell winners than losers. Our results suggest that strategic trading is amplified by regulatory accounting that shields capital from unrealized losses, or by a bank being viewed critically in the stock market. These factors appear quite robust to controlling for various other characteristics. Nevertheless, we note that the characteristics we have considered are not randomly assigned and may be correlated with other factors that affect banks' trading behavior.

6 Frictions in hedging

The evidence so far suggests that frictions in trading underwater bonds constrained bank interest-rate and liquidity risk management in 2022-23.[50] In this section, we study whether financial frictions also help explain why banks did not use interest-rate derivatives more actively as an alternative margin to manage interest rate risk. As we have shown, the volume of duration removed by hedging increased only marginally as rates rose, and banks with a high concentration of callable bonds experienced a much larger increase in risk both gross *and* net of hedging.[51]

[50] Anecdotal evidence also supports this interpretation. For example, Abrahams (2024) discusses a recent bond sale by Truist bank, writing that *"On the investor call announcing the sale, Truist Chairman and CEO Bill Rogers highlighted the opportunity to improve the bank's interest rate profile by reducing the duration of the balance sheet. Although reducing interest rate risk was not the only thing motivating Truist, it arguably has become a much more important goal for all banks in the aftermath of the collapse last year of Silicon Valley Bank. Banks have many ways to reduce rate risk, but selling securities with long duration and crystalizing a loss could be painful. Truist's gain from the sale of the insurance broker may have offset a lot of that pain. Absent an offsetting gain, Truist may have hesitated to rebalance."* In this case, Truist was able to realize unrealized losses by offsetting them against the profitable sale of a subsidiary — the article suggests that the bank may have been otherwise unwilling to sell the underwater bonds, leaving it more exposed to interest rate risk.

[51] Aside from the evidence presented above, other research has also established that banks only engage in limited hedging of interest rate risk; see, e.g., McPhail et al. (2023) and Granja et al. (2024).

A simple explanation is that banks did not hedge more because they actively *wanted* to increase the interest rate risk of their bond portfolios, either because of natural hedges with other parts of their balance sheet or distortions that encouraged risk-taking (e.g., deposit insurance, too-big-to-fail). This does not seem like a complete explanation, however, in that it does not easily explain why the change in duration was so heterogeneous across banks and so closely connected to the ex ante composition of bank portfolios, or why banks did in fact significantly reduce the duration of their non-callable bond holdings as interest rates increased — from an average of 4.5 years in 2021 to about 3 years by end-2023.

A potential alternative or complementary explanation, which we investigate below, is that financial frictions contributed to the limited use of derivatives in 2022-23 to offset rising duration. A first source of frictions are the transaction costs and margin requirements of the hedge position itself.[52] A second source arises from the fact that banks typically hedge using "qualified accounting hedges" to avoid generating misleading volatility in net income and capital. Below, we find evidence that banks' interest-rate hedging in 2022-23 was indeed systematically related to the ease of establishing such qualified hedges.

6.1 Background on hedging and hedge accounting

Banks typically hedge duration using qualified accounting hedges, which allow the bank to effectively net out offsetting gains and losses on the hedge position and the underlying securities being hedged. Hedge accounting is important because otherwise the derivatives position would generate significant earnings volatility due to the fact that derivatives are marked-to-market with gains and losses flowing through net income, but securities are not. This mismatch in accounting treatment may lead earnings to be very rate sensitive even if the bank is fully hedged economically against interest rate risk.[53]

[52] Prior research finds that most banks do not use derivatives and that the use of derivatives is strongly positively correlated with bank size, which is interpreted as evidence of fixed costs (Purnanandam, 2007; Granja et al., 2024). As discussed below, even for our sample consisting of the largest and most complex banks, hedging using qualified accounting hedges is positively correlated with bank size, and the median bank in our sample is at a corner solution of zero hedging.

[53] A simple example: imagine a bank has a $1bn Treasury bond portfolio that it hedges fully against interest rate risk using swaps, but this hedge does not have qualified hedge accounting status. Now assume that interest rates fall, generating a $100m appreciation the Treasury portfolio offset by a $100m loss on the derivatives position. The economic value of the bank is unchanged by this event, but the accounting impact would be a loss of $100m, because the derivatives loss flows through net income but the gain on the underlying securities does not. Qualified hedge accounting solves this problem because it allows the bank

Non-qualified hedging will also increase the volatility of regulatory capital for banks that exclude unrealized gains and losses on securities from regulatory capital.

Several criteria must be met in order to elect hedge accounting; e.g., the risk and hedging instrument must be eligible, and the hedging relationship must be "highly effective" (i.e., highly correlated with the hedged risk of the underlying asset over the period of the hedge). The bank must document that the hedge satisfies the relevant criteria and monitor the hedge to ensure that it remains effective over time; this documentation is subject to audit (see PricewaterhouseCoopers, 2024 for details).

Electing hedge accounting is more difficult for assets with embedded call options (such as agency MBS) because the life of the asset is uncertain. Changes to hedge accounting standards in 2017 made it easier to hedge interest rate risk for such assets by allowing the use of "last-of-layer" hedging for the portion of a portfolio of debt securities expected to be outstanding for the designated hedge period; e.g., a bank holding $1bn in agency MBS may be able to elect hedge accounting for a hedge on $300m of the portfolio if it can reasonably establish that at least 30% of the portfolio will be outstanding over the entire duration of the hedge.[54] Even so, last-of-layer hedging adds complexity and limits the proportion of the position that may be hedged for MBS and other callable bonds, which as we have shown make up a large share of bank securities portfolios.

6.2 Evidence

We test whether financial and accounting frictions influenced banks' hedging activity by studying cross-sectional variation in banks' use of qualified accounting hedges. In particular, we consider the following factors:

1. **Asset type.** The administrative and financial costs of electing hedge accounting may vary across security types; in particular, hedging may be more difficult for bonds with embedded options, as discussed above. For our sample, the most important distinction is likely to be whether the costs of hedging are higher for agency MBS than for US Treasuries, given that these two asset types comprise 58% and 30% of aggregate security holdings for our sample, respectively.

to net out offsetting gains/losses on the underlying bond and the derivative.

[54] This treatment is analogous to the structuring of a "planned amortization class" MBS tranche; these securities are structured to be free of prepayment risk by allocating prepayments to other tranches within a collateralized mortgage obligation (Fuster et al., 2023).

2. **Accounting classification.** A further limitation of hedge accounting is that banks are not permitted to hedge interest rate risk on held-to-maturity securities. While many banks had significant AFS portfolios that could be hedged, the inability to hedge HTM bonds may have been a binding constraint for some banks, particularly if not all AFS securities are easy to hedge.

3. **Bank size.** If there are fixed costs associated with establishing a qualified hedging program, we may expect that hedging would be more prevalent among larger banks and that some banks (particularly smaller institutions) may be at a corner solution where they do not use qualified hedges at all.

6.2.1 Security-level analysis

First, panel A of Table 9 estimates security-level regressions to investigate differences in hedging costs across security types. Specifically, we regress the fraction of the security position that is covered by an interest rate hedge on security type dummies as well as, in some specifications, the duration of the bond and bank $\times$ time fixed effects. We restrict the sample for these regressions to AFS securities, given that banks are not permitted to elect hedge accounting for bonds classified as HTM.

Columns 1-3 focus on the 2022-23 period and show consistently that US Treasuries, which are the omitted base category in the regression, are much more likely to be hedged than any of the other major security types. Focusing on column 3, which looks within-portfolio, the intensity of hedging is 29.4pp and 38.5pp lower, respectively, for agency MBS and municipal bonds (the two main types of callable bonds in our sample) compared to Treasuries with the same level of interest rate risk as measured by duration. Corporate, sovereign, and "other" bonds are also less likely to be hedged although the difference is less stark (e.g., hedging intensity is 19pp lower for sovereign bonds). The table also shows, unsurprisingly, that bonds with longer duration are more likely to be hedged.

These differences across security types can also be understood simply by looking at Appendix Table A.3, which reports summary statistics of the use of hedging by security type. Within banks' AFS portfolios, 49.3% of Treasury holdings are hedged against interest rate risk in 2022-23, compared to only 8.6% of agency MBS holdings. (These statistics take into account both complete and partial hedges, and weight each position by amortized cost .)

Columns 4-6 of Table 9 run the same regressions as columns 1-3, but over the period 2015-2021. Interest-rate hedging overall is much less common in this earlier period, and the differences across security types are also less stark. It is, however, quite notable that agency MBS stand out as being associated with lower hedging activity compared to any other security type; this is no longer the case in 2022-23, even though agency MBS hedging activity remains low. This difference suggests that changes in hedge accounting standards in 2017 to allow for "last-of-layer" hedging did indeed reduce frictions in hedging risk for agency MBS.

6.2.2 Bank-level analysis

Next, we consider the intensity of hedging at the bank level. Even if there are constraints on hedging individual bonds (e.g., HTM securities cannot be hedged and MBS are more difficult to hedge than Treasuries), these constraints may not be binding if other bonds can be hedged instead.

Before turning to regression analysis, we calculate some simple but revealing statistics at the bank level in 2022-23. First, consistent with the role of fixed costs, we find that there is a mass of banks with zero qualified hedging activity — hedging is zero in 52% of observations. Furthermore, the decision to engage or not engage in hedging is very persistent. For a bank that did not hedge at time t, the probability that the bank hedged at no point in 2022-23 exceeds 95%.

Second, among banks that do hedge, we calculate the fraction of observations in which the bank hedges all or almost all of the interest rate risk in its AFS Treasury portfolio. This is the part of the portfolio that is most straightforward to hedge based on our earlier discussion and bond-level results. We find that in the top quartile of active hedgers, the bank hedges 88% of the AFS Treasury duration, and in the top decile, hedges 98% or more of the duration. This indicates that a subset of banks are indeed "maxing out" their Treasury hedging activity.

Turning to regression analysis, panel B of Table 9 studies the intensity of hedging at the bank level in 2022-23, measured by the duration removed by hedging (in years).[55] We consider four specifications varying by whether or not the model controls for two bank

[55]Specifically, we measure the difference between the gross duration of the bank's securities portfolio in quarter t and the duration net of hedging.

characteristics (log size and an "AOCI in capital" dummy), and whether time fixed effects are included.

We find several results consistent with the view that financial and accounting frictions matter for banks' overall hedging activity. First, hedging intensity is negatively related to the share of bonds classified as HTM. This matches our bond-level results and is consistent with the view that the inability to elect hedge accounting for HTM bonds was a binding constraint on hedging activity at least for some banks. Second, hedging activity is positively (although not significantly) associated with the share of US Treasuries in the bank's portfolio, which by revealed preference appear to be easier to hedge based on the bond-level analysis in panel A. Third, the intensity of hedging is strongly increasing in bank size, consistent with the presence of fixed costs of hedging. Fourth, hedging activity is higher for banks that include unrealized gains and losses in regulatory capital, consistent with our earlier evidence that banks care about minimizing regulatory capital volatility. All our specifications control for the pre-hedging duration of the bank's portfolio, which is also generally positively related to the intensity of hedging.

6.3 Summary

Our results suggest that financial frictions contributed to the limited use of qualified hedges to offset rising bond duration. Many institutions are persistently at a corner solution of zero hedging; this is particularly true for smaller banks, consistent with the presence of fixed costs. The costs of hedging appear to be much lower for Treasury bonds than other types of securities, and bonds classified as HTM (which typically have significantly longer duration, as we show in the following section) may not make use of hedge accounting at all. These constraints are correlated with the intensity of hedging suggesting that they are binding at least for some banks. Also consistent with this interpretation, a subset of banks hedge effectively all the duration out of their AFS Treasury portfolio.

Many of our results line up with other analyses of bank hedging of interest rate risk (Purnanandam, 2007; McPhail et al., 2023; Granja et al., 2024; Greenwald et al., 2024); for example, the finding that hedging activity is concentrated among the largest banks is very consistent across studies and datasets. However, we reach a different conclusion to Granja et al. (2024) in terms of whether frictions limited hedging activity at least for some banks. Granja et al. calculate that banks had significant "headroom" to increase AFS hedging further and do not find a correlation between the percentage of HTM bonds and hedging activity. The two main differences between our calculations are that 1) we are able to identify the duration of each bond — typically banks do not hedge short-duration bonds, and so simply counting the face value of unhedged securities overstates the amount of interest rate risk that could be hedged; and 2) we are able to link each hedge to the underlying security and show that the costs of hedging vary significantly across security types, a point not previously established in the literature to our knowledge.

7 Bond classification

As we discuss in Section 4, an alternative margin that *was* widely used by banks to manage risk in recent years was to classify a larger share of bonds as HTM rather than AFS. Such reclassification does not reduce the economic risk of the bank's asset portfolio, but does reduce the exposure of regulatory capital to interest rate risk for most banks, and may also make unrealized losses less salient because they are not reported on the bank's balance sheet. In this section, we extend prior work by studying the determinants of which bonds are classified as HTM, and in particular, whether banks are more likely to classify risky but "hard to hedge" bonds as HTM.

Table 10 estimates security-level regressions to better understand what drives banks to classify bonds as HTM. The table separately considers 2022-23 in columns 1-3 and the earlier 2015-21 period in columns 4-6. There are two main findings. First, the table shows that bonds with more interest rate risk are more likely to be classified as HTM—this is true regardless of whether we condition on security type dummies and whether or not we restrict to "within-portfolio" variation by conditioning on bank $\times$ time fixed effects. The relationship between duration and HTM classification becomes more pronounced in 2022-23—an additional year of duration increases the probability of HTM classification by 3.6 percentage points (about 8% of the mean), while over 2015-21 the corresponding effect was 1pp (4% of the mean). Second, the bonds we previously showed are "hard to hedge"—most importantly agency MBS but also municipal bonds—are significantly more likely to be classified as HTM. This is true unconditionally but also conditional on the level of interest rate risk in the security and when restricting to within-bank variation—e.g., agency MBS are about 30 percentage points more likely to be classified as HTM than Treasury bonds, a difference that is very consistent across columns 1-3.

From a financial stability perspective, these results suggest that banks employ the

HTM classification as a substitute for hedging. While these two responses are both effective in reducing the volatility of regulatory capital and book equity, they are, of course, not equivalent in terms of the actual level of interest rate risk borne by the bank. More generally, our interpretation is that frictions in managing securities portfolio risk contributed significantly to the disconnect between the rising interest rate risk of bank portfolios and the falling portion of this risk which is recognized in regulatory capital.

8 Conclusions

The recent shift in the interest rate environment in 2022-23 induced a large increase in interest rate risk in bank securities portfolios, with significant heterogeneity across banks due to the relative concentration of bonds with embedded options. However, we find no evidence that banks most exposed to the shift in rates actively managed their portfolios to reduce portfolio risk as the environment changed, either by selling long-duration bonds or hedging them using qualified accounting hedges. We identify two types of financial and regulatory frictions that limit banks' ability to make adjustments to their portfolio risk and are particularly pronounced in rising-rate environments. First, we find that banks are reluctant to sell interest-sensitive bonds to reduce portfolio duration when doing so involves crystallizing unrealized losses. Second, frictions in establishing qualified accounting hedges affect the extent to which banks use derivatives to hedge interest rate risk. These frictions raise potential financial stability concerns that could in principle be addressed through regulatory and accounting reforms.

References

ABBASSI, P., R. IYER, J.-L. PEYDRÓ, AND F. R. TOUS (2016): "Securities trading by banks and credit supply: Micro-evidence from the crisis," *Journal of Financial Economics*, 121, 569–594.

ABRAHAMS, S. (2024): "Framing the risk of bank sales in MBS," Tech. rep., Santander.

ALAND, J. AND J. J. BURKS (2023): "Why Do Banks Gain and Loss Sell Securities?" Working paper, University of Notre Dame.

BARTH, M. E., J. GOMEZ-BISCARRI, R. KASZNIK, AND G. LÓPEZ-ESPINOSA (2017): "Bank earnings and regulatory capital management using available for sale securities," *Review of Accounting Studies*, 22, 1761–1792.

BARTH, M. E., W. R. LANDSMAN, AND J. M. WAHLEN (1995): "Fair value accounting: Effects on banks' earnings volatility, regulatory capital, and value of contractual cash flows," *Journal of Banking and Finance*, 19, 577–605.

BISCHOF, J., C. LAUX, AND C. LEUZ (2021): "Accounting for financial stability: Bank disclosure and loss recognition in the financial crisis," *Journal of Financial Economics*, 141, 1188–1217.

CATTANEO, M. D., R. K. CRUMP, M. H. FARRELL, AND Y. FENG (2024): "On Binscatter," *American Economic Review*, 114, 1488–1514.

CHIRCOP, J. AND Z. NOVOTNY-FARKAS (2016): "The economic consequences of extending the use of fair value accounting in regulatory capital calculations," *Journal of Accounting and Economics*, 62, 183–203.

CHOI, D. B., P. GOLDSMITH-PINKHAM, AND T. YORULMAZER (2023): "Contagion Effects of the Silicon Valley Bank Run," Working Paper 31772, National Bureau of Economic Research.

CIPRIANI, M., T. M. EISENBACH, AND A. KOVNER (2024): "Tracing Bank Runs in Real Time," Staff Report 1104, Federal Reserve Bank of New York.

DEMARZO, P. M., A. KRISHNAMURTHY, AND S. NAGEL (2024): "Interest Rate Risk in Banking," Working Paper 33308, National Bureau of Economic Research.

DONG, M. AND X.-J. ZHANG (2018): "Selective Trading of Available-for-Sale Securities: Evidence from U.S. Commercial Banks," *European Accounting Review*, 27, 467–493.

DRECHSLER, I., A. SAVOV, AND P. SCHNABL (2017): "The Deposits Channel of Monetary Policy," *Quarterly Journal of Economics*, 132, 1819–1876.

——— (2021): "Banking on Deposits: Maturity Transformation without Interest Rate Risk," *Journal of Finance*, 76, 1091–1143.

DRECHSLER, I., A. SAVOV, P. SCHNABL, AND D. SUPERA (2024): "Monetary Policy and the Mortgage Market," Working paper, presented at Jackson Hole Economic Policy Symposium 2024.

DRECHSLER, I., A. SAVOV, P. SCHNABL, AND O. WANG (2023): "Banking on Uninsured Deposits," Working Paper 31138, National Bureau of Economic Research.

DURSUN-DE NEEF, H. O., S. ONGENA, AND A. SCHANDLBAUER (2023): "Monetary policy, HTM securities, and uninsured deposit withdrawals," Research Paper Series 23-40, Swiss Finance Institute.

ELLUL, A., C. JOTIKASTHIRA, C. T. LUNDBLAD, AND Y. WANG (2015): "Is Historical Cost Accounting a Panacea? Market Stress, Incentive Distortions, and Gains Trading," *Journal of Finance*, 70, 2489–2538.

EMIN, M., C. JAMES, AND T. LI (2024): "Variable Deposit Betas and Bank Interest Rate Risk Exposure," Working paper.

ENGLISH, W. B., S. J. VAN DEN HEUVEL, AND E. ZAKRAJŠEK (2018): "Interest rate risk and bank equity valuations," *Journal of Monetary Economics*, 98, 80–97.

FABOZZI, F. (1988): *Fixed Income Mathematics*, Probus Publishing Company.

FLANNERY, M. J. AND S. M. SORESCU (2023): "Partial Effects of Fed Tightening on U.S. Banks' Capital," Working Paper SSRN 4424139.

FONSECA, J. AND L. LIU (2024): "Mortgage Lock-In, Mobility, and Labor Reallocation," *Journal of Finance*, 79, 3729–3772.

FUSTER, A., D. LUCCA, AND J. VICKERY (2023): "Mortgage-backed securities," in *Research Handbook of Financial Markets*, ed. by R. S. Gürkaynak and J. H. Wright, Edward Elgar Publishing, Chapters, chap. 15, 331–357.

FUSTER, A. AND J. VICKERY (2018): "Regulation and Risk Shuffling in Bank Securities Portfolios," Staff Report No. 851, Federal Reserve Bank of New York.

GLANCY, D., F. IONESCU, E. KLEE, A. KOTIDIS, M. SIEMER, AND A. ZLATE (2024): "The 2023 Banking Turmoil and the Bank Term Funding Program," FEDS paper 2024-045, Board of Governors of the Federal Reserve System.

GOMEZ, M., A. LANDIER, D. SRAER, AND D. THESMAR (2021): "Banks' exposure to interest rate risk and the transmission of monetary policy," *Journal of Monetary Economics*, 117, 543–570.

GRANJA, J., E. X. JIANG, G. MATVOS, T. PISKORSKI, AND A. SERU (2024): "Book Value Risk Management of Banks: Limited Hedging, HTM Accounting, and Rising Interest Rates," Working Paper 32293, National Bureau of Economic Research.

GREENWALD, D., J. KRAINER, AND P. PAUL (2024): "Monetary Transmission Through Bank Securities Portfolios," Working Paper 32449, National Bureau of Economic Research.

GREENWALD, E., S. SCHULHOFER-WOHL, AND J. YOUNGER (2023): "Deposit Convexity, Monetary Policy and Financial Stability," Tech. rep., FRB of Dallas Working Paper.

HAMILTON, D. (2019): "Which Post-Crisis Regulations are Constraining Banks' Market Making? Evidence from Strategic Accounting Classifications," Working Paper SSRN 3050525.

HANSON, S., A. SHLEIFER, J. C. STEIN, AND R. W. VISHNY (2015): "Banks as patient fixed-income investors," *Journal of Financial Economics*, 117, 449–469.

HANSON, S. G., V. IVANSHINA, L. NICOLAE, J. C. STEIN, A. SUNDERAM, AND D. K. TARULLO (2024): "The Evolution of Banking in the 21st Century: Evidence and Regulatory Implications," *Brookings Papers on Economic Activity*.

HANSON, S. G. AND J. C. STEIN (2015): "Monetary policy and long-term real rates," *Journal of Financial Economics*, 115, 429 – 448.

HUIZINGA, H. AND L. LAEVEN (2012): "Bank valuation and accounting discretion during a financial crisis," *Journal of Financial Economics*, 106, 614–634.

JIANG, E. X., G. MATVOS, T. PISKORSKI, AND A. SERU (2023): "Monetary Tightening and U.S. Bank Fragility in 2023: Mark-to-Market Losses and Uninsured Depositor Runs?" Working Paper 31048, National Bureau of Economic Research.

KANG-LANDSBERG, A., S. LUCK, AND M. PLOSSER (2023): "Deposit Betas: Up, Up, and Away?" Liberty street economics, Federal Reserve Bank of New York.

KASHYAP, A. K. AND J. C. STEIN (2000): "What Do A Million Observations on Banks Say About the Transmission of Monetary Policy?" *American Economic Review*, 90, 407–428.

KIM, S., S. KIM, AND S. G. RYAN (2019): "Economic Consequences of the AOCI Filter Removal for Advanced Approaches Banks," *The Accounting Review*, 94, 309–335.

——— (2023): "Banks' Motivations for Designating Securities as Held to Maturity," Working Paper SSRN 4452667.

LAUX, C. AND C. LEUZ (2009): "The crisis of fair-value accounting: Making sense of the recent debate," *Accounting, Organizations and Society*, 34, 826–834.

LITAN, R., M. LOWY, AND L. WHITE (2023): "Bank bosses are hiding $600 billion in unrealized losses to keep their mega bonuses. Here's why portfolio securities should be marked to market," *Fortune*.

MCPHAIL, L., P. SCHNABL, AND B. TUCKMAN (2023): "Do Banks Hedge Using Interest Rate Swaps?" Working Paper 31166, National Bureau of Economic Research.

ORAME, A., R. RAMCHARAN, AND R. ROBATTO (2024): "Macroprudential Regulation, Quantitative Easing, and Bank Lending," Working paper.

PEYDRÓ, J.-L., A. POLO, E. SETTE, AND V. VANASCO (2023): "Risk Mitigating versus Risk Shifting: Evidence from Banks Security Trading in Crises," Working Paper 713, ECGI.

PRICEWATERHOUSECOOPERS (2024): "Derivatives and hedging guide," Tech. rep., PricewaterhouseCoopers.

PURNANANDAM, A. (2007): "Interest rate derivatives at commercial banks: An empirical investigation," *Journal of Monetary Economics*, 54, 1769–1808.

ROSEN, S. AND X. ZHONG (2022): "Securities Portfolio Management in the Banking Sector," Working paper.

SARISOY, C. (2023): "Elevated Option-Implied Interest Rate Volatility and Downside Risks to Economic Activity," Feds note, Federal Reserve Board of Governors.

STULZ, R. M., A. G. TABOADA, AND M. A. VAN DIJK (2022): "Why are Banks' Holdings of Liquid Assets So High?" NBER Working Paper 30340, National Bureau of Economic Research, revised March 2024.

9 Tables and Figures

Table 1: Accounting treatment of investment securities

	available-for-sale (AFS)	**held-to-maturity (HTM)**
Recorded on balance sheet at:	Market value	Amortized cost
Unrealized gains / losses are reflected in:		
Net income?	No	No
Book equity?	Yes, recorded in AOCI	No
Regulatory capital?	Only for largest banks (e.g., >$700bn) + "opt out" banks	No
Realization of gains / losses through sale affects:		
Net income?	Yes	Yes
Book equity?	No	Yes
Regulatory capital?	Yes, except for largest banks + "opt out" banks	Yes
Sale / reclassification permitted by accounting regulations?	Yes	Generally no: "tainting" rule
Interest rate hedges may qualify for hedge accounting?	Yes	No

Notes: AOCI stands for accumulated other comprehensive income. "Opt out" banks are those banks that have opted out from the AOCI filter, and thus include unrealized AFS losses in regulatory capital. For further accounting details, Accounting Standards Codification (ASC) 320-10, issued by the Financial Accounting Standards Board (FASB), provides guidance on the accounting and reporting of investments in equity securities and debt securities.

Table 2: Summary statistics

A. Composition of security types

Asset Class	Nr Observations (000s)	Dollar Share (%)	Observation Share (%)
Agency MBS	1078.9	57.91	70.66
US Treasuries	40.7	30.16	2.71
Municipal Bonds	258.2	3.20	16.91
CLO	18.7	2.98	1.22
Sovereign Bonds	9.8	1.10	0.67
CMBS	22.2	1.07	1.45
Corporate Bonds	38.7	0.83	2.54
Student Loan ABS	11.0	0.79	0.72
Domestic Non-Agency RMBS	27.5	0.57	1.80
Auto ABS	6.2	0.44	0.40
Credit Card ABS	1.7	0.38	0.11
Other ABS	3.9	0.27	0.26
Other	6.4	0.15	0.43
Covered Bonds	0.8	0.10	0.05
Preferred Stock (Equity)	0.1	0.02	0.01
CDO	0.6	0.01	0.04
Foreign RMBS	0.2	0.01	0.01
Mutual Fund	0.0	0.00	0.00
Total	1527	100	100

B. Summary statistics by security type

	Agency MBS	US Treasuries	Municipal Bonds	Corp. Bonds/CLO	Sovereign Bonds	Other	**Total**
Share of Portfolio (%)	57.9	30.2	3.2	3.8	1.1	3.8	100.0
Effective Duration (years)	4.62	3.99	6.57	3.53	2.30	2.68	4.38
	(2.15)	(3.34)	(4.46)	(2.58)	(1.84)	(2.61)	(2.75)
Remaining Maturity (years)	23.90	4.43	16.67	9.07	3.06	21.28	16.95
	(7.95)	(4.12)	(8.06)	(3.61)	(1.98)	(14.75)	(11.54)
Fair Value / Amortized Cost	0.95	0.97	0.98	0.98	0.98	0.98	0.96
	(0.09)	(0.06)	(0.10)	(0.04)	(0.04)	(0.07)	(0.08)
Coupon (%, annual)	2.58	1.31	3.65	2.91	1.43	2.54	2.22
	(0.93)	(0.91)	(1.41)	(2.20)	(1.14)	(1.55)	(1.22)
AFS (%)	48.91	63.66	58.81	45.12	95.96	80.14	55.26
Hedged (%)	3.11	26.25	10.04	1.16	19.76	9.44	10.66
Callable (%)	100.00	1.36	72.07	11.82	0.18	0.50	61.16
Fixed Rate (%)	92.72	99.59	91.65	20.72	84.43	46.12	91.02
Quarterly Sale (%)	1.27	1.39	3.18	2.99	1.28	2.95	1.48

Notes: The table reports summary statistics for different security types. The sample period is 2020:Q1 to 2023:Q4. US Treasuries include Treasury bills, notes, bonds, and also agency debt. In panel A, "Other" is a collective category including cash equivalents, municipal income funds/trusts, commercial paper, collateral trust notes, note purchase agreements, among others. In panel B, all values are weighted by security amortized cost; standard deviations for continuous variables are reported in parentheses. The "Other" column includes CMBS, ABS (student loan, auto, credit card, and other), non-agency RMBS (domestic and foreign), covered bonds, CDOs, preferred stock, mutual funds, and uncategorized securities. Source: FR Y-14Q, Schedule B; IDC.

Table 3: Bank-level determinants of rising interest rate risk

	Gross Duration				Net Duration			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post-2022 × % Callable Bonds	1.690***			1.390***	1.872***			1.669***
	(0.359)			(0.464)	(0.424)			(0.551)
Post-2022 × % HTM		0.773		0.636		0.672		0.409
		(1.041)		(0.888)		(1.053)		(0.913)
Post-2022 × AOCI in capital			-0.716**	-0.300			-0.727**	-0.205
			(0.321)	(0.300)			(0.341)	(0.335)
Fixed effects	Bank, Time	Bank, Time	Bank, Time	Bank, Time	Bank, Time	Bank, Time	Bank, Time	Bank, Time
Cluster	Bank	Bank	Bank	Bank	Bank	Bank	Bank	Bank
Time period	2020-2023	2020-2023	2020-2023	2020-2023	2020-2023	2020-2023	2020-2023	2020-2023
Obs.	496	496	496	496	496	496	496	496
DV average	3.8	3.8	3.8	3.8	3.5	3.5	3.5	3.5

Notes: The table shows estimates of bank × quarter regressions of Gross/Net Duration (in years) defined as the weighted average security duration by its market value at the bank-quarter level on bank characteristics as of 2019:Q4 interacted with a post-2022 dummy equal to one from 2022:Q1 onward. Net duration accounts for security hedges (i.e., duration is zero if the security is hedged). The sample period is 2020:Q1 to 2023:Q4. Bank characteristics: % Callable Bonds: mean 0.64, st.dev. 0.29; % HTM: mean 0.19, st.dev. 0.16; # Banks with AOCI in capital: 11. The sample covers the FR Y-14Q, Schedule B banks. Standard errors (reported in parentheses) are clustered by bank. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. Source: FR Y-14Q, Schedule B; IDC; Call Reports.

Table 4: Bank-level determinants of mark-to-market equity

	(1)	(2)	(3)	(4)	(5)	(6)
Post-2022	-0.0335***	-0.0204***	-0.0194***			
	(0.002)	(0.004)	(0.004)			
Post-2022 × Securities/Assets		-0.0815***	-0.0241	-0.0235	-0.0359	-0.0270
		(0.023)	(0.029)	(0.029)	(0.032)	(0.029)
Post-2022 × MBS/Assets			-0.1156**	-0.1161**	-0.1201**	-0.1160**
			(0.045)	(0.045)	(0.048)	(0.045)
Post-2022 × Deposit Beta					0.0465**	
					(0.020)	
Deposit Expense						-0.0018
						(0.001)
Obs.	2681	2681	2681	2681	2303	2666
Bank FEs	Yes	Yes	Yes	Yes	Yes	Yes
Quarter FEs	No	No	No	Yes	Yes	Yes
DV average	0.100	0.100	0.100	0.100	0.099	0.100
DV Standard Dev	0.036	0.036	0.036	0.036	0.035	0.036

Notes: The table shows estimates of bank × quarter regressions of mark-to-market equity, calculated as (fair value of assets − book value of liabilities)/(fair value of assets) on a post-2022 dummy equal to one from 2022:Q1 onward and the interaction of this dummy with measures of balance sheet composition, namely securities/assets or MBS/assets, measured as of 2019:Q4. The sample period is 2020:Q1 to 2023:Q3. Sample consists of banks for which 10Q/10K are available, collected via S&P Global. Standard deviations: Securities/Assets: 0.15; MBS/Assets: 0.08. Deposit betas in column (5) are from Philipp Schnabl's website and based on Drechsler et al. (2021). Deposit expenses in column (6) are contemporaneous quarterly values calculated from Call Reports. Standard errors (reported in parentheses) are clustered by bank. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 5: Securities portfolio response to positive vs. negative deposit growth

Dependent variable: Δ ln(securities)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δ ln(dep) if > 0	0.246***	0.574***	0.240***	0.554***	0.403***	0.495***	0.415***	0.508***
	(0.020)	(0.125)	(0.022)	(0.134)	(0.006)	(0.046)	(0.006)	(0.049)
Δ ln(dep) if < 0	0.126***	0.091	0.129***	-0.030	0.325***	0.264***	0.277***	0.166***
	(0.024)	(0.085)	(0.028)	(0.096)	(0.008)	(0.039)	(0.008)	(0.046)
Diff: pos-neg	0.120	0.483	0.111	0.584	0.078	0.231	0.137	0.343
p-value	0.001	0.008	0.007	0.002	0.000	0.000	0.000	0.000
LR Diff: pos-neg	0.232	0.454	0.186	0.519	-0.045	0.081	0.054	0.277
p-value	0.001	0.019	0.120	0.011	0.012	0.182	0.009	0.000
Obs.	35200	35200	35160	35160	832725	832725	832542	832542
Weights	No	Yes	No	Yes	No	Yes	No	Yes
Time period	2022-23	2022-23	2022-23	2022-23	1994-2023	1994-2023	1994-2023	1994-2023
Fixed effects	Time	Time	Bank, Time	Bank, Time	Time	Time	Bank, Time	Bank, Time

Notes: Quarterly bank-level regression of Δ ln(securities), defined as the quarterly log change in the value of investment securities measured at amortized cost, on current and lagged quarterly log changes in deposits (up to three lags) split by positive and negative log changes. Sample excludes extreme values likely due to merger events, specifically observations where the absolute value of asset or deposit growth exceeds 25% or the absolute value of securities growth exceeds 50%. Weights for weighted regressions are each bank's share of total system assets at time t. Standard errors (reported in parentheses) are clustered by bank. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. Source: Call Reports.

Table 6: Strategic trading in 2022-23

A. Linear probability model

	(1)	(2)	(3)	(4)	(5)	(6)
FV/AC $\in$ [.99-1.01]	0.034***	0.030***	0.032***	0.030***	0.025***	0.021*
	(0.006)	(0.006)	(0.006)	(0.007)	(0.006)	(0.012)
FV/AC $>$ 1.01	0.035***	0.079***	0.085***	0.077***	0.072***	0.102**
	(0.010)	(0.018)	(0.019)	(0.017)	(0.017)	(0.043)
Obs.	467,728	467,728	467,728	467,728	467,728	69,563
Fixed effects	No	No	Time	Bank x Time	Bank x Time	Bank x Time CUSIP x Time
Controls	No	No	No	No	Yes	No
Weights	No	Yes	Yes	Yes	Yes	Yes
P(sale) for FV/AC $<$ 0.99	.015	.012	.012	.012	.012	.0083

B. Logit

	(1)	(2)	(3)	(4)
FV/AC $\in$ [.99-1.01]	3.650***	3.843***	3.269***	3.329***
	[2.3,5.9]	[2.4,6.2]	[2.0,5.4]	[2.2,5.1]
FV/AC $>$ 1.01	8.425***	9.735***	7.370***	8.340***
	[4.9,14.5]	[5.4,17.5]	[4.0,13.4]	[4.9,14.1]
Obs.	467,728	467,728	467,025	467,025
Fixed effects	No	Time	Bank, Time	Bank, Time
Controls	No	No	No	Yes
Weights	Yes	Yes	Yes	Yes
P(sale) for FV/AC $<$ 0.99	.012	.012	.012	.012

Notes: The table shows estimates of security-level regressions with dependent variable taking the value of one if a security is sold in the next quarter, and zero otherwise. Panel A uses OLS, panel B uses logit models. FV: fair value. AC: amortized cost. The independent variables are dummies for different bins of FV/AC; the omitted category is underwater securities (FV/AC $<$ 0.99). Controls include: security type, floating rate indicator, and remaining maturity (all from IDC/MSCI). In panel A, the coefficients can be interpreted as additive in terms of probabilities; in panel B, the coefficients are reported as odds ratios (i.e., multiplicative effects on odds). The sample period includes potential transactions from 2022:Q1 to 2023:Q4. Standard errors are clustered at the bank-quarter and CUSIP levels and are reported in parentheses in panel A; in panel B, the numbers in square brackets show the 95% confidence interval for the odds ratio. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. Source: FR Y-14Q, Schedule B; IDC; Call Reports.

Table 7: Strategic trading: 2022-23 vs. earlier years

	(1)	(2)	(3)	(4)
FV/AC $\in$ [.99-1.01]	2.936***	2.787***	2.871***	3.009***
	[2.3,3.7]	[2.2,3.5]	[2.3,3.6]	[2.4,3.7]
FV/AC $>$ 1.01	1.837***	1.715***	1.641***	1.684***
	[1.4,2.4]	[1.3,2.2]	[1.3,2.1]	[1.3,2.2]
FV/AC $\in$ [.99-1.01] $\times$ Post-2022	1.243	1.379	1.342	1.334
	[0.7,2.1]	[0.8,2.3]	[0.8,2.3]	[0.8,2.2]
FV/AC $>$ 1.01 $\times$ Post-2022	4.587***	5.677***	5.184***	6.013***
	[2.5,8.4]	[3.0,10.7]	[2.6,10.2]	[3.1,11.5]
Obs.	2,630,483	2,630,483	2,630,483	2,630,483
Fixed effects	No	Time	Bank, Time	Bank, Time
Controls	No	No	No	Yes
Weights	Yes	Yes	Yes	Yes
P(sale) for FV/AC $<$ 0.99	.014	.014	.014	.014

Notes: The table shows estimates of security-level logit regressions with dependent variable taking the value of one if a security is sold in the next quarter, and zero otherwise. FV: fair value. AC: amortized cost. The independent variables are dummies for different bins of FV/AC; the omitted category is underwater securities (FV/AC $<$ 0.99). Post-2022 is an indicator variable equal to one for the period 2022:Q1-2023:Q4 and zero for the period 2015:Q1-2021:Q4. Controls include: security type, floating rate indicator, and remaining maturity (all from IDC/MSCI). The coefficients are reported as odds ratios (i.e., multiplicative effects on odds). The sample period includes potential transactions from 2015:Q1 to 2023:Q4. Standard errors are clustered at the bank-quarter and CUSIP levels; the numbers in square brackets show the 95% confidence interval for the odds ratio. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. Source: FR Y-14Q, Schedule B; IDC; Call Reports.

Table 8: Drivers of strategic trading in 2022-23

A. AOCI filter

	(1)	(2)	(3)	(4)	(5)
FV/AC > 0.99	4.669***	2.911***	4.294***	3.168***	2.565*
	[3.0,7.3]	[1.7,5.0]	[2.9,6.4]	[1.9,5.2]	[0.9,7.1]
AOCI not in capital		0.263***		2.963	0.117
		[0.1,0.6]		[0.2,36.3]	[0.0,4.5]
FV/AC > 0.99 × AOCI not in capital		2.414*		2.366**	2.617*
		[1.0,6.1]		[1.1,5.2]	[1.0,7.1]
Log(Assets)					0.028*
					[0.0,1.1]
FV/AC > 0.99 × Log(Assets)					1.102
					[0.7,1.8]
Obs.	467,728	467,728	467,025	467,025	467,025
Fixed effects	No	No	Bank, Time	Bank, Time	Bank, Time
Controls	No	No	Yes	Yes	Yes
Weights	Yes	Yes	Yes	Yes	Yes
P(sale) for FV/AC < 0.99	.012	.012	.012	.012	.012

B. Other sources of heterogeneity

	(1)	(2)	(3)	(4)	(5)	(6)
FV/AC > 0.99	2.129**	1.727**	4.293***	1.764**	3.672***	2.079*
	[1.1,4.1]	[1.0,2.9]	[1.9,9.8]	[1.1,2.9]	[2.0,6.7]	[0.9,4.6]
FV/AC > 0.99	2.824***	3.765***	2.406**	1.562	2.295**	3.202**
× AOCI not in capital	[1.4,5.8]	[1.8,8.0]	[1.1,5.3]	[0.6,4.1]	[1.0,5.2]	[1.3,8.2]
FV/AC > 0.99	1.610					1.200
× CET1 Buffer < Median	[0.8,3.4]					[0.5,2.8]
FV/AC > 0.99		3.973***				3.182***
× PB Ratio < Median		[1.7,9.1]				[1.5,6.8]
FV/AC > 0.99			0.646			0.529
× YoY Stock Ret < Median			[0.3,1.6]			[0.2,1.4]
FV/AC > 0.99				3.588***		1.975
× Reserves/Securities < Median				[1.4,9.3]		[0.7,5.5]
FV/AC > 0.99					0.750	0.798
× Uninsured Deposits/Deposits > Median					[0.3,1.7]	[0.4,1.8]
Obs.	467,025	467,025	467,025	467,025	467,025	467,025
Fixed effects	Bank, Time	Bank, Time	Bank, Time	Bank, Time	Bank, Time	Bank, Time
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Weights	Yes	Yes	Yes	Yes	Yes	Yes
P(sale) for FV/AC < 0.99	.012	.012	.012	.012	.012	.012

Notes: The table shows estimates of security-level logit regressions with a dependent variable taking the value of one if a security is sold in the next quarter, and zero otherwise. FV: fair value. AC: amortized cost. The omitted category is underwater securities (FV/AC < 0.99). Controls include: security type, floating rate indicator, and remaining maturity (all from IDC/MSCI). The coefficients are reported as odds ratios (i.e., multiplicative effects on odds). The sample period includes potential transactions from 2022:Q1 to 2023:Q4. In Panel A, AOCI not in capital equals one if a bank filters its AOCI from the regulatory capital and zero otherwise. In Panel B, CET1 Buffer is the difference between the available CET1 capital and the bank required CET1 capital in a given quarter. Standard errors are clustered at the bank-quarter and CUSIP levels; the numbers in square brackets show the 95% confidence interval for the odds ratio. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. Source: FR Y-14Q, Schedule B; IDC; Call Reports.

Table 9: Interest rate hedging

A. Security-level

Dependent variable: fraction of position hedged

	2022-2023			2015-2021		
	(1)	(2)	(3)	(4)	(5)	(6)
Agency MBS	-0.375***	-0.419***	-0.294***	-0.238***	-0.230***	-0.211***
	(0.038)	(0.038)	(0.031)	(0.024)	(0.023)	(0.018)
Municipal Bonds	-0.333***	-0.416***	-0.385***	-0.013	-0.025	-0.051
	(0.045)	(0.049)	(0.039)	(0.042)	(0.048)	(0.047)
Corporate/CLO	-0.450***	-0.437***	-0.290***	-0.189***	-0.071***	-0.050***
	(0.038)	(0.037)	(0.027)	(0.026)	(0.027)	(0.019)
Sovereign Bonds	-0.231***	-0.168***	-0.193***	0.065*	0.102***	-0.020
	(0.043)	(0.041)	(0.027)	(0.036)	(0.037)	(0.019)
Other	-0.361***	-0.319***	-0.225***	-0.108***	-0.055**	-0.112***
	(0.044)	(0.044)	(0.033)	(0.029)	(0.028)	(0.020)
Duration [years]		0.034***	0.036***		0.025***	0.026***
		(0.003)	(0.004)		(0.002)	(0.002)
Obs.	472,037	443,645	443,645	2,238,015	2,064,580	2,064,580
Fixed effects	No	No	Bank x Time	No	No	Bank x Time
DV average	.22	.23	.23	.12	.13	.13

B. Bank-level

Dependent variable: duration removed by hedging (years)

	(1)	(2)	(3)	(4)
Duration [years]	0.036**	0.037**	0.010	0.011
	(0.016)	(0.017)	(0.020)	(0.022)
HTM [share of portfolio]	-0.142***	-0.145**	-0.227***	-0.231***
	(0.054)	(0.056)	(0.053)	(0.055)
US Treasury [share of portfolio]	0.082	0.084	0.033	0.032
	(0.063)	(0.064)	(0.056)	(0.056)
AOCI not in capital [0/1]			-0.073***	-0.074***
			(0.028)	(0.028)
Log(Assets)			0.055***	0.055***
			(0.011)	(0.012)
Obs.	263	263	263	263
Fixed effects	No	Time	No	Time
DV average	.13	.13	.13	.13

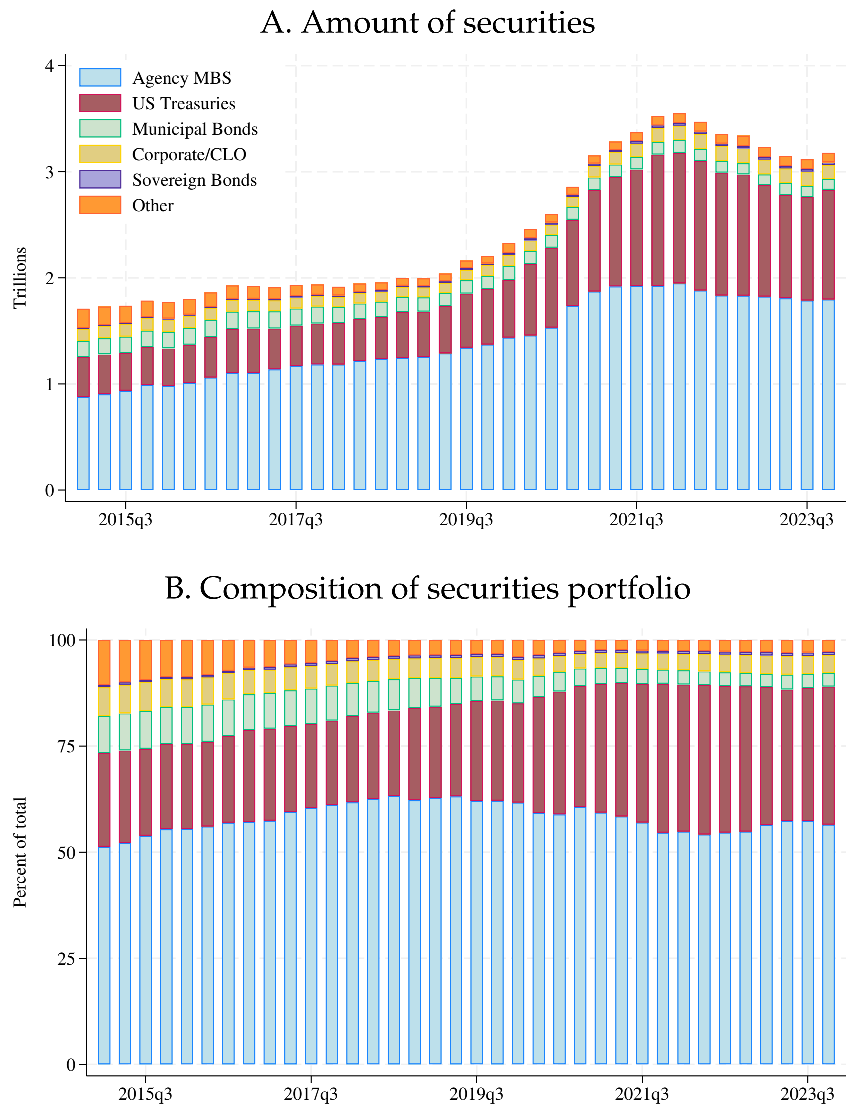
Notes: Panel A shows estimates of OLS regressions with a dependent variable the percent of the security amounts hedged from interest rate risk. Omitted security type category in Panel A is US Treasuries. Sample includes available-for-sale (AFS) securities only. Observations are weighted by amortized costs, and standard errors are clustered by bank-quarter. The dependent variable in Panel B is the difference between gross and net duration measured in years. The sample period in Panel B is from 2022 to 2023, and standard errors (reported in parentheses) are heteroskedasticity-robust. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. Source: FR Y-14Q, Schedule B; IDC; Call Reports.

Table 10: Held-to-maturity classification

	2022-2023			2015-2021		
	(1)	(2)	(3)	(4)	(5)	(6)
Agency MBS	0.318***	0.254***	0.352***	0.167***	0.173***	0.225***
	(0.047)	(0.048)	(0.049)	(0.024)	(0.025)	(0.027)
Municipal Bonds	0.217***	0.142***	0.126**	0.069***	0.093***	0.122***
	(0.041)	(0.051)	(0.056)	(0.021)	(0.024)	(0.028)
Corporate/CLO	0.346***	-0.197***	-0.020	0.067**	-0.084***	-0.003
	(0.036)	(0.034)	(0.050)	(0.033)	(0.022)	(0.028)
Sovereign Bonds	-0.206***	-0.141***	0.014	-0.132***	-0.122***	-0.101***
	(0.029)	(0.036)	(0.046)	(0.014)	(0.014)	(0.023)
Other	-0.026	-0.019	0.208***	0.009	0.013	0.063***
	(0.028)	(0.032)	(0.030)	(0.019)	(0.021)	(0.023)
Duration [years]		0.036***	0.036***		0.010***	0.010***
		(0.004)	(0.004)		(0.002)	(0.001)
Obs.	800,348	758,410	758,410	2,778,844	2,564,030	2,564,030
Fixed effects	No	No	Bank x Time	No	No	Bank x Time
DV average	.46	.45	.45	.25	.26	.26

Notes: The table shows security×quarter regressions with a dependent variable that takes one if a security is designated held-to-maturity (HTM), and zero if it is available-for-sale (AFS). The omitted security type category is US Treasuries. Observations are weighted by amortized costs, and standard errors (reported in parentheses) are clustered at the bank-quarter level. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. Source: FR Y-14Q, Schedule B; IDC; Call Reports.

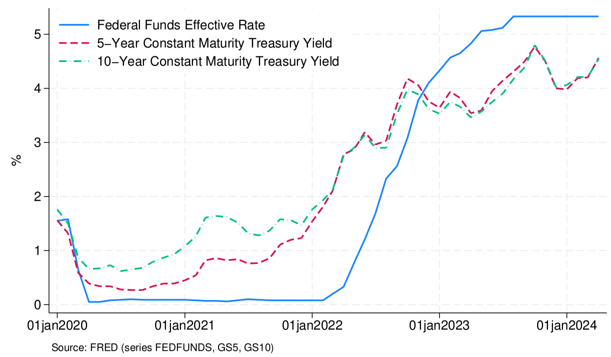
Figure 1: Total security portfolio



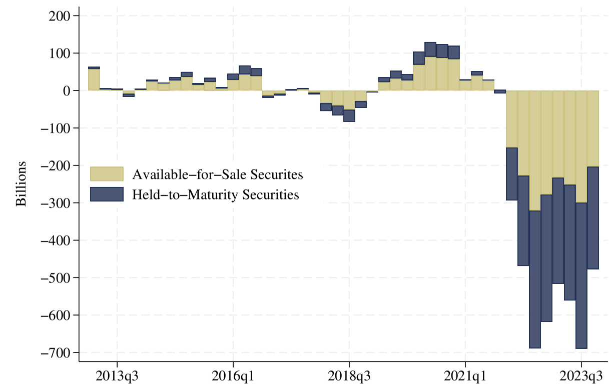
Notes: Total outstanding amounts (amortized cost) of investment securities for banks that report to FR Y-14Q, Schedule B. Based on a balanced panel of banks since 2015:Q1. "Other" includes CMBS, ABS (student loan, auto, credit card), non-agency RMBS (domestic and foreign), covered bonds, CDOs, preferred stock, mutual funds, and uncategorized securities. Source: FR Y-14Q, Schedule B.

Figure 2: The rising rate environment of 2022-2023

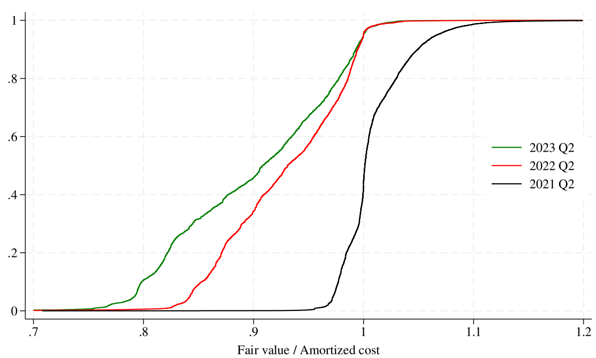
A. US interest rates



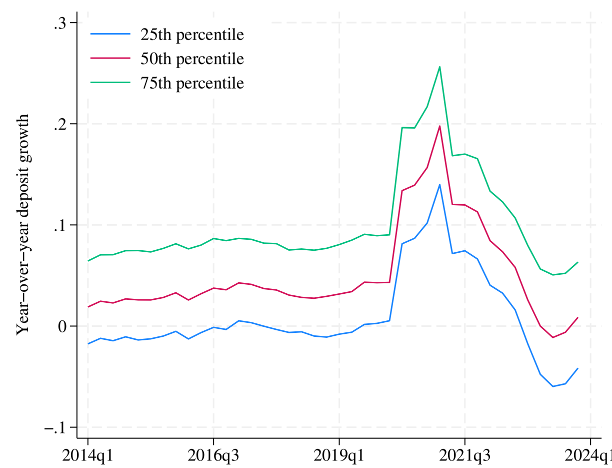
B. Unrealized gains/losses on securities



C. Fair values vs. amortized costs of securities

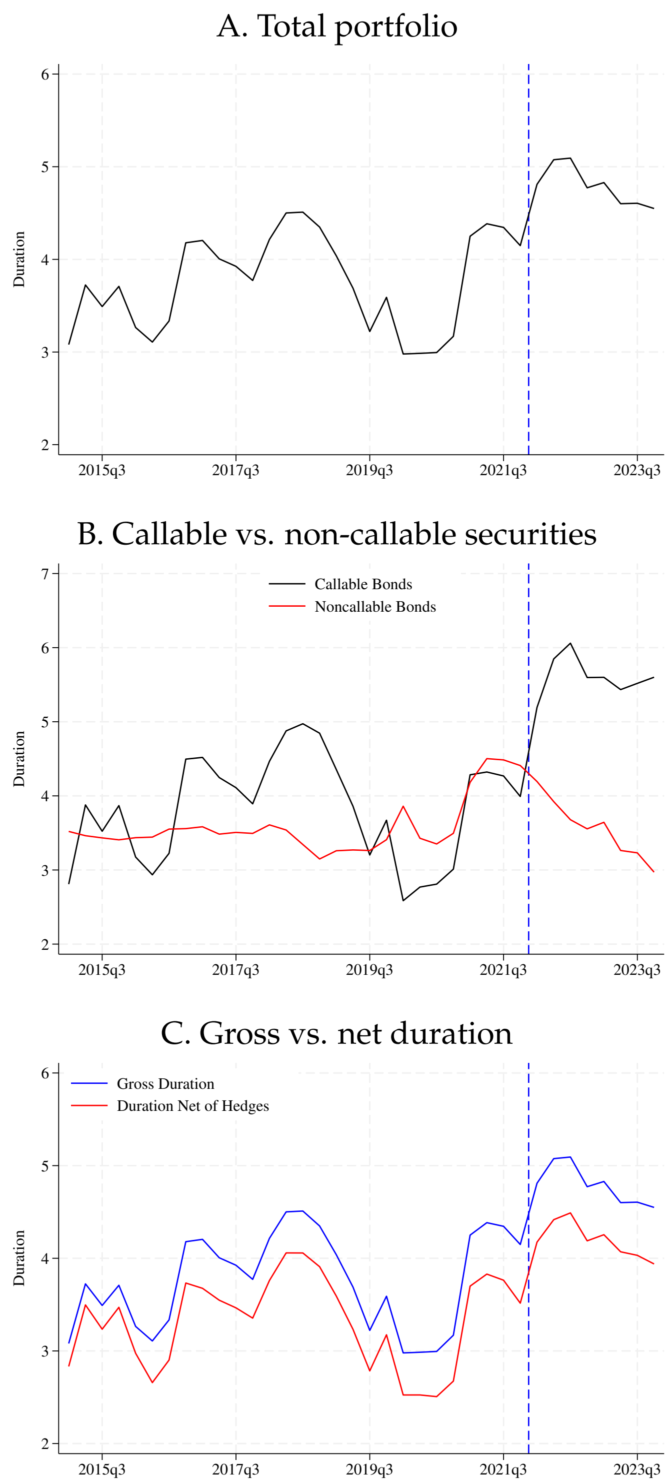


D. Deposit growth



Notes: Sources: Panel A uses FRED (series FEDFUNDS, GS6, GS10). Panel B and D use Call Reports. Panel C uses FR Y-14Q, Schedule B; IDC.

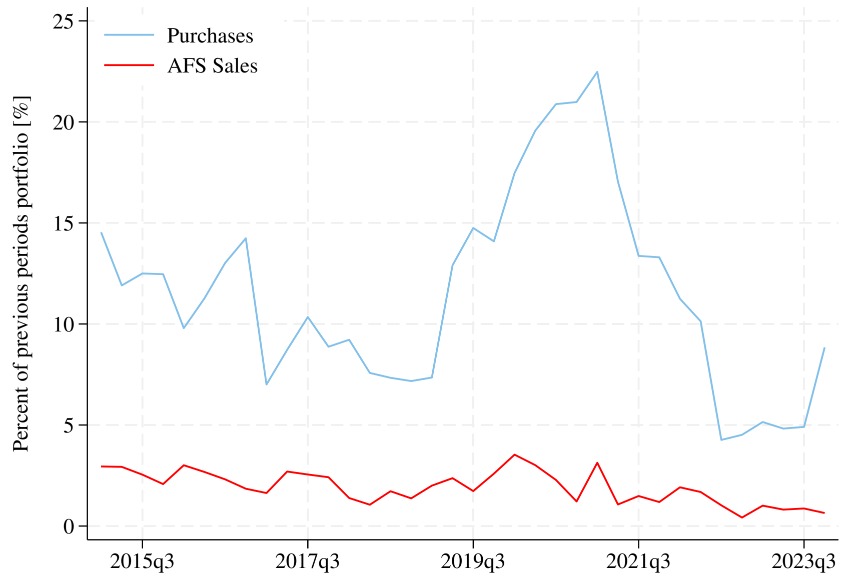
Figure 3: Duration of bank securities portfolios



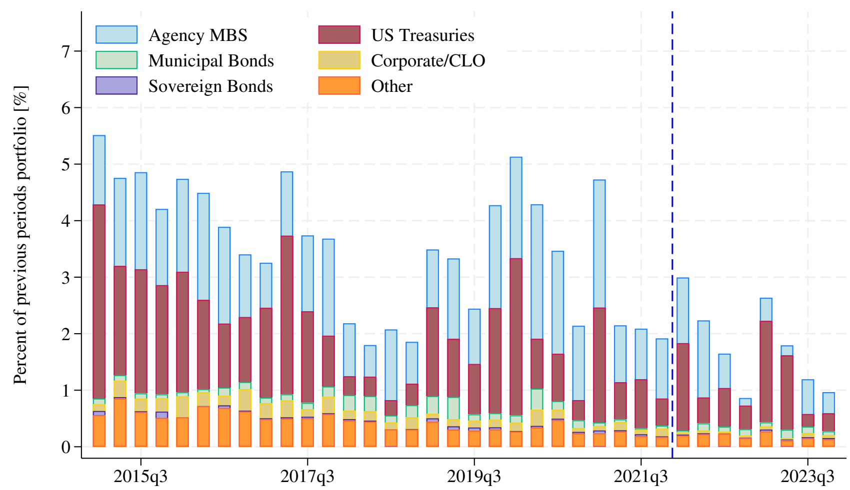
Notes: Panel A shows the weighted average duration in years for all securities (pooled across the AFS and HTM portfolios of all banks in our sample). The weight is the market value of the security. The dashed line indicates the post-2022 period. Panel B splits the sample into callable and non-callable bonds. Panel C shows gross and net duration; the latter reduces the duration proportionally to the percent of hedged security holding. The dashed line indicates 2022:Q1. Source: FR Y-14Q, Schedule B; IDC.

Figure 4: Purchases and sales of securities

A. Purchases and sales (scaled by previous quarter's portfolio size)

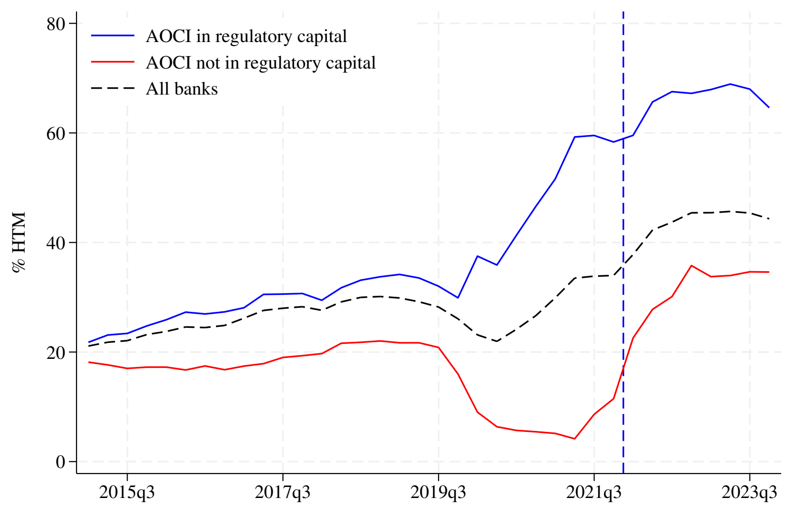


B. Composition of sales



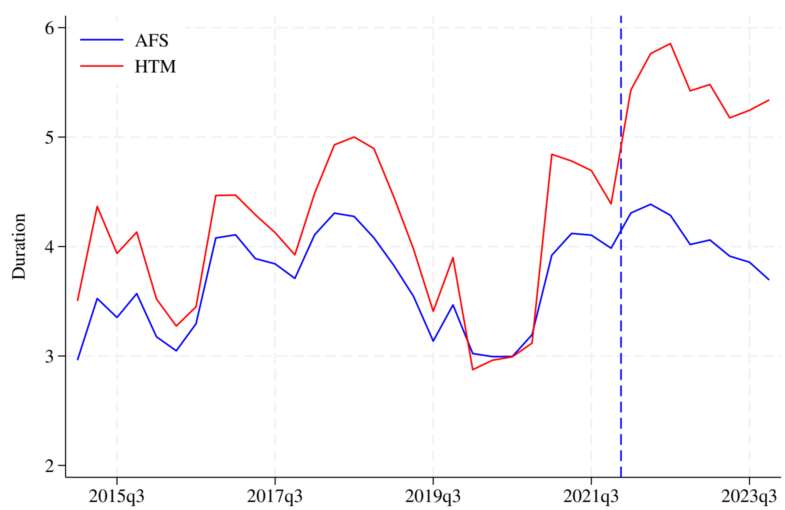
Notes: In Panel A, purchases are defined by the purchase date; securities that disappear from a bank's balance sheet in a given quarter are considered sales together with several other conditions outlined in Section 2.1.2. The dashed line in Panel B indicates 2022:Q1. Source: FR Y-14Q, Schedule B; IDC.

Figure 5: Share of securities classified as HTM



Notes: HTM stands for held-to-maturity securities. AOCI is accumulated other comprehensive income. The dashed line indicates 2022:Q1. Sources: FR Y-14Q, Schedule B; Call Reports.

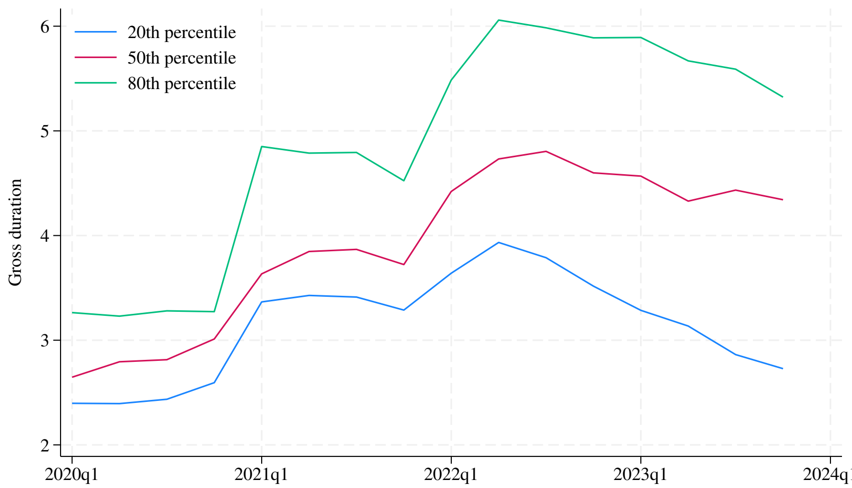
Figure 6: Duration by security classification: AFS vs. HTM



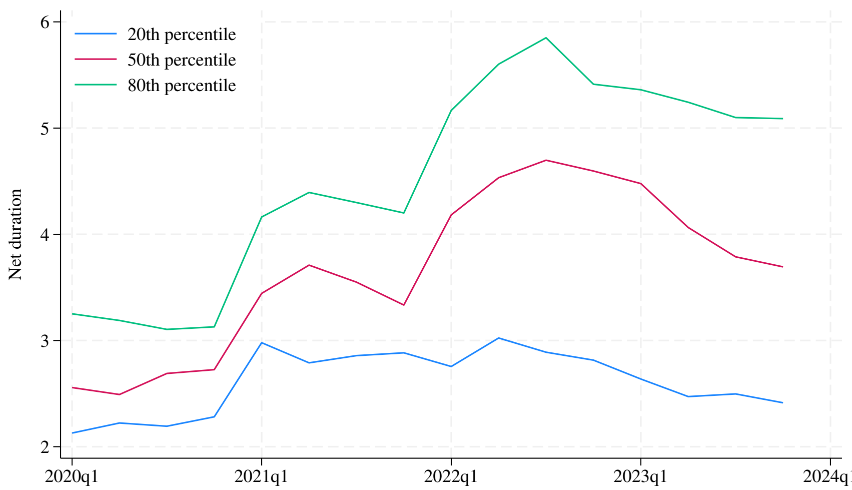
Notes: Duration is in years provided by IDC. HTM stands for held-to-maturity securities; AFS stands for available-for-sale. The dashed line indicates 2022:Q1. Sources: FR Y-14Q, Schedule B; IDC.

Figure 7: Distribution of duration across banks, 2020-2023

A. Gross duration

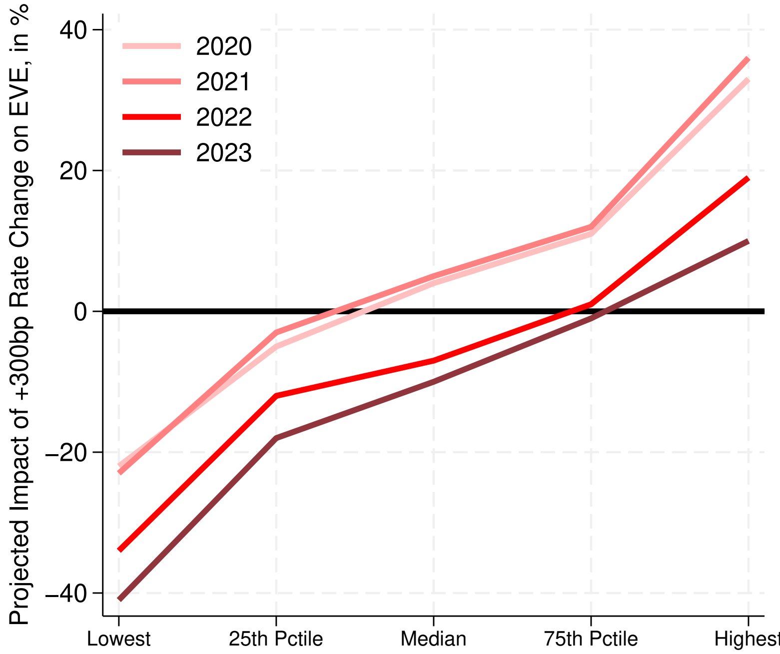


B. Net duration



Notes: Dollar-weighted gross (Panel A) and net duration (Panel B) are first calculated for each bank; next, banks are then equal-weighted to calculate the 20th, 50th and 80th percentile of duration within each quarter. Sources: FR Y-14Q, Schedule B; IDC.

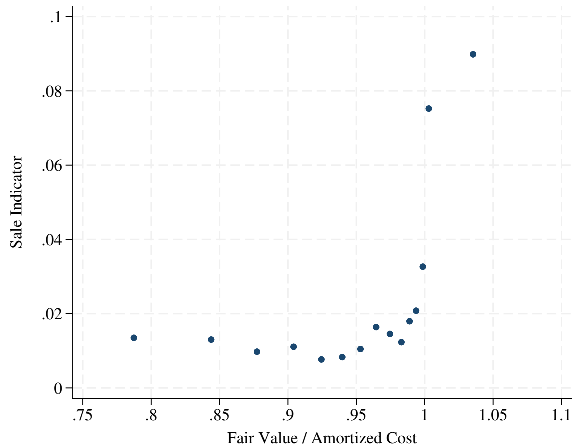
Figure 8: Exposure of banks' economic value of equity to interest rate increases



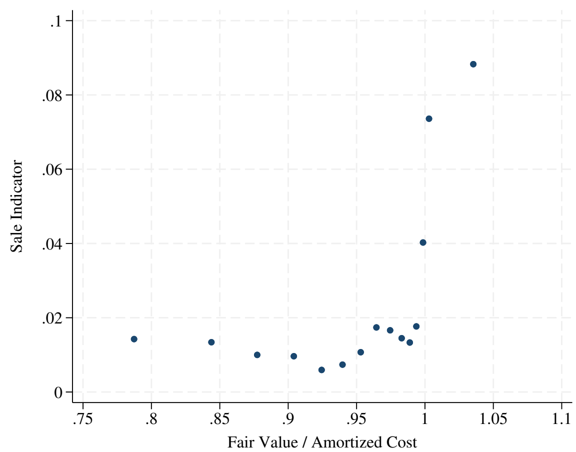
Notes: The graph shows the evolution of the projected impact of a 300 bp parallel upward shift in the yield curve on banks' economic value of equity (EVE). For each year from 2020 to 2023, five points of the impact distribution are shown (as those are the points reported in the source data). Example of how to read the graph: in 2020, the most negatively affected bank was projected to see a 22% reduction in its EVE if interest rates were to increase by 300 bp; in 2023, the corresponding value was a 41% reduction. We report data for the largest disclosed bank category: mid-sized banks with assets above $10bn. Data source: OCC Interest Rate Risk Statistics Report, Spring 2021, 2022, 2023, 2024.

Figure 9: Sales propensities in the cross section of securities in 2022-23

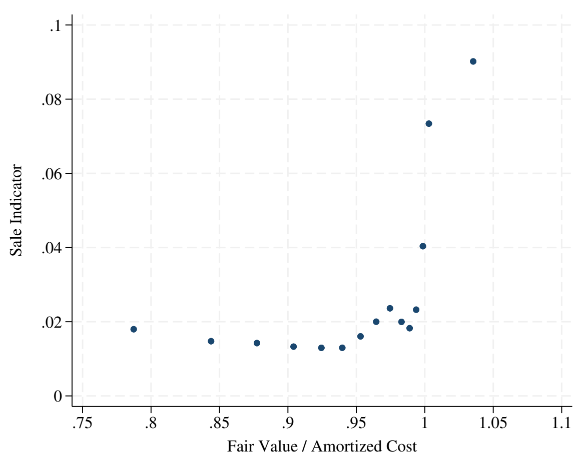
A. Raw data



B. With bank × quarter fixed effects



C. With bank × quarter fixed effects and security controls



Notes: The figure includes only AFS portfolios. Sale indicator equals one if a security is sold over the course of the next quarter. Each observation is weighted by its reported amortized cost. Sources: FR Y-14Q, Schedule B; IDC.

Appendix: Additional figures and tables

Table A.1: Summary statistics: 2015-2023

A. Composition

Asset Class	Nr Observations (000s)	Dollar Share (%)	Observation Share (%)
Agency MBS	2449.5	58.29	68.39
US Treasuries	92.8	26.49	2.63
Municipal Bonds	654.0	4.73	18.26
CLO	40.3	3.20	1.12
CMBS	51.4	1.46	1.43
Sovereign Bonds	17.6	1.08	0.51
Student Loan ABS	25.2	1.06	0.71
Corporate Bonds	110.8	1.05	3.10
Domestic Non-Agency RMBS	81.2	0.83	2.27
Credit Card ABS	4.9	0.53	0.14
Auto ABS	13.0	0.44	0.36
Other ABS	8.5	0.29	0.24
Covered Bonds	2.3	0.21	0.06
Other	10.1	0.14	0.29
Mutual Funds	4.8	0.07	0.14
Foreign RMBS	1.1	0.05	0.03
Preferred Stock (Equity)	0.7	0.03	0.02
CDO	2.0	0.02	0.06
Common Stock (Equity)	9.1	0.01	0.26
Total	3580	100	100

B. Summary statistics by security

	Agency MBS	US Treasuries	Municipal Bonds	CLO/Corporate	Sovereign Bonds	Other	**Total**
Share of Portfolio (%)	58.3	26.5	4.7	4.3	1.1	5.1	100.0
Effective Duration (years)	4.27	3.94	6.74	2.38	2.45	2.51	4.15
	(2.03)	(3.31)	(4.47)	(2.70)	(1.91)	(2.57)	(2.69)
Remaining Maturity (years)	23.99	4.47	17.15	8.75	3.18	20.36	17.54
	(7.66)	(4.22)	(8.25)	(4.12)	(1.97)	(13.59)	(11.31)
Fair Value / Amortized Cost	0.97	0.98	1.00	0.99	0.99	1.00	0.98
	(0.07)	(0.05)	(0.08)	(0.03)	(0.03)	(0.07)	(0.07)
Coupon (%, annual)	2.83	1.45	3.86	2.78	1.71	2.74	2.48
	(0.94)	(0.89)	(1.46)	(2.15)	(1.51)	(1.60)	(1.25)
AFS (%)	55.86	69.54	73.07	65.37	96.84	81.43	62.47
Hedged (%)	2.19	23.00	17.21	4.24	28.65	11.71	9.26
Callable (%)	100.00	1.78	62.74	9.93	0.34	0.53	62.31
Fixed Rate (%)	91.37	99.17	90.84	26.56	84.83	42.85	89.39
Quarterly Sale (%)	1.48	2.21	2.70	3.93	1.75	2.79	1.88

Notes: The sample period is 2015:Q1 to 2023:Q4. In panel B, all values are weighted by amortized cost, and standard deviations for continuous variables are reported in parentheses. The "Other" column includes CMBS, ABS (student loan, auto, credit card, and other), non-agency RMBS (domestic and foreign), covered bonds, CDOs, preferred stock, mutual funds, and uncategorized securities. Source: FR Y-14Q, Schedule B; IDC.

Table A.2: Strategic trading in 2022-23 (robustness checks)

	(1)	(2)	(3)	(4)
FV/AC $\in$ [.99-1.01]	3.127***	2.977**	2.912***	3.198***
	[1.4,6.9]	[1.3,6.9]	[1.6,5.4]	[1.9,5.3]
FV/AC $>$ 1.01	15.642***	17.089***	8.740***	9.590***
	[6.5,37.5]	[6.6,44.1]	[4.6,16.6]	[5.6,16.6]
Obs.	15,919	15,919	251,652	251,277
Fixed effects	No	Time	No	Bank, Time
Controls	No	Yes	No	Yes
Weights	Yes	Yes	Yes	Yes
P(sale) for FV/AC $<$ 0.99	.0087	.0087	.012	.012
Sample	Treasuries	Treasuries	2022:Q1-2022:Q4	2022:Q1-2022:Q4

Notes: The table shows estimates of security-level regressions with dependent variable taking the value of one if a security is sold in the next quarter, and zero otherwise. FV: fair value. AC: amortized cost. The independent variables are dummies for different bins of FV/AC; the omitted category is underwater securities (FV/AC $<$ 0.99). Controls include: security type, floating rate indicator, and remaining maturity (all from IDC/MSCI). The coefficients are reported as odds ratios (i.e., multiplicative effects on odds). Columns (1) and (2) restrict the sample to only US Treasuries/Agencies. Columns (3) and (4) include potential transactions from only 2022:Q1 to 2022:Q4. Standard errors are clustered at the bank-quarter and CUSIP levels; the numbers in square brackets show the 95% confidence interval for the odds ratio. ***, **, and * indicate statistical significance at the 1%, 5% and 10% levels, respectively. Source: FR Y-14Q, Schedule B; IDC; Call Reports.

Table A.3: Interest-rate hedging by security type: 2022-23

A. AFS portfolio

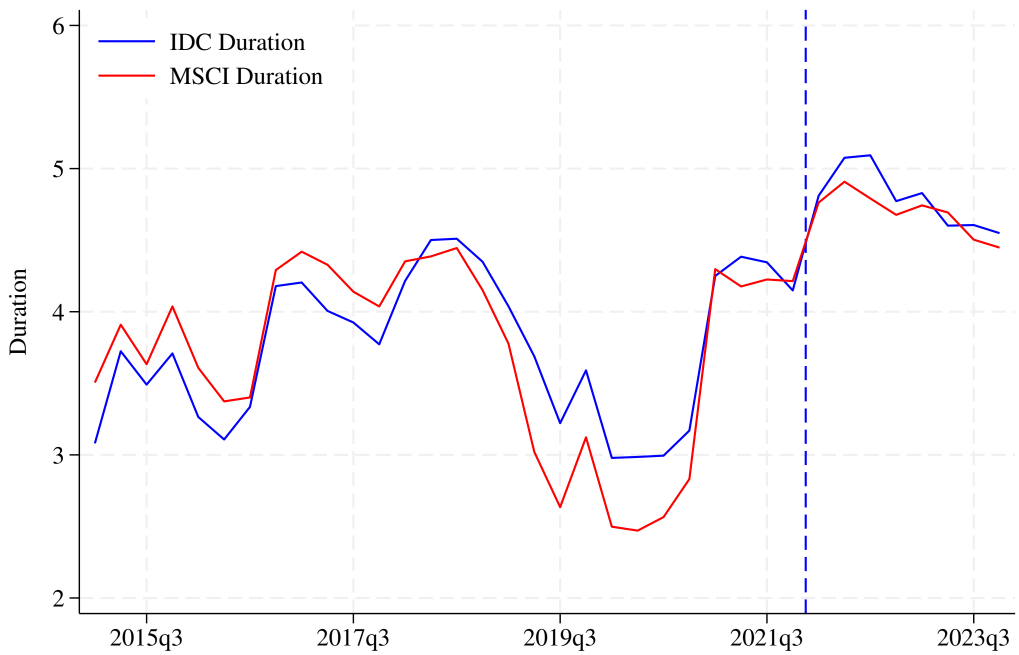
Security type	% Probability of Hedge	% Hedged	% Last-of-layer	% Select CF hedge	% Other FV hedge
Agency MBS	17.4	8.6	4.4	0.9	3.3
US Treasuries	53.7	49.3	0.1	9.0	40.2
Municipal Bonds	19.1	12.6	1.0	4.6	6.9
Corporate/CLO	1.9	1.8	0.0	0.4	1.4
Sovereign Bonds	24.1	23.1	0.0	1.1	22.0
Other	7.9	7.6	0.1	1.4	6.1
Total	30.6	24.5	2.2	4.2	18.2

B. Total portfolio (AFS + HTM)

Security type	% Probability of Hedge	% Hedged	% Last-of-layer	% Select CF hedge	% Other FV hedge
Agency MBS	7.9	3.4	1.7	0.4	1.3
US Treasuries	40.6	27.6	0.1	5.0	22.5
Municipal Bonds	10.0	6.5	0.5	2.4	3.6
Corporate/CLO	1.7	1.6	0.0	0.4	1.2
Sovereign Bonds	22.8	21.7	0.0	1.0	20.7
Other	4.0	3.8	0.1	0.7	3.1
Total	18.3	11.4	1.0	1.9	8.5

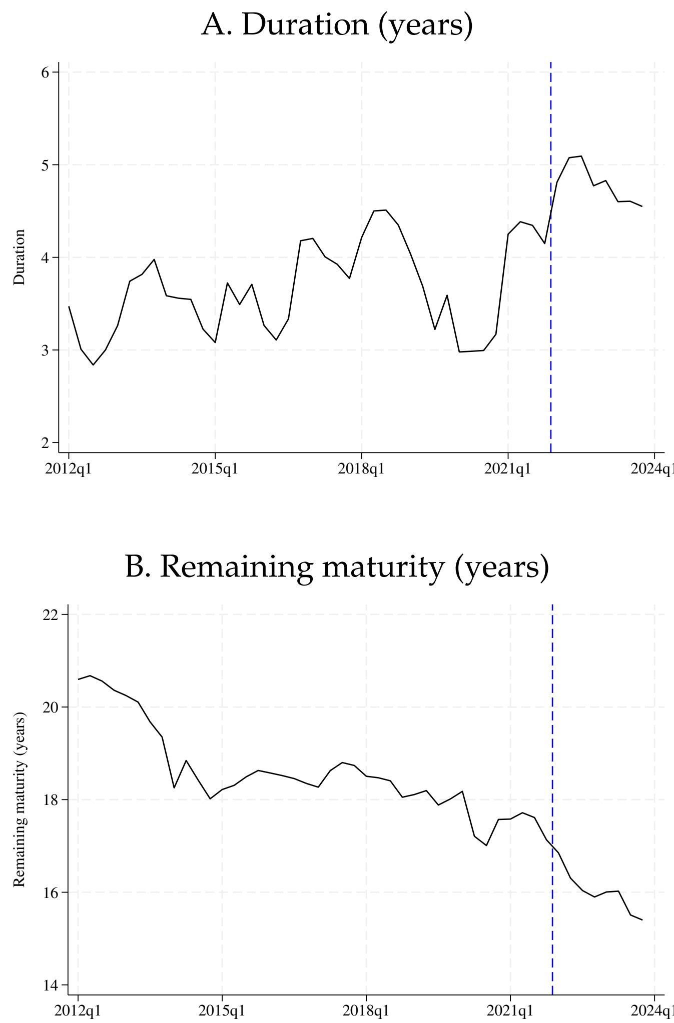
Notes: Summary statistics on the weighted fraction of securities that are hedged against interest rate risk, accounting for both partial and complete hedges. Constructed from FR Y14-Q, Schedule B. Note that banks are not permitted to elect hedge accounting for bonds classified as HTM; as a result, the hedging percentage is zero and therefore not separately reported.

Figure A.1: Validation of duration measure (IDC vs. MSCI)



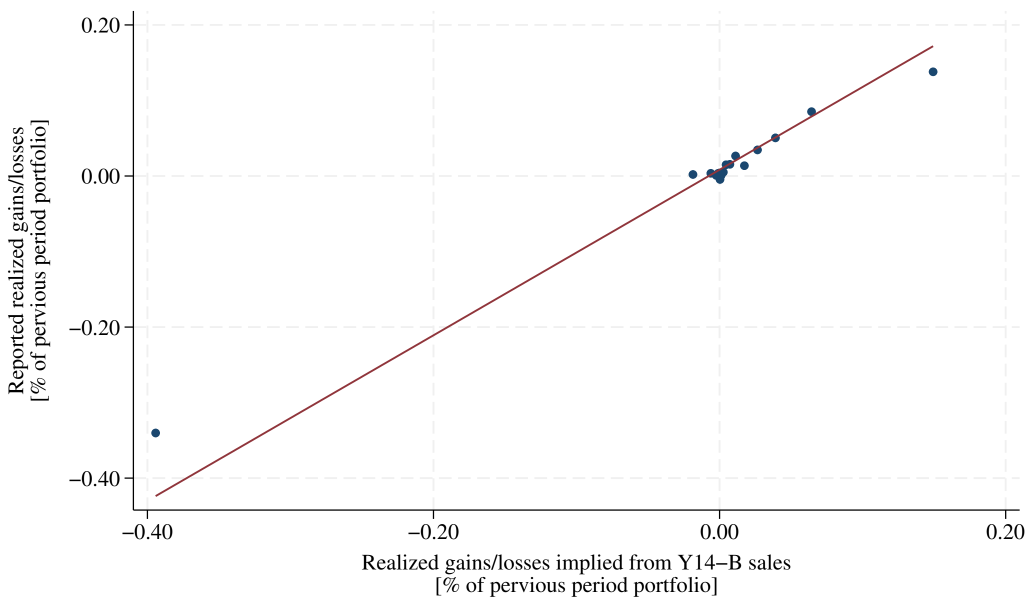
Notes: The graph shows weighted average duration. Each security is weighted by its reported market value. The dashed line indicates 2022:Q1. Source: FR Y-14Q, Schedule B; IDC; MSCI.

Figure A.2: Duration of banks securities portfolios: 2012-2023



Notes: Panel A shows weighted average duration. Panel B shows weighted average remaining maturity. Each security is weighted by its reported market value. The dashed line indicates 2022:Q1. Source: FR Y-14Q, Schedule B; IDC; MSCI.

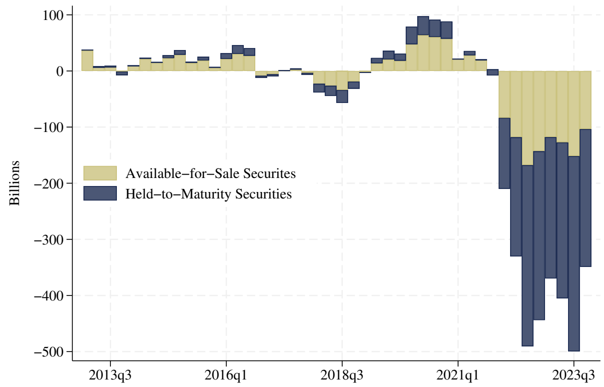
Figure A.3: Validation of sales (Y-9C vs. Y-14Q)



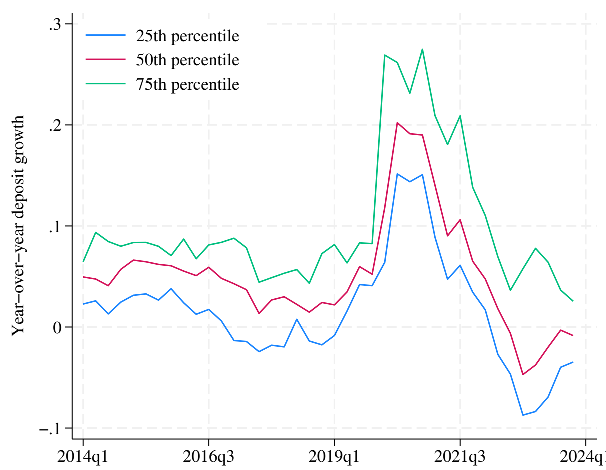
Notes: This is a binscatter using bank-quarter level data from 2015-2023. Source: FR Y-14Q, Schedule B; Call Reports.

Figure A.4: The rising rate environment of 2022-2023 – additional evidence

A. Unrealized gains/losses on securities – Y-14 filers



B. Deposit growth – Y-14 filers



C. Deposit growth – uninsured deposits only (all banks)

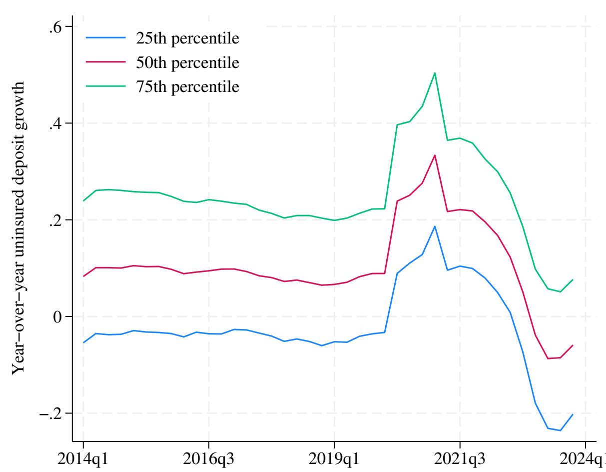
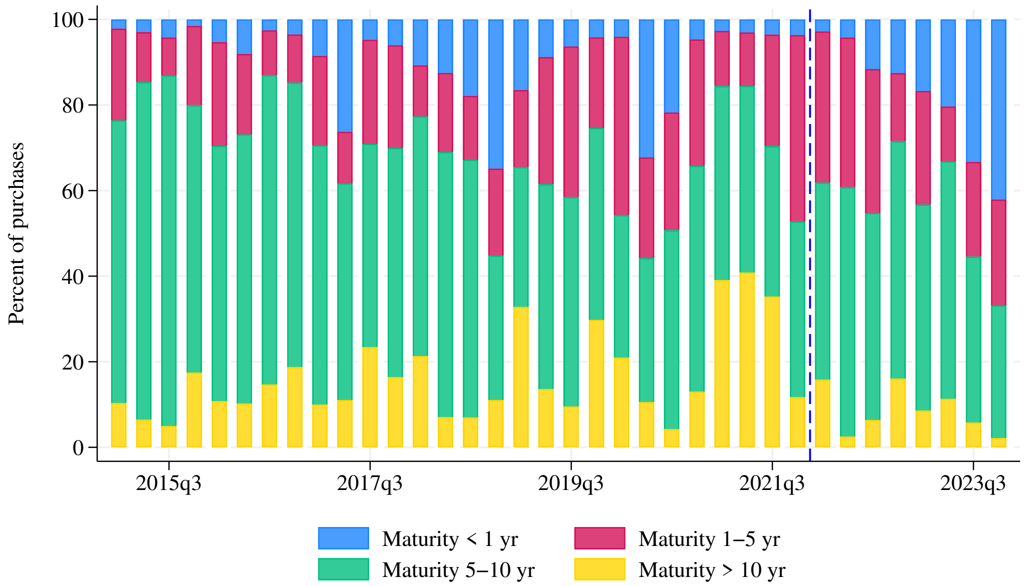


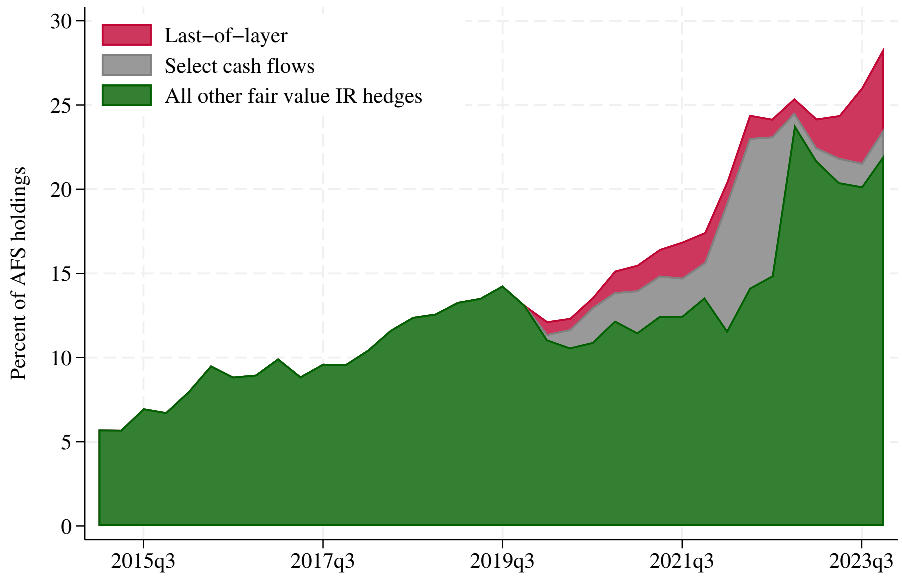
Figure A.5: Maturity of US Treasury purchases



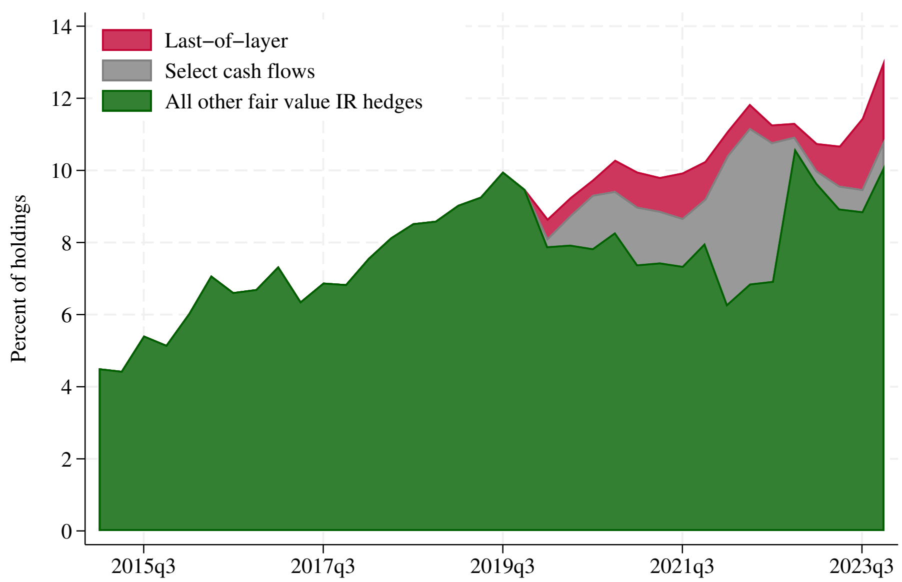
Notes: Weighted-average original maturity of US Treasury purchases, weighted by amortized cost. Source: FR Y-14Q, Schedule B; IDC; MSCI.

Figure A.6: Fraction of securities portfolio hedged against interest rate risk

A. AFS portfolio

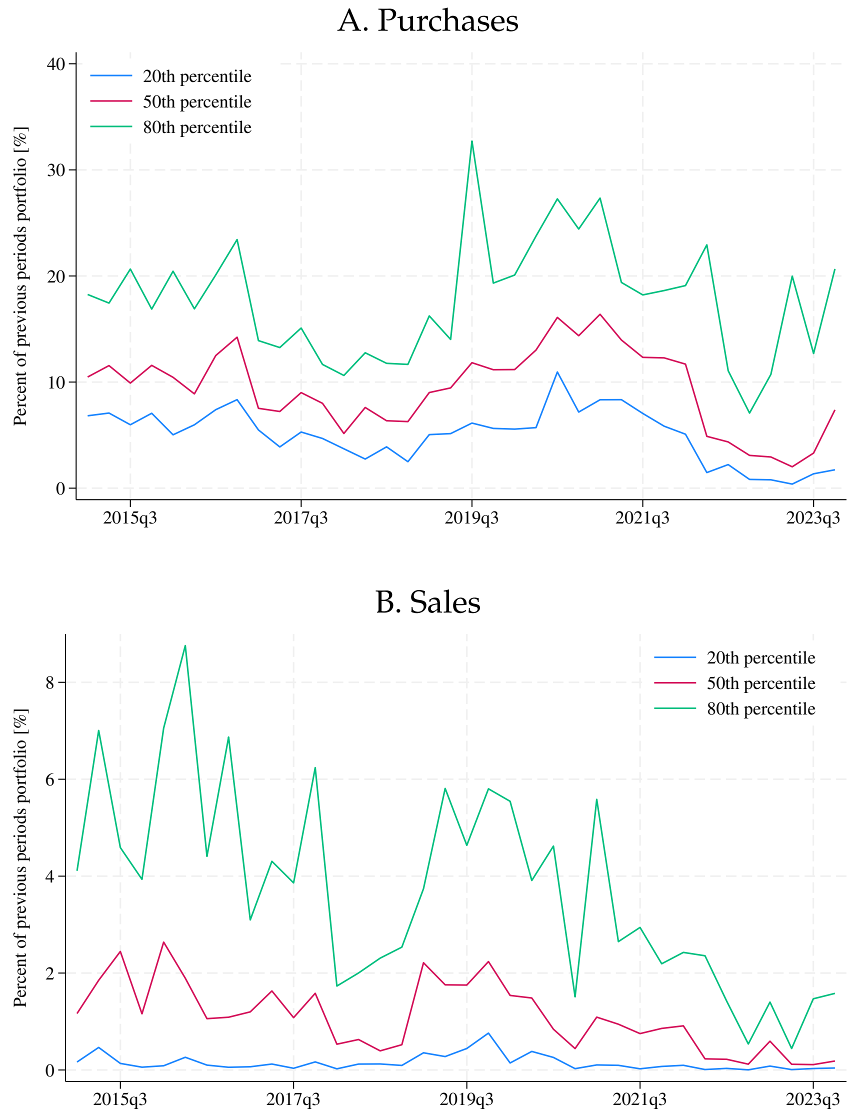


B. Total portfolio (AFS + HTM)



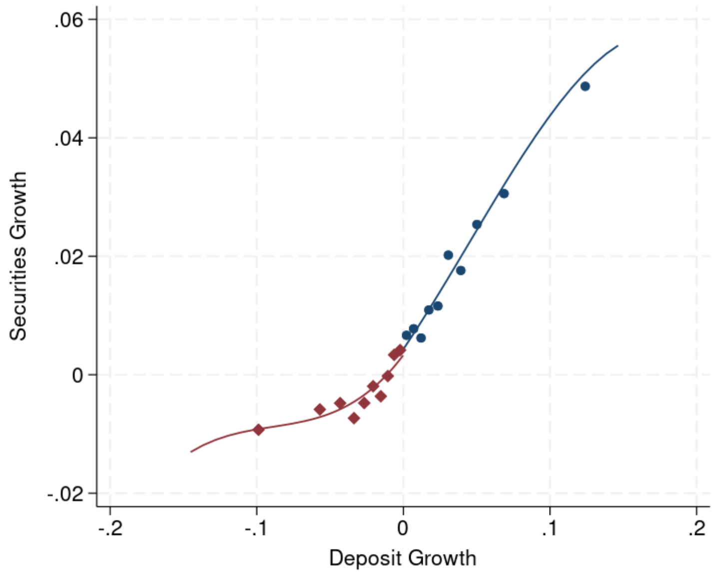
Notes: The graph shows the weighted fraction of securities that are hedged against interest rate risk, accounting for both partial and complete hedges. Split by hedge accounting designation. Source: FR Y14-Q, Schedule B.

Figure A.7: Distribution of purchases and sales across banks



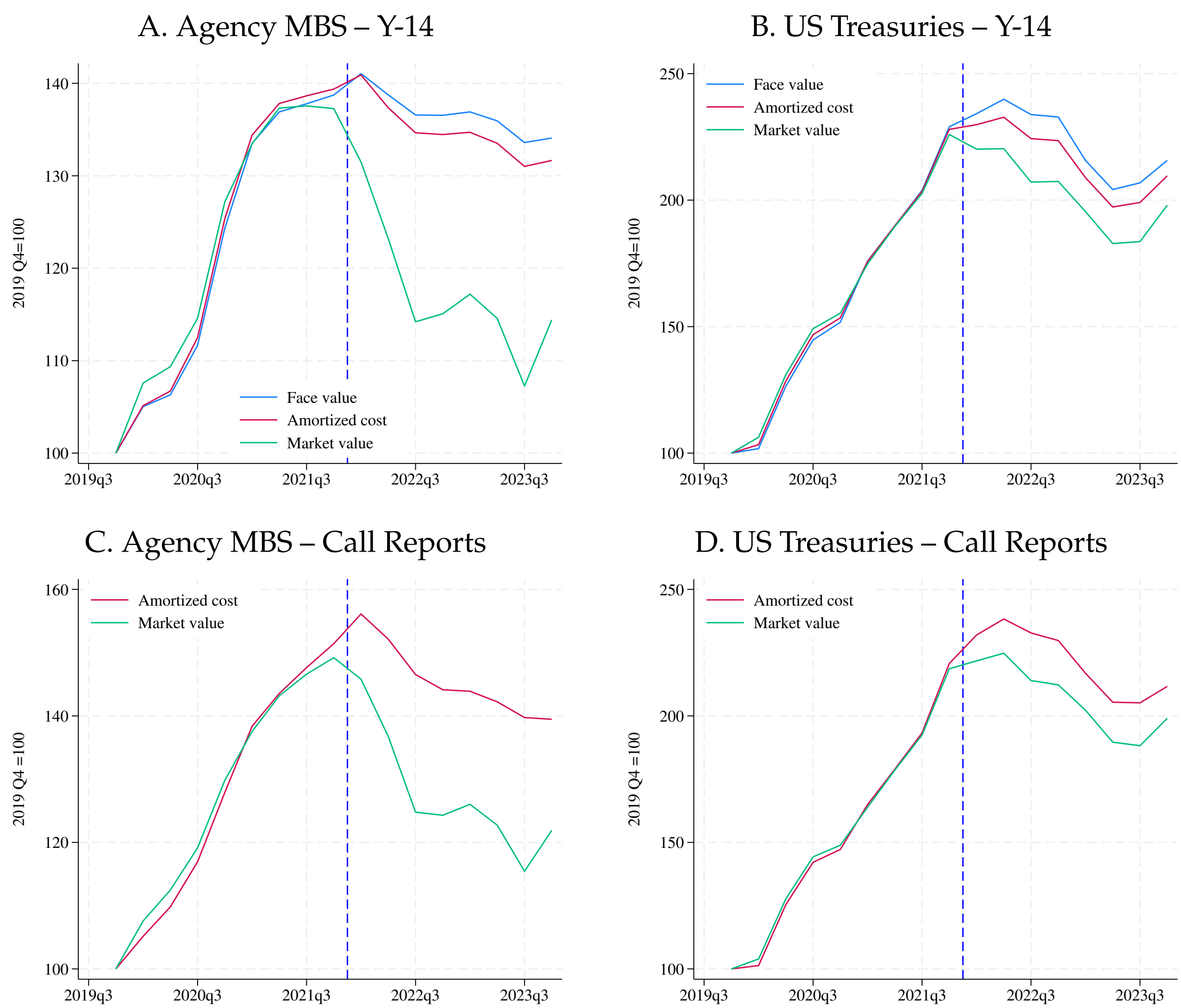
Notes: Purchases (Panel A) and sales (Panel B) are first calculated for each bank, and expressed as a fraction of the previous periods portfolio; next, banks are then equal-weighted to calculate the 20th, 50th and 80th percentile of trading within each quarter. Sources: FR Y-14Q, Schedule B; IDC.

Figure A.8: Deposit growth vs. securities portfolio growth: 2022-23



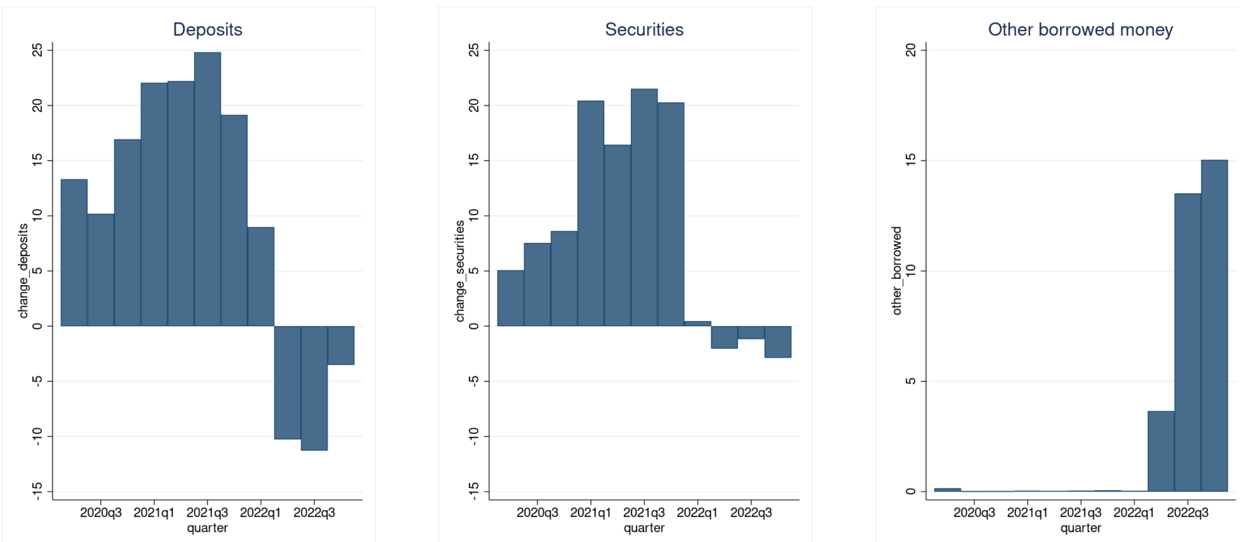
Notes: Binned scatter plot of the quarterly log change in investment securities (measured at amortized cost) against the quarterly log change in deposits. Line of best fit is based on polynomial regressions of order 3 estimated separately for positive and negative values of deposit growth, using the Stata package *binsreg*. Estimated using Call Reports data. Sample period is 2022:Q1 to 2023:Q4.

Figure A.9: The evolution of MBS and Treasury portfolios over 2019-2023



Notes: Figure shows the evolution of banks' total holdings of agency MBS (Panels A and C) and US Treasuries (Panels B and D) based on different measures of holdings. In the Y-14 data, we observe face value, amortized cost, and market (or fair) value; in the Call Reports, face value is not reported. In all panels, a balanced panel of banks since 2019:Q4 is used, and all series are indexed to equal 100 in 2019:Q4. The dashed line indicates 2022:Q1. Source: FR Y-14Q, Schedule B; Call Reports.

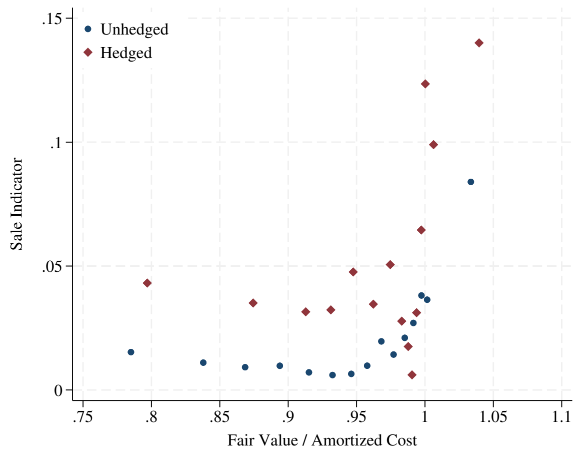
Figure A.10: Silicon Valley Bank did not sell securities even as interest rate risk increased and deposits flowed out



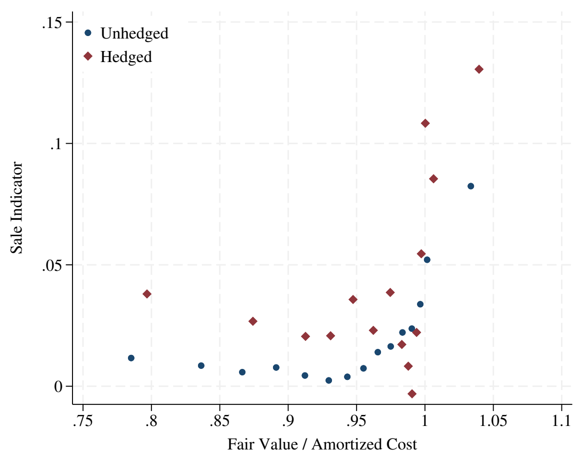
Source: Call Reports.

Figure A.11: Sales propensities in the cross section of unhedged vs. hedged securities in 2022-23

A. With bank × quarter fixed effects and security controls



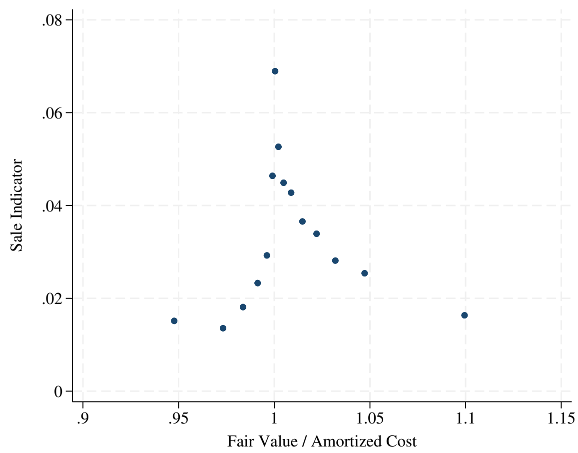
B. With bank × quarter fixed effects and security controls (also control for duration)



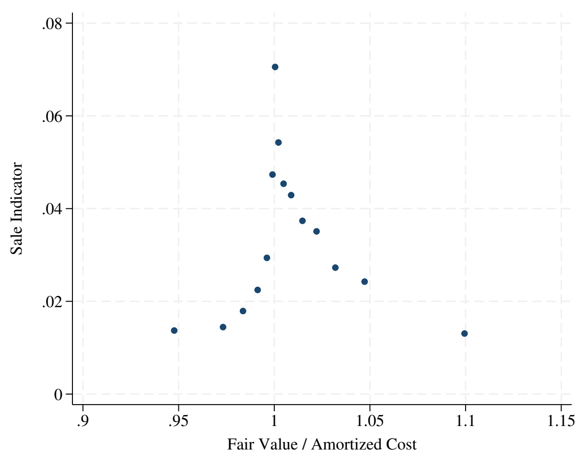
Notes: Sale indicator = 1 if a security is sold over the course of the next quarter. Includes only AFS portfolios; each CUSIP observation is weighted by its reported amortized cost.

Figure A.12: Sales propensities in the cross section of securities in 2015-21

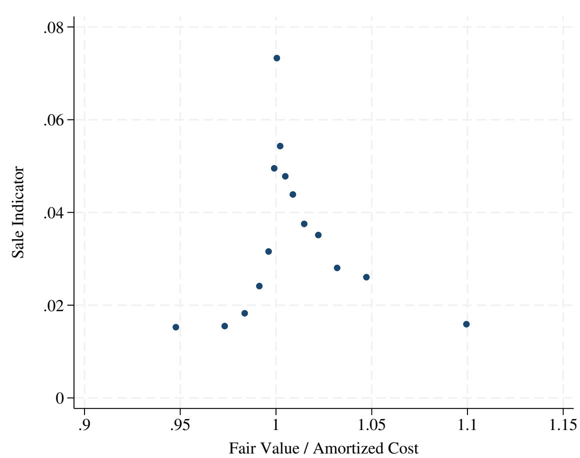
A. Raw data



B. With bank × quarter fixed effects



C. With bank × quarter fixed effects and security controls



Notes: Sale indicator = 1 if a security is sold over the course of the next quarter. Includes only AFS portfolios; each CUSIP observation is weighted by its reported amortized cost.